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National Medical Library Building
Ansari Nagar, Ring Road,
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E-Mail : imsahq@ndf.vsnl.net.in
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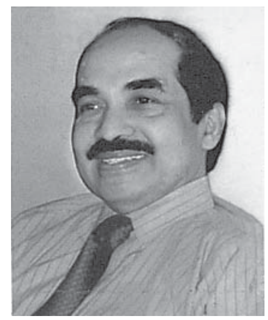
PRESIDENT WRITES

Dear Fellows and Members,



Wish You a Very Happy and productive New Year.

IMSACON 2006 at Lahore, Pakistan was indeed a very memorable event and we look forward to the IMSACON 2007 to be held at Manipal, India.

This issue of the JIMSA highlights "Interventional Radiology". So many conventionally "difficult-to-do" procedures have been successfully managed by Interventional Radiologists. Patient safety, cost of hardware and long-term results must be the key track off, lest technology blindly drives patients care. A galaxy of articles by eminent authors fills the pages of the JIMSA, I am sure that this interesting update will be cherished by all.

Dr. K. Jagadeesan,
President, IMSA

IMSACON 2007 Manipal, Karnataka, India

Annual Conference of International Medical Sciences Academy **IMSACON 2007** will be held on November, 2nd – 4th 2007 at Manipal Karnataka India,

Dr. Padmaraj Hegde is the Organising Secretary.

Theme : "Frontiers of Medicine – Medicine in the 21st Century"

Venue : Hotel Valley View International, Manipal, Karnatak India

Host : Manipal University

Visa: Visa is required for India and must be obtained before Travel. Please allow at least 3 months before conference date for application to be processed.

First information brochure can be seen on the IMSA website "**www.imsaonline.com**". The brochure contains all details about registration fee, registration form, details of hotel stay etc.

Non fellows accompanying the fellows of IMSA are welcome to participate. You are requested to register yourself early and participate with your spouse and enjoy hospitality of the hosts.

Registration Fee	**Before 1st Aug 07**	**1st Aug 07 onwards**
Delegates (India, SARRC, S.E Asia)	Rs. 3000	Rs. 4000
Accompanying Person	Rs. 2500	Rs. 3000
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Post Graduates	Rs. 1,500	Rs. 2,000

In case participants intend to present paper in the Scientific Programme of the conference, they may send "Abstract" of the paper to the Chairman Scientific Programme **Prof. Joseph Thomas, Head of the Dept. Urology, KMC Hospital, Manipal – 576104, drjosephthomas@yahoo.com, ph : 0911-820-2922242**

For details contact :

IMSACON 2007
Conference Secretariat

Dr. Padmaraj Hegde
Orgnaising Secretary IMSACON 2007
KMC Hospital, Manipal, - 576104
Karnataka, India
Ph : 091-820-2922242
E-mail: padmaraj.hegde@manipal.edu

International Medical Sciences Academy
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Dr. H.K. Chopra
Secretary General, IMSA WHQ
2nd Floor, National Medical Library Building
Ring Road, Ansari Nagar, New Delhi
Ph : 26589660, 26588226, Mobile: 9811090204
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imsawhq@imsaonline.com

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FROM EDITOR'S DESK

In this era of exploding knowledge, biotechnology and newer advances in the diagnosis and therapeutic interventions, CME, for the professionals, assume much greater significance. During the last 2 decades, Interventional Radiology has emerged as one of the proud achievements of Medical Science that has benefitted the patients belonging to all the disciplines of medicine. The primarily objective of JIMSA has always been to update a knowledge of the Medical fraternity through special issues and symposia, covering topics of current interest.

This issue on "**Interventional Radiology**" focuses on a number of important subjects related to this topic. I sincerely thank **Col. (Dr.)Chandra Mohan,** *Professor and Senior Adviser Radiodiagnosis and Vascular and Interventional Radiology* for offering his services as a **Guest Editor** of this valuable publication. His keen interest and pains taking efforts in bringing out this very informative issue, deserves all the appreciation. No doubt it has been a commendable task achieved by him. This issue includes wide ranging topics, contributed by a galaxy of eminent experts. I am confident, readers of JIMSA will find this publication of immense benefit and will most certainly like to preserve a copy in their reference libraries. Col. (Dr.) Chander Mohan has really worked hard in the compilation of this exhaustive collection of scientific material; I extend my grateful thanks to him once again and also to all the contributors of this special issue.

I take this opportunity to thank all the members of Editorial and Advisory Boards for their help and also the various pharmaceutical firms and Scientific equipment manufacturers, without whose help this publication would not have been possible.

P. D. Gulati

JIMSA BEST PUBLISHED ARTICLE AWARDS

Journal of International Medical Sciences Academy has instituted award for **three (3)** best original articles published during the previous 3 years; **guidelines** are as below:

(1) **Original articles** belonging to any discipline of medicine published in JIMSA during the previous three years.
(2) Age Limit for the principal author/main researcher should be 45 years and below.
(3) Number of awards: Three (3) annually, carrying a gold plated medal, citation and cash prize (1st Rs. 3000/-, 2nd Rs. 2000/-, 3rd Rs. 1000/-)
(4) Awardee should preferably be a fellow/member of IMSA; non-fellows/ non members can also be considered for the award if the original work is outstanding; and if selected for the award will be required to apply for fellowship/membership of IMSA.
(5) Awardees should preferably plan to receive the award at the annual IMSA conference - IMSACON.

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1. Klemmer PJ.Blood Purif. 2005; 23 Suppl 1:12-9 2. Chertow GM, et al. Kidney Int.2002;62:245-252 3. Chertow GM. J Am Soc Nephrol. 2003;14:S310-S314 4. NKF. Clinical Practice Guidelines for bone metabolism and disease in CKD. Am J Kidney Dis.2003;42(Suppl3):S1-S201 5.Maurizio Gallieni, et al. J Nephrol.2001;14:176-183 6.Bleyer AG, et al.Am J Kidney Dis.1999;33:694-701 7.Collins AJ.Clin Nephrol 2000;54:334-341 8. Rosenbaum DP. Nephrology Dial Transplant. 1997;12:961-964 9. Chertow GM.et al. Am J Nephrol. 2003;23:307-314

OUR GUEST EDITOR

Col. (Dr) Chander Mohan, SM

Colonel (Dr) Chander Mohan is currently Professor & Senior Adviser (Radiodiagnosis and Vascular & Interventional Radiology) in the state of the art, super specialty, & tertiary care prestigious Army Hospital (Research & Referral), Dhaula Kuan, New Delhi. He passed MBBS from University College of Medical Sciences, New Delhi with distinction in 1975. After internship from Safdarjung Hospital, New Delhi, he joined the department of Paediatrics as a junior resident but soon resigned to fulfill his dream to serve the Armed Forces in 1977.Initially, he served in Army Medical Corps as a general duty medical officer in the state of Jammu & Kashmir, Punjab and Rajasthan. In 1984, he completed his post graduation in Radiodiagnosis and Imaging from Armed Forces Medical College, Pune. There after, he served as head of department in various military hospitals at Calcutta, Kirkee, Pune and Srinagar. He has the distinction of serving in four tertiary centers of Armed Forces Medical Services viz, Orthopaedic centre, Cardio-thoracic centre, Tertiary trauma centre and tertiary care super specialty centre. During this period, he underwent six months Post doctoral certificate in Radiodiagnosis Oncology at Tata Memorial Hospital, Mumbai and two years post doctoral training in Vascular & Interventional Radiology at King Edward Memorial Hospital. Later, he also had a short stint in Neurointerventional Radiology at Redcliff Infirmary, Oxford, UK.

Dr Chander Mohan enjoys the distinction of starting & establishing the sub specialty of Vascular & Interventional Radiology in the Armed Forces. He is the senior most Interventional Radiologist in the Armed Forces Medical Services. He is a fellow of Indian College of Radiology & Imaging, International Medical Science Academy and Endovascular Interventional Society of India and Member of National Academy of Medical Sciences, Indian Radiological & Imaging Association, Indian College of Radiology& Imaging, Indian Society of Vascular & Interventional Radiology and Indian Society of Neuro radiology.

Dr Chander Mohan has published more than thirty five scientific papers, delivered over forty five guest lectures and thirty scientific papers in various national & international conferences and has been involved in more than ten research projects. He has contributed four chapters on various topics in books.

Dr Chander Mohan is a post graduate teacher and examiner of various universities for MD (Radiodiagnosis) and Diplomat of National Board Examination He is a member of various expert groups in Defence Medical Services, Defence Research Development Organization, and Ministry of Health & Family Welfare. He has been regularly organizing Continuing Medical Education programmes and live workshops. He has carried out pioneering work on role of computed tomography in penetrating missile injuries. He has one of the largest experiences of bronchial artery embolization in India. He has also been associated with large number of endovascular reconstructions of aortic aneurysms.

He has received number of professional awards, notable one being late Major General LG Latey Memorial Silver Medal. He was awarded for exemplary service during Kargil war. Later, he was decorated with the prestigious Sena Medal for distinguished services by the Hon'ble President of India in the year 2005. He has been elected Dr KM Rai Memorial Orator 2008 by the Indian Radiological & Imaging Association recently.

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EDITORIAL

INTERVENTIONAL RADIOLOGY : CRUISING FROM A GLORIOUS PAST TO A SUCCESSFUL FUTURE

C. Mohan
Department of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India

"... It should be evident that the vascular catheter can be more than a tool for passive means for diagnostic observations: used with imagination it can become an important surgical instrument."
— Charles T. Dotter at Karlovy, Vary, Czechoslovakia, 1963

Interventional Radiology was "born in January 16, 1964, when Charles Dotter percutaneously dilated a tight, localized stenosis of the superficial femoral artery in an 82-year-old woman with painful leg ischemia and gangrene who refused leg amputation" [1]. "Interventional diagnostic Radiology", a term first coined by Dr. Alexander Margulis in 1967 [2], is essentially a Radiology based "patient-care" specialty, focusing on minimally invasive targeted treatments performed under guided imaging.

Since then, Interventional Radiology has offered revolutionary breakthroughs in medical management in a variety of clinical settings and body regions, benefiting numerous patients across the world. By clever, skillful and innovative use of catheters, wires, balloons, coils, glue particles through percutaneous vascular and non vascular access points in the human body, under constant guidance of a variety of radiology and imaging machines like radiography, fluoroscopy, Ultrasonography, CT and rarely MRI, Interventional Radiology has emerged as a valuable specialty, which is much easier on a patient, less expensive than conventional surgery, often allowing successful life-saving operations accessed by simple percutaneous route.

The specialty was shaped in the early to mid-1960s by several pioneers like Forsmann, Sven Ivan Seldinger[3], Dotter [4,5], Gianturco[1]. Their brilliant medical innovations augmented by professional passion, visionary foresight and extremely gifted skills, has truly catalyzed this budding specialty into the pristine form, shape and status it has assumed presently in clinical medical practice. Not surprisingly, by virtue of its significant impact on medical practice and its vital role in patient management "Interventional Radiology today is a medical specialty recognized by the American Board of Medical Specialties and the American Medical Association" in the United States.

In the past few years, a flurry of significant advances has beneficially impacted Interventional Radiology. They include introduction of steerable guidewires; new types of bigger, smaller, stiffer, softer balloons; digital fluoroscopy; newer drugs; better trained radiologists and technologists; and stents and stent-grafts[6]. Consequently today, the procedures done by interventional radiologists are well established and successful, which can be categorized as either vascular or non vascular interventions.

Commonly performed vascular interventions comprise of clot-lysing agents to prevent strokes or heart attacks, opening of clogged arteries in legs or kidneys with balloon angioplasty with or without stent insertion, deployment of stent-grafts for aortic aneurysms, angioplasty and stenting of narrowed and occluded carotid arteries, embolizing blood vessels using occluding materials like coils, gel foam, particles or glue, to stop bleeding or vessels "feeding" a tumor, deploying catheters into large veins for hemodialysis, total parenteral nutrition, cancer treatment or prior to bone-marrow transplantation, "chemoembolization" to treat tumors, treating claudication by balloon angioplasty and/or stenting, dissolving large clots in leg veins with urokinase, and uterine artery embolization for fibroids.

Correspondingly, common non-vascular interventional procedures that are performed include drainage of abdominal, thoracic, neck and pelvic abscesses, inserting feeding gastrostomy tubes, obtaining biopsy tissue percutaneously from almost any organ or tissue in the body, cementing the vertebra by percutaneous vertebroplasty, radiofrequency ablation and cryoablation of tumors, carrying out a transjugular intrahepatic portosystemic shunt in case of chronic liver disease, dilating esophagus and trachea in stenotic lesions and opening of fallopian tubes to treat infertility in females.

While Interventional Radiology is a unique and innovative specialty, few grey areas are present[7,8]. These include a) a constant need for professional training ; b) turf battles and competition from other specialties; c) a growing need for encouraging initial consultation with interventional radiologists; d) incessant evolution and updates of hardware technology; e) challenging legal and professional issues during patient management and f) lack of direct access to

Correspondence : Dr. C. Mohan, M.D.Professor & Senior Adviser Department of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India
e-mail : colcm30@yahoo.com

patients and need for providing total patient care[9]. All these issues are being successfully addressed by experts in Interventional Radiology and by authoritative bodies like Society of Interventional Radiology (SIR), American College of Radiology (ACR) and the American Society of Interventional and Therapeutic NeuroRadiology (ASITN), Indian Society of Vascular and Interventional Radiology (ISVIR), to sustain the desired vision of an exultant future of interventional Radiology[8,9].

To meet this desired vision in reality, strategic initiatives with a series of transitions have been designed by leading experts in Interventional Radiology to propel Interventional Radiology as a speciality per se, towards unprecedented growth from this point in time to the future[8]. The transitions comprises of "*procedure-oriented to clinically oriented practices ; primarily vascular to diverse practice including vascular; part-time practitioners to full-time specialists; secondary referral recipients to primary referral recipients; no public awareness to high public awareness; preventing competition to tough competitor; waits for referrals to practice builder; part of diagnostic radiology to a unique component of radiology; imaging as incidental to the procedure to imaging as a primary tool for diagnosis, consultation, triage, and procedural guidance*"[8].

In time ahead, Interventional Radiology is expected to undergo further metamorphosis, an exciting situation that is highlighted by tremendous advances in hardware like drug eluting stents, laser delivery systems, use of robotic interventional guidance systems. Additionally, significant refinements of catheter based pharmacotherapy, therapeutic angiogenesis and myogenesis, catheter based detection devices of plaque vulnerability and plaque composition and catheter-directed gene therapy are all making inroads from research areas into medical practice. It is further expected that specialized centers for minimally invasive treatment, manned by a team of specialists, spearheaded by interventional radiologists will be the next step in evolution.[11]

In distant future, most human diseases will be understood, studied and treated at a fundamental level of molecules, genetics and cellular functions. It is therefore expected that "image guided" gene therapy will gradually come into practice, such as catheter-directed transarterial gene therapy in patients with colon cancer metastatising to liver or transarterial intrahepatic gene therapy for hemophilia (factor IX deficiency) etc. It is expected that image-guided cancer therapies will flourish with increasing use of embolization, chemoembolization, gene therapy, and direct tumor ablation by means of injection, radio frequency, and real-time MR-guided high intensity focused ultrasound[11].

It is indisputably clear that the Interventional Radiology has grown strongly over the last few decades as a specialty that has enhanced patient management and greatly improved the quality of patients' lives. The ongoing professional momentum and unrelenting technological advances will carry it reassuringly into the future, with a far-reaching and sweeping intensity. Evidently this success story has no end.

As a final point, this special issue has been compiled underscoring a fundamental theme of "a glorious past and a successful future in Interventional Radiology". It focuses on a wide range of interventional applications, as clinically experienced and practiced today in a millennial India. Besides, this issue also highlights few notable features like the "pioneers" who shaped Interventional Radiology in yesteryears as well as few neglected but important issues related to ethical practice. And lastly, on behalf of the editorial team, I express my sincere thanks to all authors who have contributed in abundant measure to make this issue a truly special one.

ACKNOWLEDGMENT :

The guest editor also expresses his special thanks to Maj. Gen. (Dr.) O.P. Mathew, AVSM, SM, Commandant & Director,Army Hospital (Research and Referral),for his whole hearted support & guidance at every stage and Surg.Cdr.(Dr.) IK Indrajit, CT/MRI Specialist, Dept of Radiodiagnosis, Army Hospital (Research and Referral), Delhi Cant for his editorial assistance during preparation of this Special Issue of JIMSA on Interventional Radiology.

REFERENCES

1. *Rösch J,Keller FS,Kaufman JA The Birth, Early Years, and Future of Interventional Radiology J Vasc Interv Radiol 2003; 14:841–853*
2. *Margulis AR. Interventional diagnostic Radiology—a new subspecialty (Editorial). AJR Am J Roentgenol 1967; 99: 761–762.*
3. *Doby T.A Tribute to Sven-Ivar Seldinger 1984 AJR 142:1-3*
4. *Dotter CT. Cardiac catheterization and angiographic techniques of the future. Cesk Radiol 1965; 19:217–236.*
5. *Dotter CT, Judkins MP. Transluminal treatment of atherosclerotic obstructions: description of a new technique and preliminary report of its applications. Circulation 1964; 30:654–670.*
6. *Casarella WJ. Vascular and Interventional Radiology from Oregon to Zurich to Louisville: The Making of a Specialty AJR 2000;174:16–17*
7. *Becker GJ. Interventional Radiology 2000 and beyond: back from the brink. The 1999 Charles T. Dotter Lecture. J Vasc Interv Radiol 1999; 10:681– 687.*
8. *Bakal CW, Darcy MD, Brunner MC. Strategic Initiatives in Interventional Radiology: A New Vision Journal of Vascular and Interventional Radiology 2002;13:559-562*
9. *Kinnison ML, White RI Jr, Auster M, et al. Inpatient admissions for interventional Radiology: philosophy of patient management. Radiology 1985; 154:349–351.*
10. *American College of Radiology. White paper: clinical practice of interventional Radiology and neurointerventional Radiology; March 2003. Available at: http://www.acr.org/dyna/?doc_departments/stand_accred/standards/ir_white_paper.html Accessed on 12 May 2006*
11. *Becker GJ. 2000 RSNA annual oration in diagnostic Radiology: the future of interventional Radiology. Radiology 2001;220:281–292.*

PIONEERS IN INTERVENTIONAL RADIOLOGY

WERNER FORSMANN

Most celebrated self-experimenter who first pioneered cardiac catheterisation in man

- German surgeon
- During surgery training, experimented on human cadaver and realized how easy it was to guide a urological catheter from an arm vein into the right atrium.
- In 1929, at the age of 25, while his training at Eberswalde, a small town near Berlin, he self catheterised his heart
- He inserted a ureteral cannula into his antecubital vein for 65 cm using fluoroscopic control and a mirror and then climbed stairs to the X-ray department, where a chest radiograph showed the catheter lying in his right atrium.
- Forssmann wanted to use this technique in emergencies to administer drugs directly into the heart, and also to study the heart for diagnostic purposes.
- He catheterised his own heart on six more occasions and also injected the contrast material, Uroselectan, in 1931 in an attempt to produce an angiocardiogram.
- Received and shared, the coveted Nobel Prize (for physiology and medicine) in 1956 with New York surgeons André Cournand and Dickinson Richards "for their discoveries concerning heart catheterization and pathological changes in the circulatory system"

REFERENCES :

- ***Image Source*** *: Forsman at http://www.angiocardio.com/personna.htm*
- *Sourkes TL. Nobe! Prize winners in medicine and physiology London, New York, Toronto: Abelard -Schuman, 1966*
- *Novel e-Museum. Werner Forssmann—biography Available at http://www.nobel.se/medicine/laureates/1956/forssmann-bio.html; Accessed on 30 May 2005*
- *Forsmann W. Die soniderung des rechten herzens. Klin.Wschr. 1929; 8: 2085*
- *Davies MK, Hollman A. Werner Forssmann. Heart 2002;87: 409*

SVEN-IVAR SELDINGER

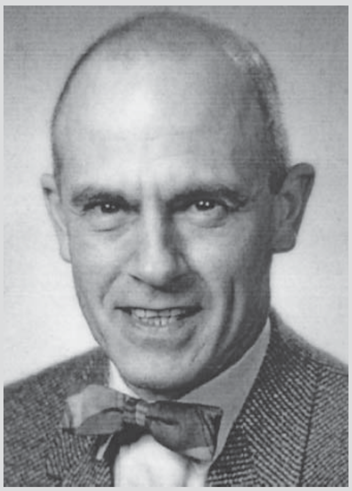
Pioneering vision in percutaneous entry techniques

- Era : 1921-1999
- Born in Mora, Sweden
- Just over 30 years ago, Sven-lvar Seldinger described a simple method of introducing a catheter percutaneously which has revolutionized radiology
- Graduated in medicine from the Karolinska Institute in 1948
- Created a Percutaneous entry technique, while experiencing "an acute attack of common sense" as described in his own words
- "Now! After an unsuccessful attempt to use this technique, I found myself, disappointed and sad, with three objects in my hand - a needle, a wire and a catheter - and ... in a split second I realized in what sequence I should use them: Needle in, wire in, needle off, catheter on wire, catheter in, catheter advance, wire off".
- In 1953, Dr. Seldinger published the description of a percutaneous entry technique in the journal, Acta Radiologica.
- Percutaneous entry technique required only a thinwall introducer needle, a wire guide and a plastic preformed catheter
- Pioneered in applying his technique to localization of tumors by arteriography, selective renal angiography, percutaneous transhepatic cholangiography, and portal venography. Further applied in interventional radiology, urology, anesthesiology and critical care medicine.

REFERENCES :

- ***Image Source:*** *Doby T.A Tribute to Sven-Ivar Seldinger 1984 AJR 142:1-3*
- *Sven-lvar Seldinger: Biography and Bibliography*
- *Seldinger SI. Catheter replacement of the needle in percutaneous arteriography (a new technique). Acta Radio! (Stockh) 1953:39: 368-376*
- *Sven-Ivar Seldinger. American Journal of Neuroradiology, 1999, 20 (6): 1180-1181.*

PIONEERS IN INTERVENTIONAL RADIOLOGY



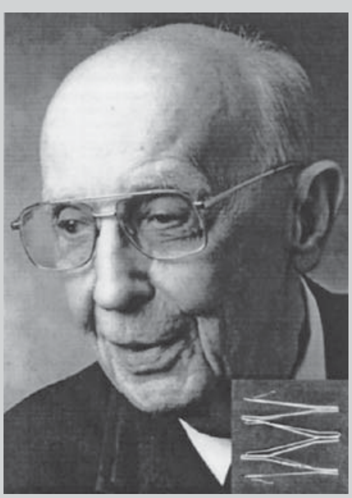
CHARLES T. DOTTER

Father of Interventional Radiology

- Era : 1920-1985
- Born in Boston, Massachusetts.
- Studied Medicine and Radiology at Cornell University, from 1950 to 1952
- Served as Professor and Chairman of Radiology at the University of Oregon Medical School for 33 years.
- Considered as the father of Interventional Radiology
- Stated in Czechoslovak Radiological Congress on on June 19, 1963 that "the angiographic catheter can be more than a tool for passive means for diagnostic observation; used with imagination, it can become an important surgical instrument,"
- First described transluminal angioplasty in 1964
- Modified Seldinger technique for therapeutic purposes
- European radiologists institutionalized a new term, "Dottering" of patients
- Four gold medals in radiology
- Nominated for Nobel Prize in Medicine in 1978

REFERENCES :

- ***Image Source** : Rösch J,Keller FS,Kaufman JA The Birth, Early Years, and Future of Interventional Radiology J Vasc Interv Radiol 2003; 14:841–853 ;*
- *Dotter CT. Cardiac catheterization and angiographic techniques of the future. Cesk Radiol 1965; 19:217–236.*
- *Dotter CT, Judkins MP. Transluminal treatment of atherosclerotic obstructions: description of a new technique and preliminary report of its applications. Circulation 1964; 30:654–670.*
- *Dotter CT. Transluminally-placed coilspring endarterial tube grafts: longterm patency in canine popliteal artery.Invest Radiol 1969; 4:329 –332.*
- *Dotter CT : Pioneers at http://www.cookgroup.com/history/dotter.html*
- *Kinnej TB. Radiologic History Exhibit Charles T. Dotter: A Pioneering Interventional Radiologist RadioGraphics 1996; 16:697-707*



CESARE GIANTURCO

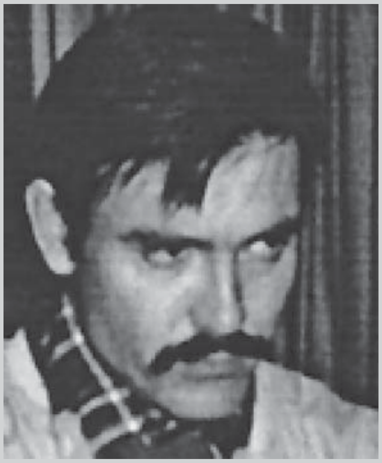
Researched balloon angioplasty technology

- Era : 1905-1995
- Born in Naples, Italy
- Graduated in medicine from the University of Naples in 1927.
- Resident radiologist at the University of Rome from 1927 to 1929, resident pathologist at the University of Berlin from 1929 to 1930
- Founding member and Chief of Radiology at the Carle Hospital and Clinic from 1934 to 1968
- In 1968, became Professor of Radiology at the University of Texas System Cancer Center, M.D. Anderson Hospital and Tumor Institute
- Researched balloon angioplasty technology in 1967, outfitting cannula with a shrink tube balloon
- Co authored with J.H. Anderson and S. Wallace, first published arterial occlusion using coiled spring "wooly tails" in 1975
- Created the "bird's nest" vena cava clot filter and biliary and vascular stents, utilizing percutaneous entry placement techniques
- Dr. Gianturco received the gold medal of the Radiological Society of North America in 1970

REFERENCES :

- ***Image Source** : Rösch J,Keller FS,Kaufman JA The Birth, Early Years, and Future of Interventional Radiology J Vasc Interv Radiol 2003; 14:841–853*
- *Sigwart V, Puel J, Mirkovitch V, Joffre F, Kappenberger L. Intravascular stents to prevent occlusions and restenosis after transluminal angioplasty.N Engl J Med 1987; 316:701–706.*

PIONEERS IN INTERVENTIONAL RADIOLOGY



ANDREAS GRUENTZIG

Forever altered the role of treatment of cardiovascular disease.

- Era : 1939–1985
- Swiss German cardiologist
- Created a device that would revolutionize interventional radiology and jump-start interventional cardiology.
- Developed balloon catheter made of polyvinyl chloride
- Performed the first successful balloon dilations of coronary arteries / procedure of coronary angioplasty in 1976 on an awake human patient.
- Developed a balloon that, when inflated conformed to the shape of a blood vessel
- Widely used to open up blocked blood vessels all over the body.
- Dr Andreas Gruentzig liked flying and owned a twin-engine plane that took him back and forth between Atlanta and Sea Island and was unfortunately killed on one of these trips when he was just 46 years old.

REFERENCES :

- ***Image Source**: Rösch J,Keller FS,Kaufman JA The Birth, Early Years, and Future of Interventional Radiology J Vasc Interv Radiol 2003; 14:841–853*
- *Grüntzig A, Hopff H. Percutane Recanalization chronischer arterieller verschlüsse mit einem neuen dilatationskatheter. Dtsch Med Wochenschr 1974; 99:2502–2505*
- *Grüntzig A. Percutane dilatation von koronarstenoses. Beschreibung eines neuen kathetersystem. Klin Wochenschr 1976; 54:543–545.*
- *Tribute to a Legend in Invasive/Interventional Cardiology: Andreas Gruentzig, M.D 2005 The Society for Cardiovascular Angiography and Interventions http://www.scai.org/drlt1.aspx?PAGE_ID=4031*

ETHICAL ISSUES IN INTERVENTIONAL RADIOLOGY PRACTICE

C. Mohan and I.K. Indrajit
Department of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India

Abstract : *Interventional Radiology is an exciting specialty on constant move, and has undergone a significant period of transition, particularly in last two decades. This sweeping transition has changed Interventional Radiology "from a Procedure-oriented specialty to Clinically oriented specialty". Ethical issues are always ever present in Interventional Radiology practices, just as in many disciplines of medicine and surgery. Ethical issues that are faced by Interventional Radiologists include a range of subject matter like importance of the written informed consent, litigation, turf battles, omissions and shortcomings in patient communication skills, battery, ongoing training and staffing issues, hazards of radiation etc. Indeed, shortcomings and potentially messy situations can be prevented by a combination of measures like maintenance of high standards in daily practice, continuous training, strict patient selection criteria, adoption of simple precautions and guidelines, observing adequate and clear communication and appropriate documentation of any procedure carried out along with a completed patient's consent form.*
Key Words: Ethical issues; litigation; consent; practice standards

INTRODUCTION

Interventional Radiology is an exciting specialty, constantly on the move. Over the years, its vital role in clinical practice has been firmly established across medical institutions world over, assisting management of a variety of disease conditions. An Interventional Radiologist today, is not only involved in diagnostic radiology practice, but also participates in invasive procedures, either alone or as a member of a team.

EVOLUTION BY TRANSITION

It is now increasingly clear that Interventional Radiology has undergone a significant period of transition, particularly in last two decades. This sweeping transition has changed Interventional Radiology "from a Procedure-oriented specialty to Clinically oriented specialty"[1]. Indeed the transitioning times in Interventional Radiology has generated a sense of excitement, and grabs the attention from all specialites. However, it must be however remembered that ethical issues is an important area that needs addressing. Ethical statements and guidelines have been developed by specialized bodies of Interventional Radiology, primarily for the benefit of the patient. Expectedly, "an Interventional Radiologist must recognize responsibility not only to patients, but also to society, to other physicians, to other health professionals, and to self "[2].

RANGE OF ETHICAL ISSUES

What are ethical issues that are faced by Interventional Radiologists today while incorporating invasive techniques in daily practice? This is indeed not an easy question to answer. They comprise a disparate range of issues, like importance of the written informed consent [3], litigation, turf battles,omissions and shortcomings in patient communication skills [4], ongoing training and staffing issues etc. Now let us examine some of them.

Correspondence : Dr. C. Mohan, M.D.Professor & Senior Adviser Department of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India **e-mail** : colcm30@yahoo.com

WRITTEN INFORMED CONSENT

Written informed consent entails "adequate communication with a written consent form mandatorily before any invasive radiological procedure. Patient should know in detail the benefits and the risks of the scheduled procedure and whether the proposed therapy is a new form of treatment or part of a randomized trial [3]." Written patient's informed consent clearly is an integral part of communication between physicians and patients. "The doctrine of informed consent requires that the patient must act voluntarily and in the light of adequate information in order to give legally valid consent to medical care[5]".

MEDICAL LITIGATION

Medical litigation that arises in clinical practice is usually "driven by unfavourable outcomes and not by malpractice[6]". Litigation can be prevented by a combination of measures like maintenance of high standards in daily practice, continuous training, strict patient selection criteria, adoption of simple precautions and guidelines, adequate and clear communication and appropriate documentation of any procedure carried out along with a completed patient's consent form.

COMPLEX ETHICAL ISSUES

It must be remembered that Interventional radiological procedures often have important legal implications. "The patient should be informed well before elective invasive procedures ("informed consent") and the amount of detailed information which is requested to be given to the patient appears to be increasing. Reversal of this trend in the future is unlikely[7]". Radiologists must discuss their own procedures with patients and informed consent for radiological procedures cannot be left to clinicians. Complex questions that are often posed to the interventional radiologists in practice include "How much should the patient be told about the procedure?" and "Should all potential complications be explained?".

ETHICAL ISSUES DURING NEW FORMS OF THERAPY

Interventional radiological procedures occasionally involve new forms of therapy or new techniques, as a part of its continuous evolution. Special caution needs to be taken at such critical times, as Duda et al rightly express that "where new forms of therapy are attempted, the information should be even more detailed. In particular it is necessary to stress the experimental nature of the procedure"[7]. "A calm, clear, direct and properly documented disclosure of risks of a procedure is the best defense in any jurisdiction[8]." "The interventionalist is likely to become an increasingly frequent defendant by virtue of several factors-the surgical and procedural nature of interventional radiology, sporadic complications that occur, unrealized expectations by patients, and the occasional need to alter initially planned therapy[9]." Ocasionally the radiologist is liable with regards to the indications of imaging studies, too[10,11].

ETHICAL ISSUES RELATED TO BATTERY

Another key ethical area in Interventional Radiology is a term called battery which denotes "unauthorized touching". It encompasses a procedure on the wrong patient, or performance of a procedure without any consent or performance of a substantially different procedure from that for which consent was obtained. A recently coined variant term is a "technical battery" that describes a procedure performed is alleged to have exceeded the scope of the consent given[9].

ETHICAL ISSUES RELATED TO RADIATION

Interventional Radiology procedures have increased substantially. It would be prudent to take into account of potential occurrences of Radiation injuries. Currently, many fluoroscopically guided procedures are diagnostic a well as therapeutic. These imply greater fluoroscopic durations and greater patient radiation exposure[(12)]. While refinements in radiologic equipment have improved image quality and also reduce X-ray dose rates,there is a potential risk for an increased overall patient and operator exposure and possibility of radiation-induced injury.

ETHICAL STRATEGIES AND INITIATIVES

When a complication occurs, a poor physician-patient relationship is often a setup for litigation or a potential moment for redressal. Once a problem is sensed, it would be skilful to intervene early to help prevent discord and potential legal action. After a complication has occurred, a practical and successful strategy would be to deal with honesty with the patient and family. Eventually the basic tenets of correct interventional radiology practices comprises of good patient care, communication, documentation, quality assurance, and follow-up[9].

TURF STRUGGLES AND INCURSION BY OTHER SPECIALITIES

Turf struggles in interventional radiology is a common problem experienced world over. It can assume as "competition with surgeons who use traditional surgical procedures, and competition with non-radiologists who use techniques similar to those employed by radiologists". Typical examples quoted in literature includes "vascular surgeon who rarely permits the diagnostic angiographer to perform angioplasty on his patients" and "cardiologist who performs peripheral angioplasty while usually bypassing both the surgeon and the radiologist"[13]. Turf battles are "distasteful in part because of the inherent selfish motivations involved: usually money or power"[13]. A survey showed that vascular and interventional radiology procedures were being infringed on by other specialities to a substantial degree. Neither the presence of a fellowship-trained vascular/interventional radiologist nor the presence of a dedicated interventional radiologist protects a group from incursion by non-radiologists into interventional radiology [14].

CONCLUSION

Interventional Radiology is an evolving speciality, where the practice involves new and difficult areas, new technical advances, increasing number and complexity of imaging techniques, their efficiency and the need for multidisciplinary approach. Ethical issues are always ever present in Interventional Radiology practices, just as in many disciplines of medicine and surgery.

REFERENCES

1. *Bakal CW, Darcy MD, Brunner MC. Strategic Initiatives in Interventional Radiology: A New Vision Journal of Vascular and Interventional Radiology 2002;13:559-562 Available at http://www.jvir.org/cgi/content/full/13/6/559 ; Accessed on 22 May 2006 .*
2. *SIR Code of Ethics Available at http://www.sirweb.org/aboutUs/CodeOfEthics.shtml Accessed on 22 May 2006*
3. *Mavroforou A, Giannoukas A, Mavrophoros D, Michalodimitrakis E Physicians' liability in interventional radiology and endovascular therapy. Eur J Radiol. 2003;46(3):240-3*
4. *Grubar M, Gruber JM. Communication: a pound of prevention. Gastroenterol Nurs 1990; 12:183-186.*
5. *Perry C. Negligence in securing informed consent and medical malpractice. J Med Humanit Bioeth. 1988;9(2):111-20*
6. *Mavroforou A, Michalodimitrakis E. Physicians' liability in ophthalmology practice. Comment in: Acta Ophthalmol Scand. 2003;81(4):319-20*
7. *Duda SH, Holzer H. The physician's duty to inform in interventional radiological therapeutic procedures. Rofo. 1995;163(4):335-40*
8. *Johnson BA, James AE Jr. The radiologist and informed consent: a review, comments and proposals. Curr Probl Diagn Radiol. 1979;8(6):1-19*
9. *vanSonnenberg E, Barton JB, Wittich GR, Radiology and the Law, with an emphasis on Interventional Radiology 1993; 187:297-303*
10. *Picard L, Bracard S, Braun M, Anxionnat R, Moret C, Lebedinsky A, Finitsis S, Schmitt E, Kremer S. Risks and responsibilities in diagnostic and interventional radiology. Ethical and medicolegal considerations. J Radiol. 2005;86(5 Pt 2):579-85*
11. *Reuter SR. Medicolegal aspects of intravascular stenting. Semin Intervent Radiol 1991; 8:31 1-315.*
12. *Clinical Competence Statement on Physician Knowledge to Optimize Patient Safety and Image Quality in Fluoroscopically Guided Invasive Cardiovascular Procedures. Circulation. 2005;111:511-532*
13. *Hall FM. Turf Battles in Interventional Radiology AJR 151:1247-1248 Smith TP, Cragg AH, Berbaum KS. Political Trends in Vascular and Interventional Radiology: A Randomized Survey Radiology 1989; 170:941-944*

INTRACRANIAL ANEURYSMS: CLIPPING OR COILING? A NEUROSURGICAL PERSPECTIVE

Harjinder S Bhatoe, M Ch
Department of Neurosurgery, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India

Abstract: *The management of intracranial aneurysms has been a fascinating challenge for neurosurgeons. Post-operative mortality and morbidity after aneurysm surgery has shown a progressively downward trend due to a combination of factors like technical and technological advances, improvements in anaesthesia, introduction of clinical grading system, improvements in imaging and critical care and perioperative brain protection techniques. Introduced in 1991, endovascular treatment of aneurysms with Guglielmi detachable coils (GDC) has emerged as an alternative method of treating intracranial aneurysms, while attempting to minimize the mortality and morbidity associated with surgery of aneurysms. At this point in time, surgical management of aneurysms has evolved, and microvascular techniques have become standardized. However endovascular techniques need to evolve further to be able to replace the established techniques of aneurysm obliteration. Currently, surgery and endovascular techniques should be taken as complementary techniques, with the goal not to establish the superiority of one technique over the other, but to use both techniques synergistically and individually.*
Key Words: Intracranial aneurysms; Microvascular techniques; Guglielmi detachable coils

INTRODUCTION

Ever since their description in 1765, intracranial aneurysms have thrown a fascinating challenge at generations of neurosurgeons. The management of these lesions has been a saga of agony and ecstasy, trials and tribulations, achievements and tragedies. Often, the clipping of a difficult intracranial aneurysms elevates the neurosurgeon to the flight of Icarus, to be often followed by sobering self realization when faced with its sequelae like infarction, brain swelling, haemorrhage, etc.

EVOLUTION OF MANAGING AND TREATING INTRACRANIAL ANEURYSMS

First pathological description of an intracranial aneurysm came from an autopsy of a patient who had died of apoplexy[1]. Modern era in the management of intracranial aneurysms dates from the publications of Sir Charles Symonds, which established subarachnoid haemorrhage as a distinct and important entity[2].Introduction of cerebral angiography by Egas Moniz in 1927 made it possible to visualize the aneurysm preoperatively. Norman Dott carried out the first ever planned obliteration of the aneurysm by wrapping it with muscle in 1933. On March 23, 1937, Walter Dandy carried out a landmark surgery, when he clipped the neck of a posterior communicating artery aneurysm with a silver clip. Thereafter, aided by technical and technological advances, improvements in anaesthesia, introduction of clinical grading system, improvements in imaging and critical care and in perioperative brain protection techniques, postoperative mortality and morbidity after aneurysm surgery has shown a progressively downward trend.[3,4] Nevertheless, aneurysm surgery, especially that for posterior circulation aneurysms has remained a high risk venture and there are constant endeavours to make the occlusion safe for the patient.

Correspondence : Col Harjinder S Bhatoe, M Ch
e-mail: hsbhatoe@indiatimes.com harjinderbhatoe@yahoo.co.in

ENDOVASCULAR TREATMENT OF ANEURYSMS

Endovascular treatment of aneurysms with Guglielmi detachable coils (GDC) introduced in 1991 was a major breakthrough in the continuing efforts to minimize the mortality and morbidity associated with surgery of aneurysms.

To evaluate the comparative efficacy and safety of GDC coils with that of surgical clipping, International Subarachnoid Aneurysm Trial (ISAT) was designed and carried out in centers across several countries of Europe and North America.[5] This randomized multicentre trial compared neurosurgical clipping versus endovascular coiling in 2143 patients with aneurismal SAH. Clinical outcomes were assessed at two months and one year by assigning the modified Rankin scale (MRS) score. It was reported that 23.7% patients of the endovascular group were dependent or dead (MRS 3-6), compared to 30.1% patients of group with surgical clipping. Based on these results, the authors concluded that endovascular coiling offers better option in terms of survival and quality of life as compared to clipping in groups matched for other variables.

The fact that the publication demonstrated superior results of non-surgical treatment has led to its intense scrutiny by neurosurgeons, literally setting cat among the pigeons. Close scrutiny of the ISAT revealed many unanswered issues and several flaws in the study that were glossed over. For instance, the basic design of the study was not adhered to, the samples were probably non-representative: majority of the aneurysms were good grade anterior circulation aneurysms. Moreover, of the 9559 patients with SAH assessed, 7416 (77.6%) were excluded, and only 2143 patients (22.4%) were randomized. On follow-up, there was a high rebleeding rate among the patients undergoing coiling, and the "safe and noninvasive" treatment is more likely to have the "dangerous" fatal consequence. Thus, the ISAT has been deemed to be a flawed study with a bias towards promotion of GDC coils.[6]

CURRENT EVIDENCE ON ENDOVASCULAR TREATMENT OF ANEURYSMS

There have been other, major studies that have evaluated the efficacy of coils vis-à-vis surgical clipping. Murayama et al published their 11-year experience with GDC embolization of cerebral aneurysms.[7] In their series, 916 aneurysms were treated in 818 patients of which only 55% of the patients had complete occlusion at the time of treatment. In follow-up, overall recanalization rate was 20.9%, with a high of 59.1% in giant aneurysms. Overall morbidity and mortality for the series was 9.4%.

In another study on 101 patients with unruptured intracranial aneurysms selected for coil embolization, complete aneurismal obliteration was achieved in 56% versus a 93.2% in surgical group.[8] Disregarding transient reversible postoperative complications, permanent complications were higher in the endovascular group at 7.5% versus 1.7% in the surgical group.

Friedman et al retrospectively analyzed their results with GDC for endovascular occlusion of acutely ruptured saccular aneurysms over a 10-year-period.[9] At follow-up angiography over a mean period of 11.6 months, 30% had complete occlusion, 26% had dog-ear remnant, 5% had residual neck and 3% had residual filling aneurysm. Significantly, 34% of the patients required two or more endovascular procedures to secure their aneurysms and three patients required open surgical intervention. All these studies refute the statement that endovascular coiling is as effective as direct clip reconstruction in completely obliterating the aneurysm. Moreover, the incidence of ischaemic complications after coiling is high: Pelz et al reported 28% incidence of thromboembolic events.[10]

Aneurysms of the posterior circulation, involving the vertebrobasilar system and their branches have traditionally been a challenging field, because of anatomical inaccessibility, and the gross neurological morbidity associated with intraoperative rupture and consequent dissection and clip application. Hence it has been concluded that aneurysms of the posterior circulation are better coiled than clipped. Review of literature however reveals different conclusions.

In a large study of 111 patients with ruptured vertebrobasilar aneurysms treated by GDC coiling, spread over 10 years by Groden et al, follow-up angiography was done at one year in 53 and at 18 months in 59 patients.[11] It was observed that complete obliteration of the aneurysms was not achieved in 23 (21%) aneurysms, while enlargement of the neck or reopening of the aneurysm was noticed in 12 of the 53 aneurysms at 12-month follow-up. Nine patients with angiography at 18 months or later had to be retreated with GDC coils, and three patients had subarachnoid hemorrhage necessitating repeat endovascular procedures. In another series of basilar trunk aneurysms treated by endovascular coiling by Uda et al, near complete occlusion occurred in 85.4% patients.[12] The results of these two series does not indicate any clear cut advantage of coiling over surgical clipping in posterior circulation aneurysms.

STRATEGY FOR "POOR RISK" CASES

What should be the strategy for "poor risk" cases? In a comparison of operative versus endovascular treatment of anterior circulation aneurysms, Groden et al found similar outcomes in the two groups: out of 41 patients, 20 were treated by surgery and 20 by endovascular techniques and one patient received both the modalities of treatment.[13] Good outcomes were achieved in 6 of surgically treated and six of the coiled patients. However, the presence of haematoma was an indication for operative intervention, since the evacuation of the haematoma would not be possible by endovascular techniques.

Clipping by microneurosurgical techniques remains the gold standard for assessment of aneurismal occlusion and rebleeding. The argument that endovascular techniques are less demanding and requirement of hospital resources is less is simply not true. The ICU stay is more a function of the neurological status than the intervention carried out. Add to this the requirement of frequent monitoring by angiography and the figures in terms of expenditure involved can be quite sobering. In a study on 171 patients (68 endovascular treatment and 103 surgical treatment), Niskanen et al compared the use of resources in the two groups. The median stay in ICU (1.7 vs1.8 days) and hospital stay (14 vs 15 days) were similar.[14] The modality of treatment did not decrease the requirement of ICU beds or hospital stay. Clipping results in complete, permanent obliteration of the aneurysm, and does not have the obligatory requirement of regular angiographic follow-up. In India, often only one postoperative angiography is possible even in major, referral centers, and an annual study is generally not possible. Once the surgeon is past the learning curve, aneurysm surgery is done with high success rate and safety. The overall mortality rate of nearly 4.95% has been reported from a major center.[4] With the keyhole surgery getting refined, a number of these aneurysms can now be clipped with ease by keyhole, minimally invasive techniques aided by neuroendoscopy.

CONCLUSION

In summary, one can say that while surgical management of aneurysms has evolved and the microvascular techniques have become standardized, the endovascular techniques need to evolve further to be able to replace the established techniques of aneurysm obliteration. Coiling thus far has demonstrated a number of shortcomings when compared to microsurgical clip reconstruction. Direct clip application is associated with higher rate of permanent aneurysm obliteration. Endovascular techniques need not be looked as a panacea for management of aneurysms. In fact, surgery and endovascular techniques should be taken as complementary techniques, and the patients are best served with both the modalities available. The goal should not be to establish the superiority of one technique over the other, but both the techniques should be used synergistically and individually.

Aneurysms have been operated for nearly 70 years, and surgery is firmly established as a definitive procedure for aneurismal obliteration. On the other hand, GDC coils were introduced only recently, and their long-term efficacy needs to be evaluated further. With the passage of time, we will see the march of technology translating into the aneurysms being treated with less and less of invasive techniques, whether surgical or endovascular. It is for the physicians to further refine and evolve the techniques that they are practicing and achieve low morbidity and improved clinical outcome.

REFERENCES

1. *Bull J. A short history of intracranial aneurysms. Lond Clin Med J 1962; 3:47-51.*
2. *Symonds CP. Contributions to the clinical study of inracranial aneurysms. Guy Hosp Rep 1923; 73:129-32.*
3. *Yasargil MG. Microneurosurgery: Clinical considerations, surgery of intracranial aneurysms and results. Stuttgart: Georg Thieme; 1984.*
4. *Misra BK. Clipping versus coiling for the treatment of aneurysms: An overview. Ind J Cerebrovasc Surg 2005, 1:2-5.*
5. *ISAT collaborative group: International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysm: A randomized trial. Lancet 2002, 360:1267-74.*
6. *Barrow Daniel L. Bad science ISAT: The impact on Neurosurgery. Clin Neurosurg 2004; 51:126-31.*
7. *Murayama Y, Nien YL, Duckwiler G, et al. Guglielmi detachable coil embolization of cerebral aneurysms: 11-years' experience. J Neurosurg 2003, 98:959-66.*
8. *Raftapoulos C, Goffette P, Vaz G, et al. Surgical clipping may lead to better results than coil embolization. Results from a series of 101 consecutive unruptured intracranial aneurysms. Neurosurgery 2003, 52:1280-7.*
9. *Friedman JA, Nichols DA, Meyer FB, et al. Guglielmi detachable coil treatment of ruptured saccular cerebral aneurysms: Retrospective review of a 10-year single center experience. AJNR 2003, 24:526-33.*
10. *Pelz DM, Lownie SP, Fox AJ. Thromboembolic events associated with the treatment of cerebral aneurysms with Guglielmi detachable coils. AJNR 1998, 19:1541-7.*
11. *Groden C, Eckert B, Ries T, Probst TN, Kucinski T, Zeumer H. Angiographic follow-up of vertebrobasilar aneurysms treated with detachable coils. Neuroradiology 2003, 45:435-440.*
12. *Uda K, Murayama Y, Gobin YP, Duckwiler GR, Vinuela F. Endovascular treatment of basilar artery trunk aneurysms with Guglielmi detachable coils: Clinical experience with 41 aneurysms in 39 patients. J Neurosurg 2001, 95:624-632.*
13. *Groden C, Kremer C, Regelsberger J, Hansen HC, Zeumer H. Comparison of operative and endovascular treatment of anterior circulation aneurysms in patients in poor grades. Neuroradiology 2001, 43:778-783.*
14. *Niskanen M, Koivisto T, Ronkainen A, et al. Resource use after subarachnoid haemorrhage: Comparison between endovascular and surgical treatment. Neurosurgery 2004, 54:1081-6.*

LITERATURE REVIEW

Pregnancy in renal transplant recipients. *Gutierrex MJ, Acebedo-Ribo M, Garcia-Donaire JA etal Transpant. Proc 2005 Nov.;7 (9): 3721-3722.*

Fertility is restored after renal transplantation when good function achieved. Gutierrez and group from the Renal Transplant Unit, Nephrology Department, Madrid, Spain described the gestations of transplanted patients, analyzing outcomes and complications as well as long-term evolution of renal function.From 1976 to 2004, 43 gestations occurred in 35 renal transplanted women: Their mean age was 31.7 + 4.06 years, with a mean time from the transplant to pregnancy of 4.32 years (0.4-13). At conception, all showed normal renal function (SCr 1.05 + mg/dl). There were 19 abortions (43.8%), nine of them spontaneous (21%) and 10 therapeutic (six cases for non-compliance with described criteria of European Best Practice Guidelines for Renal Transplantation, especially pregnancy <6 months after transplantation). Excluding these six cases of therapeutic abortions, 24 successful pregnancies occurred in 37 women (65.7%), although eight (29.1%) had premature delivery with live fetuses.Arterial hypertension was the most frequently complication (64%). Pre-eclampsia occurred in nine (37.5%) pregnancies, with proteinuria in five and only two with mild renal function deterioration. The majority patients received cysclosporine (n-20) or tacrolimus (n-19). Since 1996, mycophenolate mofetil and sirolimus were stopped before conception.Birth weight was lower than 2,500 g in 33.3% of pregnancies. Every newborn baby was healthy. Afterward, of the 24 patients with successful pregnancy, 21 (87.5%) have functioning renal transplants at 53.2 months.After delivery, all currently show good renal function (SCr 1.16 $\pm$ 0.35 mg/dl, CrCl 91 $\pm$28.45 ml/m).

The study concluded that pregnancy in renal transplant women shows a success rate of 65.6%. However, complications related to arterial hypertension such as pre-eclampsia are frequent. The incidence of spontaneous abortions was similar to other series (21%). Long term graft survival does not seem to be negatively affected by pregnancy.

Renal Function and Cardiac Angiography

Ayumi Niboshi, Masashi Nishida, Toshiyuki Itoi, et.al.

Indian J Pediatr 2006; 73 (1): 49-53

The objective was to study the effect of non-ionic contrast medium on renal function in children with cardiovascular disease. Analysis of renal function in 98 children with cardiovascular disease before and after the use of Iopamidol, Iohexol, and loversol was done for angiography. Serum creatinine (s-cre), urinary N-acety-beta-D-glucosaminase(u-NAG),urinary beta 2-microglobulin(u-BMG),and urinary alpha 1-microglobulin(u-AMG)levels were evaluated. Although s-Cre levels remained unchanged, u-NAG/Cre, u-AMG/cre and u-AMG/Cre significantly increased 12 hours after angiography. Levels of u-NAG/Cre, u-AMG/cre and u-AMG/Cre after angiography were significantly higher in neonates and infants (age<12-months, n=32) than in children (age>1-year, n=61), in patients with more than 5ml/Kg of contrast medium (n=25) than in those with less than 5 ml/Kg (n=70) and in cyanotic patients (n=13) than in non-cycanotic (n=80) patients.Transient renal tubular dysfunction occurred in all of these three non-ionic contrast mediums. Although renal tubular function was intact on a long-term basis, one should be careful of contrast medium-induced nephropathy, especially in neonates and infants, in patients receiving more than 5ml/Kg of contrast mediums in total, and in patients. With cyanotic heart disease in using non-ionic contrast mediums. *E-mail: Khamaoka@koto.kpu-m.ac.jp*

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Dosage guidelines:

Usual Adult Dosage	Dosage in Renal Impairment		Dosage for Most Pediatric Patients†
2g to 4g per day IM or IV, in equally divided doses every 12 hours. Maximum dosage: up to 8g per day. In cases where doses above 80mg/kg/day of cefoperazone activity are necessary, additional cefoperazone should be administered separately	Creatinine clearance	Maximum recommended dosage	Usual dosage of MAGNEX is 40-80mg/kg/day, in two to four equally divided doses. In serious or refractory infections, dosage may be increased up to 160 mg/kg/day, in two to four equally divided doses. †See prescribing information for important additional information on dosage in neonates.
	15-30mL/min	2g b.d.	
	<15mL/min	1g b.d.	

References: 1. Jones RN, *et al. Am J Clin Pathol* 1985; 84:496-504. 2. Data on file, Pfizer Inc. 3. Klastersky. Auwera PV. In-vitro activity of sulbactam in combination with various β-lactam antibiotics. *Diagn Microbiol Infect Dis.* 1989; 12: 165S-169S. 4. Uete.T, Matsuo K. *Jpn J Antibiot* 1989; 42(4):896-909. 5. Kunii O. In: β-lactamase Blocking Agents, Ueda Y, Neu HC (eds)University of Tokyo Press, 1986;61-67. 6. Kawada Y, Nishiura T. In: β-lactamase Blocking Agents, Ueda Y, Neu HC (eds) University of Tokyo Press, 1986;69-76.

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MEX-03-04

COMPARATIVE ASSESSMENT OF INTRACRANIAL ANEURYSMS USING 3D ROTATIONAL DSA AND 3T MRI: INITIAL EXPERIENCES

IK Indrajit, C Mohan and K Pathak

Department of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India

Abstract: *A pretreatment analysis of intracranial aneurysms by state of art imaging essentially entails accurate delineation of size and location of aneurysms, the aneurysm neck and its relation to parent and branch vessels. 3T MRI is a recently developed, costly, high-field imaging equipment, that is endowed with advantageous features such as high signal to noise ratio, easy applicability of increasing matrix size, superior background tissue suppression, the combination of which results in improved spatial resolution. This has enabled increased conspicuity of smaller intracranial vessels, with straightforward detection of small aneurysms.*

This preliminary study analyzed the efficacy of 3T MR angiography on comparison with 3D rotational DSA, in assessment of ruptured and unruptured intracranial aneurysms, at our institute during the last six months. The study was performed in 6 patients with intracerebral aneurysms. The MRA data were examined as axial source data, MPR images of the source data, and MIP and 3D volume rendered images. Comparison were made with the 3D rotational DSA findings by analyzing aneurysm location, size, neck morphology, and branch vessel relationship to the aneurysm. Of the 6 aneurysms examined, 1 were small (,10 mm), two were large (10–25 mm), and two were giant (25 mm). One aneurysm was not detected with MRA, due to faulty technique of patient moving his head during the scan. 3D reconstructions of 3D rotational DSA and 3D reconstructions of 3T MRI in VR, were equal in accuracy. MPR images were particularly useful for defining branch vessels and the aneurysm neck. MRA is currently comparable to 3D rotational DSA in pretreatment assessment of intracranial aneurysms, and can miss lesions due toimproper technique.

Key Words: Intracranial Aneurysms ; 3T MR angiography ; 3D rotational DSA

INTRODUCTION

Pretreatment assessment is an important step in the management of patients presenting with features of intracranial aneurysms, for both aneurysm detection and surgical planning. Currently available imaging techniques include DSA, CTA, MRA and Transcranial Color Doppler[1]. Compared with the conventional DSA, rotational 3D-DSA can delineate intracranial vessels sharply[2] and intracranial aneurysms with greater levels of sensitivity and accuracy[3,4]. Since the first few studies in late 1980's, MR Angiography has emerged as an useful correlative neuroimaging modality to the gold standard DSA and is found increasingly useful in evaluation of intracranial aneurysm[5,6,7,8,9].

3T MRI is a recently developed, costly, high field imaging equipment, that is endowed with advantageous features such as high signal to noise ratio, easy applicability of increasing matrix size, superior background tissue suppression, the combination of which results in improved spatial resolution[10,11]. This has enabled increased conspicuity of smaller intracranial vessels, with straightforward detection of aneurysms with diameters even smaller than 2 mm and vessels smaller than 1 mm.[12] Further augmenting are post processing techniques, that offers multiple projections using MIP and SSD algorithm. MR image analysis comprises of axial source data, maximum intensity projection (MIP)[13] and shaded surface rendering. This study was designed to compare 3T MRA with 3D rotational DSA in the pretreatment assessment of both ruptured and unruptured cerebral aneurysms. The study was performed in patients with intracerebral aneurysms. MRA was analysed in the axial source data, multiplanar reconstruction (MPR), MIP and 3D SSD.

Correspondence : Dr. I.K. Indrajit, Consultant, Department of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India **E-mail** : inji63@gmail.com

MATERIAL AND METHODS

Patients: Six patients presenting with intracerebral aneurysms in a two month period were subject in the pretreatment assessment to 3T MRA and 3D Rotational DSA at our hospital. All patients in this study were subject to 3D Rotational DSA followed by 3T MRA a day later. The study group consisted of 4 female and 1 male; average age, 59 years). These patients presented either with aneurysmal subarachnoid hemorrhage (SAH) (n=5) or symptoms related to focal mass effect (n=1). The number of ruptured and unruptured cerebral aneurysms were five and one respectively. 4 patients were subject to elective clipping while two patients are under follow up.

IMAGING MODALITIES AND ACUISITION

All intra-arterial DSA studies were performed on a Siemens 3D Rotational Biplane DSA system. Selective four vessel angiography using a standard projection format (anteroposterior, lateral, periorbital, and reverse-oblique) was performed initially with a femoral approach. Selective catheterization of the vessel harboring the aneurysm was performed by using a 5-F catheter. Three-dimensional DSA images were produced by a Workstation (Leoanrdo, Siemens Medical Systems) with the use of data from rotational

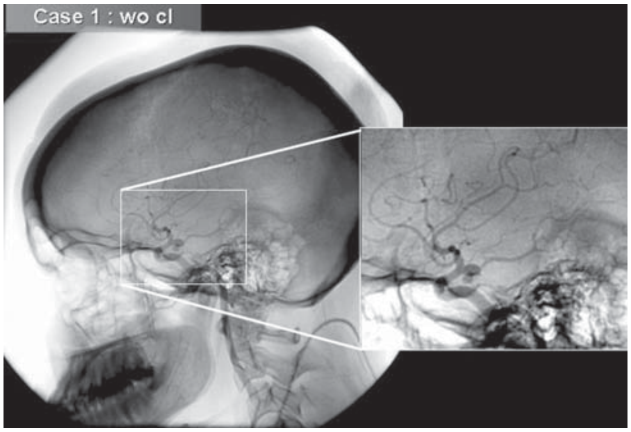

Figure 1A: A 53 year-old woman presented with abrupt onset of headache and intractable pain. CT revealed subarachnoid hemorrhage. A diagnostic 3D rotational DSA showed a lobulated aneurysm located in the supraclinoid ICA

Figure 1B: Thin Maximum intensity projection (MIP) reconstruction of MR angiogram (3D time-of-flight spoiled gradient-echo sequence, 24 msec /3.75 msec/ 1; TR/TE/NSA) shows a lobulated aneurysm located in the supraclinoid ICA

Figure 2A: A 50 year-old woman presented with mild headache, nausea and vomiting. CT revealed an unruptured aneurysm with no subarachnoid hemorrhage. She was assessed as Grade 4 SAH. A diagnostic 3D rotational DSA showed a small 2 mm sacular aneurysm in the junction of the callosomarginal and pericallosal of left anterior cerebral artery

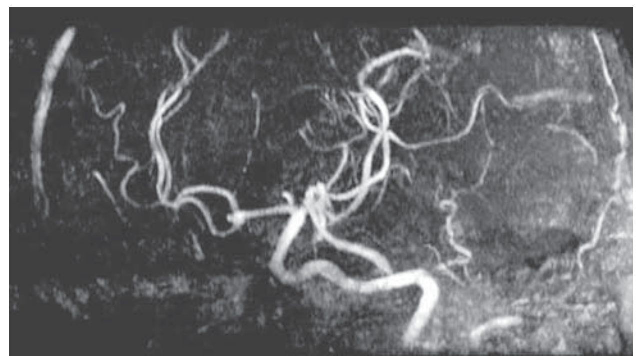

Figure 2B: Maximum intensity projection (MIP) reconstruction of MR angiogram (3D time-of-flight spoiled gradient-echo sequence, 24 msec /3.75 msec/1; TR/TE/NSA) shows the a small 2 mm sacular aneurysm in the junction of the callosomarginal and pericallosal of left anterior cerebral artery. The relationship of the callosomarginal and pericallosal to the aneurysm can be clearly seen along its whole length.

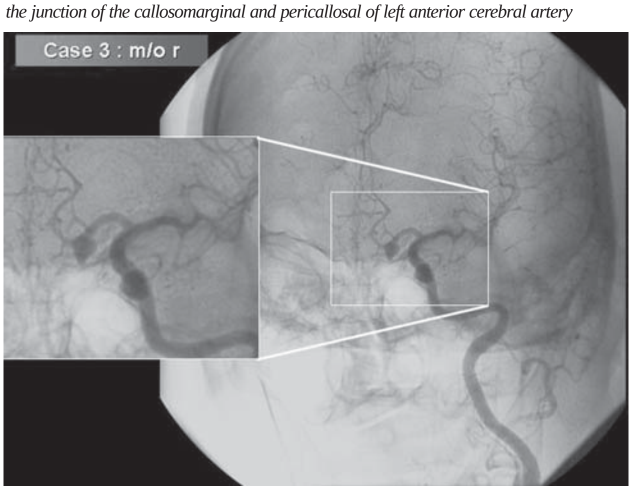

Figure 3A: A 62 year-old woman presented with severe headache with loss of consciousness for 2 days. CT revealed subarachnoid hemorrhage. She was assessed as Grade 4 SAH. A diagnostic 3D rotational DSA showed a 7 mm aneurysm in the A1 segment of the anterior cerebral artery

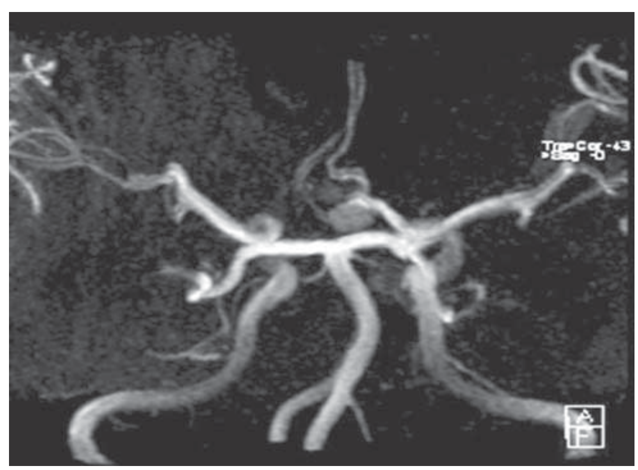

Figure 3B: Maximum intensity projection (MIP) reconstruction of MR angiogram (3D time-of-flight spoiled gradient-echo sequence, 24 msec /3.75 msec/1; TR/TE/NSA) shows the aneurysm in the A1 segment of the left anterior cerebral artery

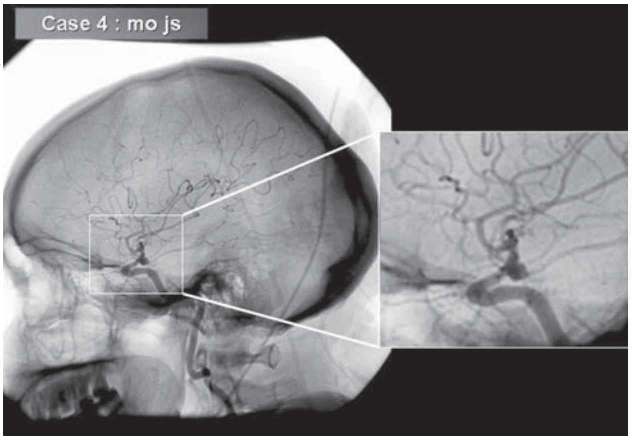

Figure 4A: A 61 year-old woman presented with severe headache. CT revealed subarachnoid hemorrhage. She was assessed as Grade 2 SAH. A diagnostic 3D rotational DSA showed a 9 mm sacular aneurysm in the left posterior cerebral artery

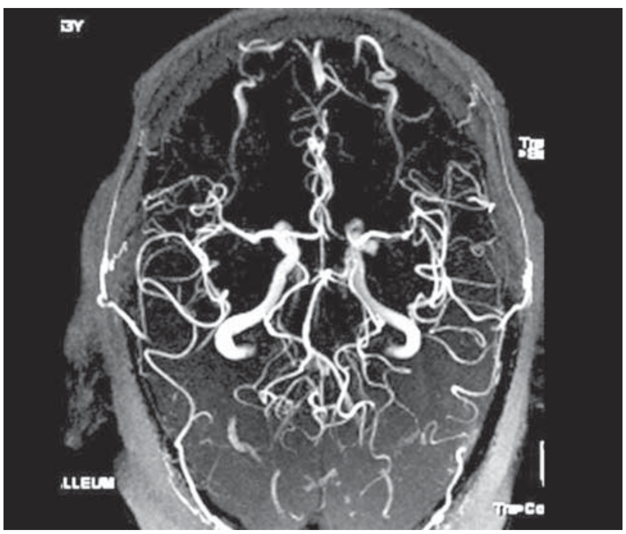

Figure 4B: Maximum intensity projection (MIP) reconstruction of MR angiogram (3D time-of-flight spoiled gradient-echo sequence, 24 msec /3.75 msec/1; TR/TE/NSA) shows the sacular aneurysm in the left posterior cerebral artery The ipsilateral middle cerebral artery is of decreased caliber compared with the MIP-MRA projection.

angiographies. Rotational angiography was performed with a 200° rotation of the C arm in 5 seconds. The matrix size of each frame was 512x512 pixels. Fifteen to 25 ml of the contrast medium (Iohexol, 300 mg/dl) was injected at a rate of 3 to 5 ml/s via a catheter positioned at the cervical portion of the carotid arteries and/or vertebral arteries. Both mask data and contrast data were automatically transferred to the workstation. 3D subtraction images were automatically produced on the workstation by a 3D-reconstruction algorithm based on the algebraic reconstruction technique. Reconstructed images, including MIP and shaded surface display were produced from the data. Minimum density threshold processing was automatically performed at the same levels. The maximum diameters of each aneurysm were calculated on the workstation.

MR examinations were performed on a 3-T Trio (Siemens) by use of a quadrature head coil. After a localizer scan was performed, 3D-TOF single-slab MRA acquisition (24/3.75/1; TR/TE/NSA); flip angle, 15; FOV, 22 cm; matrix, 512 x 512; slice thickness, 0.6 mm with 4 ot 5 slabs each comprising of 40 contiguous slices) was then performed through the circle of Willis, giving an effective voxel size of 0.6 x 0.3 x 0.6 mm. The acquisition time ranged from 8 to 9 minutes. Background tissue suppression was maximized by the addition of an off-resonance magnetization transfer gradient. An axial gradient spin-echo sequence (4500/110/4; FOV 22, cm; matrix, 256 x 256; echo train length, 8) through the brain was routinely performed in each case. The MR data were transferred to a Leonardo Syngo workstation for viewing and post processing.

VIEWING AND POST PROCESSING

The 3D rotational DSA was reviewed first on the workstation monitor. MRA source images were displayed on the workstation, and MPRs were generated and viewed. Aneurysm size was assessed using MPR measurements along the maximum plane as well as MIP images that produced angiogram-like images. Three standard series of MIP reconstructions were produced, each consisting of 42 projections evenly spaced around a single rotational axis (foot-to-head, right-to-left, and front-to-back). Each aneurysm was rendered in multiple projections, with a comparable projection to the DSA projection. Thereafter SSD and VR were performed.

POST PROCESSING OF IMAGES AND COMPARISON OF TECHNIQUES

Comparison of the visualization methods was retrospectively reviewed non-blinded by two senior radiologists. DSA findings and MR data (the source images, MPR, and MIP, 3D SSD, VR) were viewed to derive information on four key parameters: aneurysm detection, aneurysm shape and size morphology, neck and branch vessel characteristics. Measurements were made from the MPR data, with secondary measurement correlations taken form MIP images.

TECHNIQUES AND RESULTS

On 3D rotational DSA, four aneurysms were in the distribution of the anterior communicating artery aneurysms, two were located in the middle cerebral artery. Of the 6 aneurysms examined with MRI, 1 were small (10 mm), two were large (10–25 mm), and two were giant (25 mm). One aneurysm showed minimal blurring from movement artifact due to faulty technique of patient moving his head during the MRI scan. In three cases, the aneurysm responsible for hemorrhage was surrounded by high-signal hematoma on MRI. Two patients subsequently underwent surgical clipping. Four aneurysms were not treated.

The majority of aneurysms were displayed well by all

Table 1: *Intracranial aneurysm : patient presentation and characteristics*

S No	Pt Name	Age	Sex	Symptoms	Hunt and Hess clinical classification	Aneurysm Morphology on DSA				Treatment
						Location of Aneurysm	Size	Neck	Relationship with vessels	
1	w/o c lp	44	F	Abrupt onset of headache	Grade 1	Origin of left posterior communicating artery	8 x 5 mm Bilobed	Pointing posteriorly, inferiorly and medially	Vasospasm in proximal left posterior communicating artery	Intraoperative Clipping
2	w/o ms	42	F	Mild headache nausea and vomiting	Unruptured	Junction of callosomarginal and pericallosal of left ACA	3.25 x 1.84 mm sacular aneurysm	Pointing anteriorly	ACA Normal	Conservative
3	m/o r	73	F	Severe headache Loss of consciousness	Grade 4	Anterior communicating artery	5.76 x 4.13 mm	Pointing inferiorly and medially	Filling of contralateral ACA via Anterior communicating artery	Intraoperative Clipping
4	m/o js	53	F	Severe headache	Grade 2	Origin of left posterior communicating artery	4.34 x 4.24 x 5.02 mm	Pointing posteriorly, and laterally		Intraoperative Clipping
						Distal part of M1 segment of MCA	1.72 x 2.12 mm	Pointing posteriorly	Vasospasm of A1 and distal M2 segment	
5	BS	45	M	Headache Focal neurologic deficits	Grade 3	Bifurcation of left MCA	10x10x9 mm lobulated	Pointing anteriorly, superiorly and laterally	Vasospasm of MCA branches distal to aneurysm	Transorbital Clipping
6	m/o zh	60	F	Severe headache Meningismus	Grade 4	Bifurcation of right MCA	7 x 3 mm Lobulated	Pointing inferiorly and laterally	Haematoma lifting up branches of right MCA	Transorbital Clipping

The Hunt and Hess clinical classification of SAH :
Grade 1 - Headache, slight nuchal rigidity
Grade 2 - Cranial nerve palsy, severe headache, nuchal rigidity
Grade 3 - Mild focal deficit, lethargy, confusion
Grade 4 - Stupor, moderate-to-severe hemiparesis, early decerebrate rigidity
Grade 5 - Deep coma, decerebrate rigidity, moribund appearance

techniques, including those shown by 3D rotational DSA. Interpretation was sequentially done, beginning from the axial source data, followed by MPR images and then reconstructed images. The smallest aneurysm detected by DSA and MRI was 2 mm. This aneurysm was located at junction of pericallosal and callosomarginal artery branching. None of the cases demonstrated intramural thrombus on MRI as hypointense crescentic area on MRI , or its correlates on the post processed 3D rotational DSA images. Measurements were made on source images or MPR images. The MPR, SSD and VR images were comparable to 3D rotational DSA images in all categories.

Regarding aneurysm detection MIP images were most suitable for aneurysm detection, including a 2mm aneurysm. As regards aneurysm morphology VR and SSD was better than MPR and MIP. Regarding aneurysm neck VR , SSD and MIP was better. Concerning branch relationship MIP delineated spasm more accurately than the surface rendered image. Regarding post processing techniques, the axial source data images were significantly inferior to 3D rotational DSA images. MPR was superior to MIP, excepting aneurysm detection. In the majority of cases, MRA images complemented 3D rotational DSA, without any significant add on information.

DISCUSSION

Intracranial aneurysm is a common neurosurgical entity that is often asymptomatic until the time of its rupture. During rupture, the resultant subarachnoid hemorrhage rupture is a medical emergency and a potentially lethal event with a mortality rate as high as 50 percent[14]. Nearly 90 percent are saccular or berry aneurysms, which are responsible for most of the morbidity and mortality caused by subarachnoid hemorrhage[15].

Pretreatment assessment is an important step in the management of patients presenting with features of intracranial aneurysms, for both aneurysm detection and surgical planning. Intraarterial DSA has been traditionally considered the gold standard investigation modality for intracranial aneurysmal disease. It is an invasive technique with a 1% complication risk . Besides studies show that it has a 0.5% rate of persistent neurologic deficit[16,17].

One study compared the sensitivity and specificity of CTA, MRA and Transcranial Color Doppler for detecting intracranial aneurysms. While Magnetic resonance angiography has a sensitivity and specificity of 69 to 100 and 75 to 100%, the corresponding values for Computed tomographic angiography was 85 to 95 % and Transcranial Doppler ultrasonography was 50 to 91% and 87.5%[18]. A recent study analyzed the diagnostic accuracy of magnetic resonance angiography in correlation with 3D-digital subtraction angiographic images. 3D-TOF MRA was performed in 82 patients with 133 cerebral aneurysms. One hundred five (79%) of all 133 aneurysms were detected with MRA by a neuroradiologist, 100 (75%) were detected by an experienced neurosurgeon, 84 (63%) were detected by a general radiologist, and 80 (60%) were detected by a resident neuroradiologist. Evidently, the detectability was lower for small aneurysms (<3 mm in maximum diameter) and/or for those located at the internal carotid artery and anterior cerebral artery. False-positive diagnosis occurred due to complex flow in a tortuous artery and susceptibility artifacts[5]. MRA has been evaluated as a modality for the prospective detection of intracranial aneurysms[19].

Recently, Rotational 3-dimensional DSA (3D-DSA) has been increasingly used to obtain detailed information about the morphology and dimensions of intracranial aneurysms[19,20]. One such recent case analyzed the morphology of a patient presenting with a distal pericallosal artery aneurysm, revealed to be a saccular bifurcation aneurysm by 3D-DSA. The case report further highlights the value of 3D-DSA in establishing the appropriate treatment plan for patients with unique cerebral aneurysms. The authors rightly state that "accurate pre-interventional evaluation and differential diagnosis are critical to designing the most effective lowest risk treatment plan".[21]

The promise of evaluating aneurysms in 3D rotational DSA and 3T is slowly being realized across the world. To a large extent this is due to the fact that "recent neurointerventional and neurosurgical technologies require an understanding of lesions and adjacent structures in three dimensions"[22]. One study compared data of 52 patients treated before availability of 3D DSA with 33 patients treated after availability of 3D DSA (group B, 33 patients). The study showed that "3D DSA allowed acquisition of high-quality 3D images of cerebral arteries and also allows observation and analysis from multiple directions to determine the appropriate working projection for embolization"[22].

Another important aspect is "angiogram negative intracranial haemorrhage". This well established entity is encounterd in practice[23]. A study by Renowden SA evaluated 334 patients with DSA, of which no cause for haemorrhage could be identified in 41 (12%) cases. Of these 30 had predominantly subarachnoid (SAH) and 11 predominantly

Table 2: *Intracranial Aneurysm : Comparison Of Morphology*

S No	Pt Name	Modality	Comparative Aneurysm Morphology on 3D Rotational DSA and 3T MRI			
			Location of Aneurysm	Size	Neck	Relationshi p with vessels
1	w/o c lp	3D Rotational DSA	Origin of left posterior communicating artery	8 x 5 mm Bilobed	Pointing posteriorly, inferiorly and medially	Vasospasm in proximal left posterior communicating artery
		3T MR A	At origin of left posterior communicating artery	7.8 x 4.5 mm Irregular	Pointing posteriorly, inferiorly and medially	Normal calibre
2	w/o ms	3D Rotational DSA	Junction of callosomarginal and pericallosal of left ACA	3.25 x 1.84 mm sacular aneurysm	Pointing anteriorly	ACA Normal
		3T MR A	Junction of callosomarginal and pericallosal of left ACA	3 x 1.7 sacular aneurysm	Pointing anteriorly	ACA Normal
3	m/o r	3D Rotational DSA	Anterior communicating artery	5.76 x 4.13 mm	Pointing inferiorly and medially	Filling of contralateral ACA via Anterior communicating artery
		3T MR A	Anterior communicating artery	5.8 x 4.2 mm	Pointing inferiorly and medially	NA
4	m/o js	3D Rotational DSA	Origin of left posterior communicating artery	4.34 x 4.24 x 5.02 mm	Pointing posteriorly, and laterally	Normal calibre
		3T MR A	Origin of left posterior communicating artery	4.3 x 4 x 5 mm	Pointing posteriorly, and laterally	Normal calibre
		3D Rotational DSA	Distal part of M1 segment of MCA	1.72 x 2.12 mm	Pointing posteriorly	Vasospasm of A1 and distal M2 segment
		3T MR A	Distal part of M1 segment of MCA	1.8 x 2.4 mm	Pointing posteriorly	Vasospasm of A1 segment
5	BS	3D Rotational DSA	Bifurcation of left MCA	10x10x9 mm lobulated	Pointing anteriorly, superiorly and laterally	Vasospasm of MCA branches distal to aneurysm
		3T MR A	Bifurcation of left MCA	11x8x9 mm lobulated	Pointing anteriorly, superiorly and laterally	Vasospasm of MCA branches
6	m/o zh	3D Rotational DSA	Bifurcation of right MCA	7 x 3 mm Lobulated	Pointing inferiorly and laterally	
		3T MR A	Bifurcation of right MCA	1 cm x 3 mm Lobulated	Pointing inferiorly and laterally	Haematoma lifting up branches of right MCA

parenchymal haemorrhage (PH). An MRI was perfomed 1–6 weeks after the ictus, of which studies were positive in 7 patients (17%). In the 30 patients examined after SAH, 2 studies were positive, showing an aneurysm in one case and a brain stem lesion of uncertain actiology in the other. In those examined after PH, cavernous angiomas were shown in 2, a tumour in 1 and a vascular malformation in another; useful diagnostic information was thus obtained in 36% of this group of “angiogram negative intracranial haemorrhage” patients[23].

A study conducted at 8.0 T by Kangarlu and Shellock[24] reported that “all aneurysm clips, even those made from titanium or titanium alloy, displayed positive translational attractions (deflection angles ranged from 5 to 53 degrees). Importantly, several aneurysm clips reported to be safe at 1.5 T were found to be potentially unsafe at 8.0 T because they showed excessive deflection angles and relatively high qualitative torque values”. The authors also recommend that at present, “aneurysm clips made from commercially pure titanium or titanium alloy are definitely safe because they exhibit no magnet-related movements in association with exposure to 3.0-T MR imaging systems. Aneurysm clips made from stainless steel alloy, Phynox, and Elgiloy, while displaying acceptable deflection angles (<45 degrees) and thus considered safe for patients and other persons in the long- and short-bore MR environments, require further characterization of torque effects to determine safety for patients who have these clips before allowing them to undergo MRI[25].

CONCLUSION

Pretreatment assessment is an important step in the management of patients presenting with features of intracranial aneurysms, for both aneurysm detection and surgical planning. 3T MRI is a recently developed, costly, high field imaging equipment, that is endowed with advantageous features such as high signal to noise ratio, easy applicability of increasing matrix size, superior background tissue suppression, the combination of which results in improved spatial resolution. This has enabled increased conspicuity of smaller intracranial vessels, with straightforward detection of aneurysms with diameters even smaller than 2 mm and vessels smaller than 1 mm. 3T MRA is particularly useful in complex anatomic areas like middle cerebral artery bifurcation or anterior communicating artery. It is also useful in equivocal DSA studies in patients presenting with small aneurysms as also patients presenting with SAH with negative angiography.

REFERENCES

1. *White PM, Wardlaw JM, Easton V. Can noninvasive imaging accurately depict intracranial aneurysms?: a systematic review. Radiology. 2000; 217: 361–370*
2. *Kang HS, Han MH, Kwon BJ, Kwon OK, Kim SH, and Chang KH, Evaluation of the Lenticulostriate Arteries with Rotational Angiography and 3D Reconstruction Am. J. Neuroradiol., 2005; 26(2): 306 - 312.*
3. *Unger B, Link J, Bohm-Jurkovic. Digital 3D-rotational angiography in preoperative and preinterventional diagnosis of intracranial aneurysms [in German]. Rofo Fortschr Geb Rontgenstr Neuen Bildgeb Verfahr. 1999; 170: 482–491*
4. *Tanoue S, Kiyosue H, Kenai H, Nakamura T, Yamashita M, Mori H. Three-dimensional reconstructed images after rotational angiography in the evaluation of intracranial aneurysms: surgical correlation. Neurosurgery. 2000; 47: 866–871*
5. *Okahara M, Kiyosue H, Yamashita M, Nagatomi H, Hata H, Saginoya T, Sagara Y, Mori H. Diagnostic accuracy of magnetic resonance angiography for cerebral aneurysms in correlation with 3D-digital subtraction angiographic images: a study of 133 aneurysms. Stroke. 2002;33(7):1803-8.*
6. *Anzalone N, Righi C, Simionato F, et al. Three-dimensional time-of-flight MR angiography in the evaluation of intracranial aneurysms treated with Guglielmi detachable coils. AJNR Am J Neuroradiol 2000; 21:746-752*
7. *Atlas SW, Sheppard L, Golberg HI, Hurst RW, Listerud J, Flamm E. Intracranial aneurysms: detection and characterization with MR angiography with use of an advanced postprocessing technique in a blinded-reader study. Radiology 1997; 203:807-814*
8. *Wilcock D, Japsan T, Holland I, Cherryman G, Worthington B. Comparison of magnetic resonance angiography with conventional angiography in the detection of intracranial aneurysms in patients presenting with subarachnoid haemorrhage. Clin Radiol. 1996; 51: 330–334*
9. *Masaryk TJ, Modic MT, Ross JS, Ruggieri PM, Laub GA, Lenz GW, Haacke EM, Selaman WR, Wiznitzer M, Harik SI. Intracranial circulation: preliminary clinical results with three-dimensional (volume) MR angiography. Radiology. 1989; 171: 793–799*
10. *Willinek WA, Gieseke J, von Falkenhausen M, Born M, Hadizadeh D, Manka C, Textor HJ, Schild HH, Kuhl CK. Sensitivity encoding (SENSE) for high spatial resolution time-of-flight MR angiography of the intracranial arteries at 3.0 T. Rofo. 2004;176(1):21-6.*
11. *Majoie C, Sprengers ME, van Rooij MJJ,Lavini C,Sluzewski M, van Rijn JC, den Heeten GJ. MR Angiography at 3T versus Digital Subtraction Angiography in the Follow-up of Intracranial Aneurysms Treated with Detachable Coils AJNR Am. J. Neuroradiol 2005; 26(6): 1349 - 1356.*
12. *Adams WM, Laitt RD, Jackson A. The Role of MR Angiography in the Pretreatment Assessment of Intracranial Aneurysms: A Comparative Study. Am J Neuroradiol 2000; 21:1618–1628*
13. *Anderson CM, Saloner D, Tsuruda JS, Shapeero LG, Lee RE. Artifacts in maximum-intensity-projection display of MR angiograms. AJNR Am J Neuroradiol 1990;154:623–629*
14. *Vega C, Kwoon JV, Lavine SD. Intracranial Aneurysms: Current Evidence and Clinical Practice. Am Fam Physician 2002;66:601-8.*
15. *Yong-Zhong G, van Alphen HA. Pathogenesis and histopathology of saccular aneurysms: review of the literature. Neurol Res 1990;12:249-55.*
16. *Heiserman JE, Dean BL, Hodak JA et al. Neurological complications of cerebral angiography. AJNR Am J Neuroradiol 1994; 15:1401–1407*
17. *Mayberg MR, Batjer HH, Dacey R, Diringer M, Haley EC, Heros RC, et al. Guidelines for the management of aneurysmal subarachnoid hemorrhage. A statement for healthcare professionals from a special writing group of the Stroke Council, American Heart Association. Stroke 1994;25:2315-28*
18. *Wardlaw JM, White PM. The detection and management of unruptured intracranial aneurysms. Brain 2000;123(pt 2):205-21*
19. *Hiraia T, Korogic Y, Suginoharab K, Onoa K, Nishia T . Clinical Usefulness of Unsubtracted 3D Digital Angiography Compared with Rotational Digital Angiography in the Pretreatment Evaluation of Intracranial Aneurysms. Am Jour Neuroradiology 2003; 24:1067-1074*
20. *Piotin M, Daghman B, Mounayer C, Spelle L, and Moret J. Ellipsoid Approximation versus 3D Rotational Angiography in the Volumetric Assessment of Intracranial Aneurysms Am. J. Neuroradiol 2006; 27(4): 839 - 842.*
21. *Woodworth GF, McGirt MJ, Clatterbuck R, Gailloud P. Evaluation of a distal pericallosal aneurysm visualized with 3-dimensional digital subtraction angiography: case report and treatment implications. Surg Neurol. 2005;64(4):321-4*
22. *Abe T, Hirohata M, Tanaka N, Uchiyama Y, Kojima K, Fujimoto K, Norbash AM, Hayabuchi N. Clinical benefits of rotational 3D angiography in endovascular treatment of ruptured cerebral aneurysm . AJNR Am J Neuroradiol. 2002 Apr;23(4):686-8.*
23. *Renowden SA, Molyneux AJ, Anslow P and Byrne JV. Diagnostic Neuroradiology. The value of MRI in angiogram-negative intracranial haemorrhage Neuroradiology 1994; 36: 6: 422 - 425*
24. *Kangarlu A, Shellock FG. Aneurysm clips: evaluation of magnetic field interactions with an 8.0 T MR system. J Magn Reson Imaging 2000;12:107–111*
25. *Shellock FG, Tkach JA, Ruggieri PM. Aneurysm Clips: Evaluation of Magnetic Field Interactions and Translational Attraction by Use of “Long-Bore” and “Short-Bore” 3.0-T MR Imaging Systems Am J Neuroradiol 2003; 24:463–471*

ENDOVASCULAR TREATMENT OF RUPTURED INTRACRANIAL ANEURYSMS: IMMEDIATE RESULT AND LONG TERM FOLLOW UP.

AK Gupta, H Sonwalkar, S Purkayastha, N Bodhey
Department of Imaging Sciences and Interventional Neuroradiology,
Sree Chitra Tirunal Institute for Medical Sciences and Technology,Trivandrum – 695 011 INDIA

Abstract: Background: *Endovascular treatment of ruptured intracranial aneurysms is being used increasingly and has evolved as an alternative to surgical clipping. However, its long-term efficacy has yet to be established. The purpose of this study is to discuss the immediate angiographic result and to identify factors that might be important in predicting initial efficacy of this treatment and a long term follow up to study the clinical and angiographic results of treated aneurysms. A total of 27 ruptured intracranial aneurysms in were treated with selective endovascular coil occlusion and the percentage of occlusion calculated. The shape of aneurysm rest was noted on the immediate post treatment and follow-up angiograms. Immediate and follow up clinical status was also noted using Glasgow outcome scale. The clinical and radiological changes on follow up were assessed and possible factors involved were analyzed. It is retrospective hospital based (tertiary teaching hospital) study. Of the 27 patients of intracranial aneurysms that underwent selective aneurysm coiling, good immediate outcome (Glasgow outcome scale 1 and 2) was seen in 24/27 (88.88%) cases. The narrow necked aneurysm showed good immediate angiographic result (90-100% packing) in all the cases 18/18(100%). Amongst the wide necked aneurysms, good packing (90-100%) was achieved in 7/9 (77.77%) cases. No subarachnoid hemorrhage was seen in any of the followed up cases of coiled aneurysms. A positive relationship was noted between the neck size and the immediate angiographic outcome. The long-term angiographic recurrences were found more often in large sized aneurysms. Endovascular treatment of intracranial aneurysms is a safe and effective treatment modality that offers protection from recurrent subarachnoid hemorrhage.*
Key words: Aneurysm, subarachnoid hemorrhage, aneurysm coiling.

INTRODUCTION

Intracranial aneurysms have a prevalence of 0.5% to 6% in adults and most of them are asymptomatic[1,2]. However, the most dreaded complication of intracranial aneurysm is rupture causing subarachnoid hemorrhage (SAH) with a mortality of 32-67%[3] .The aim of ruptured aneurysm treatment is exclusion of the aneurysm from circulation and prevention of rebleed. Endovascular treatment is being increasingly used for this purpose, however, long terms efficacy of this mode of treatment are still lacking. The purpose of this study is to discuss the immediate angiographic result and to identify factors that might be important in predicting initial efficacy of this treatment and a long term follow up to study the clinical and angiographic results of treated aneurysms.

MATERIALS AND METHODS

This retrospective study was conducted in our department between May 1997 to July 2004. A total of 27 aneurysms in 27 patients (18 males, 9 females; age range: 46 to 72 years, mean: 57 years) were treated. SAH was noted in all patients. Sixty-two percentage aneurysms were in the anterior circulation and 37.03% in posterior circulation. Clinical presentation, Hunt and Hess grading and location of the aneurysms are given in Tables 1,2,3.

Correspondence : Dr. Arun Kumar Gupta, Professor and Head, Department of Imaging Sciences and Interventional Neuroradiology Sree Chitra Tirunal Institute for Medical Sciences and Technology Trivandrum – 695 011, India
e-mail : gupta209@yahoo.com

Table 1: *Presentation of Intracranial Aneurysms*

CLINICAL PRESENTATION	NUMBER OF PATIENTS
1. HEADACHE	27
2. LOSS OF CONSCIOUSNESS	2
3. VOMITING	25

Table 2: *Clinical Presentation of Ruptured Aneurysms*

HUNT & HESS	NO. OF PATIENTS
GRADE 1	15
GRADE 2	5
GRADE 3	7
GRADE 4	0
GRADE 5	0
TOTAL	27

Table 3: *Location Wise Distribution of Endovascularly Treated Intracranial Neuysms*

LOCATION	COILING
ICA- COMMUNICATING SEGMENT	4
ICA- OPHTHALMIC SEGMENT	3
ICA-MCA GRAFT	1
MCA BIFURCATION	3
A1-ACOM JUNCTION	6
BASILAR TOP	7
BASILAR TRUNK	1
PCA	2
TOTAL	27

TECHNIQUE OF EMBOLIZATION

A complete clinical evaluation, hematology, blood biochemistry and coagulation profile was done in all patients. A diagnostic cerebral angiography were done in each case to define the location of aneurysm in relation to the parent vessel, its anatomical location, geometric arrangement, size of the fundus and the neck and presence of thrombus within its lumen for taking decision regarding the mode of treatment (coiling vs parent vessel occlusion). In selected cases of complex anatomy, CT angiography was also done. Our institutional review board approved the procedure. Informed consent was taken from all patients.

The anatomical location of aneurysm in ICA territory was done according to the Bouthillier classification of ICA segments[4]. In terms of geometry the aneurysm was classified into truncal, sidewall, bifurcation and terminal. In terms of the size the aneurysms were classified as small (<10mm), large (10-25mm) and giant (>25mm)[5,6,7,8]. The neck was classified as small <= 4mm and large > 4mm[6,9,10,11].All fusiform aneurysms were classified as wide necked. A detailed neurological evaluation was done in all and in cases of SAH an initial classification of patients according to Hunt and Hess scale and the Glasgow outcome scale were undertaken[12, 13].

Endovascular coiling was done under general anesthesia. Intravenous heparin was given at the dose of 50-100 IU/ kg body weight to obtain an ACT between 2-2.5 times of baseline and maintained subsequently with hourly bolus of half the initial dose. With co-axial technique a microcatheter was introduced carefully into the aneurysm sac and a working projection obtained with a roadmap. In cases of unfavorable anatomy additional techniques like balloon remodeling were done and the aneurysm was coiled. The aim of coil placement was to pack the aneurysm as densely as possible without jeopardizing the adjacent normal vasculature.

The initial degree of occlusion is defined angiographically as 100% minus the amount of residual aneurysm filling. The angiographic outcome was broadly categorized on the basis of residual aneurysm filling on angiography[14]. Morphological results were also classified as: complete obliteration, dog-ear, residual neck and residual aneurysm. The clinical outcome of patient immediately as well as on follow up was evaluated using the Glasgow outcome scale (1-complete recovery; 2-moderate disability but independent; 3-severely disabled but conscious; 4-persistent vegetative state and 5-death). A detailed neurological examination was done for the patient on follow up at an interval of three months for the first year and yearly thereafter in uncomplicated cases. Follow up angiography was advised for each patient between one to six months and at two years in cases with complete occlusion and yearly for those with residual neck. Follow up angiograms were compared with immediate post procedure angiograms and then assigned to one of the three categories: (a) Further thrombosis, when the amount of contrast agent filling the aneurysm decreased; (b) Unchanged, when a similar degree of aneurysm occlusion was found on multiple Angiographic results: Relation between immediate angiographic outcome and aneurysmal size are given in Tables 4. On post procedure angiograms, small sized aneurysms (< 10mm dome diameter) showed complete occlusion in 15/19 (78.94%) cases with stable occlusion noted in 17/19 (89.47%) of cases and progressive thrombosis seen in 1/19 (5.26%) case on follow up angiograms at 6 months and 1 year. In large sized aneurysms (10-25mm), complete occlusion was noted in only 4/8 (50%) cases on immediate post procedure angiogram with near complete occlusion seen in 1/8 (12.5%)

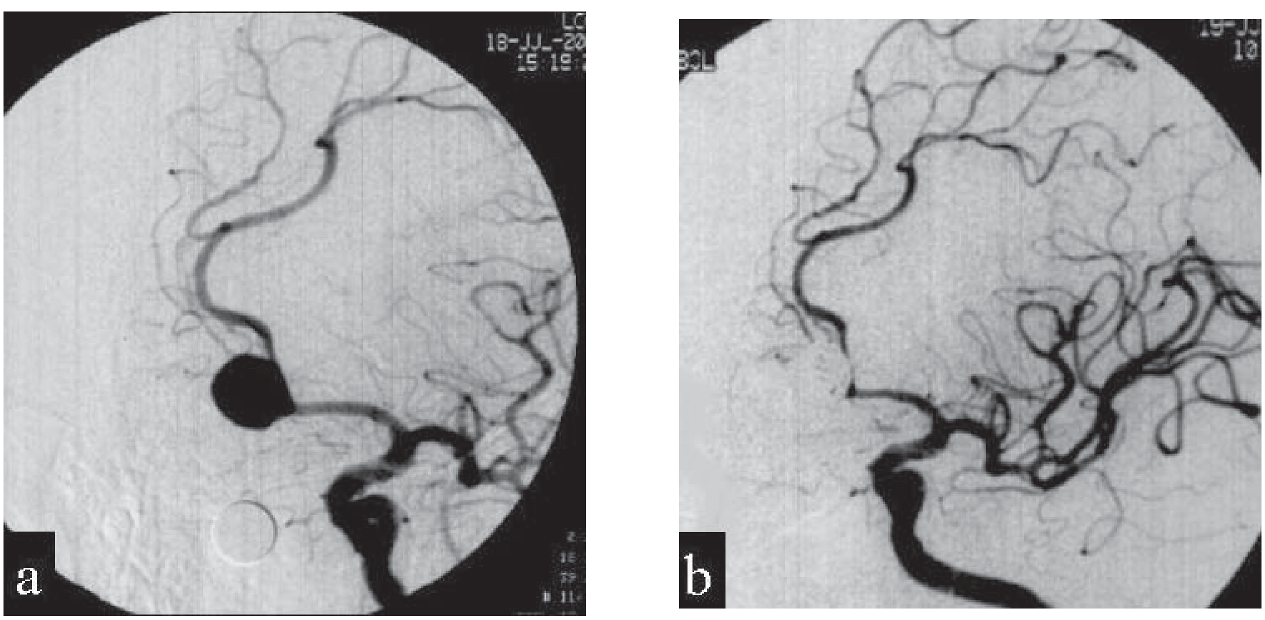

Figure 1: (a) Left internal carotid artery injection shows a giant aneurysm with wide neck. (b) Post coiling angiogram shows complete packing and total obliteration of the aneurysm.

Table 4: *Relationship Between Aneurysm Morphology And Results*

LUMINAL DIAMETER		NO. OF ANEURYSMS	IMMEDIATE RESULT			
			PACKING %	NO.	ANGIO RESULT	NO.
<10mm	SMALL	19	100%	12(63.15%)	CO	15(78.94%)
			90-99%	7(36.84%)	DE	3(15.78%)
			<90%	0	RN	1(5.26%)
10-25mm	LARGE	8	100%	3(37.5%)	CO	4(50.0%)
			90-99%	3(37.5%)	DE	2(25.0%)
			<90%	2(25.0%)	RN	2(25.0%)
NECK WIDTH		NO. OF ANEURYSMS	IMMEDIATE ANGIOGRAPHIC RESULT			
			PACKING %	NO.	ANGIO RESULT	NO.
<4mm	NARROW	18	100%	11(61.11%)	CO	15(83.33%)
			90-99%	7(38.88%)	DE	2(11.11%)
			<90%	0	RN	1(5.55%)
>=4mm	WIDE	9	100%	3(33.33%)	CO	4(44.44%)
			90-99%	4(4.44%)	DE	3(33.33%)
			<90%	2(22.22%)	RN	2(22.22%)

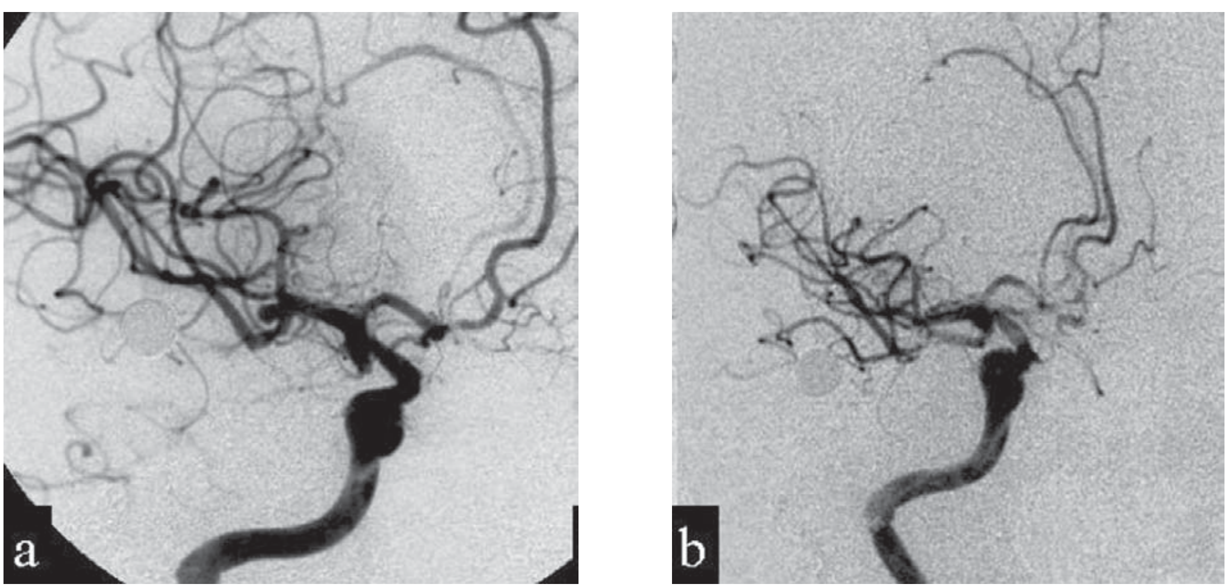

Figure 2: Right internal carotid artery injection shows a small narrow necked middle cerebral artery bifurcation aneurysm. (b) Post coiling angiogram shows total obliteration of the aneurysm.

case [Figure 1]. On follow up angiogram at 1 year, stable unchanged result was seen in only 4/8 (50%) cases with recanalization seen in 4/8 (50%) cases. Thus, the recanalization rate was much higher for large sized aneurysm (50.0%) than for small sized aneurysm (15.78%).

In case of narrow necked aneurysms (neck <=4mm), complete and near complete occlusion was seen in 15/18 (83.33%) cases [Figure 2] with 16 cases (88.88%) showing stable status and 2 (11.11%) showing recanalization on follow up angiogram at 1 year. Wide necked aneurysms showed complete and near complete occlusion in 4/9 (44.44%) cases with progressive thrombosis in 2 cases (22.22%) [Figure 3] and recanalization in 3 cases (33.33%) on follow up imaging. Aneurysm with wide neck showed slightly higher rate of recanalization (33.33%) compared to narrow necked aneurysms (11.11%).

CLINICAL RESULTS

Clinical results at discharge are given in Table 5. Long term clinical follow up was available in 19/27 patients. The duration of follow-up in them was 1-6 years. The clinical outcome of patient immediately as well as on follow up was evaluated using the Glasgow outcome scale.

Of the 27 cases of intracranial aneurysms that underwent selective aneurysm coiling, good immediate outcome (Glasgow outcome scale 1 and 2) was seen in 24/27 (88.88%) cases with poor clinical outcome in the remaining 3/27(11.11%) cases. The patients presenting with Grade 1 SAH had much better immediate clinical outcome (14/15) as compared to those presenting in Grade 2 or Grade 3 SAH (10/12) with good outcome in 93.33% and 83.33% cases respectively. Long-term follow up was available in 19/25 cases with good outcome (Glasgow outcome scale 1 and 2) in 17/19 (89.47%) cases and poor outcome in 2 cases. No rebleed was seen in any of the treated cases.

COMPLICATIONS

Complications associated with endovascular treatment of intracranial aneurysms were classified as minor (leaving no neurological deficit or deficit not interfering with daily

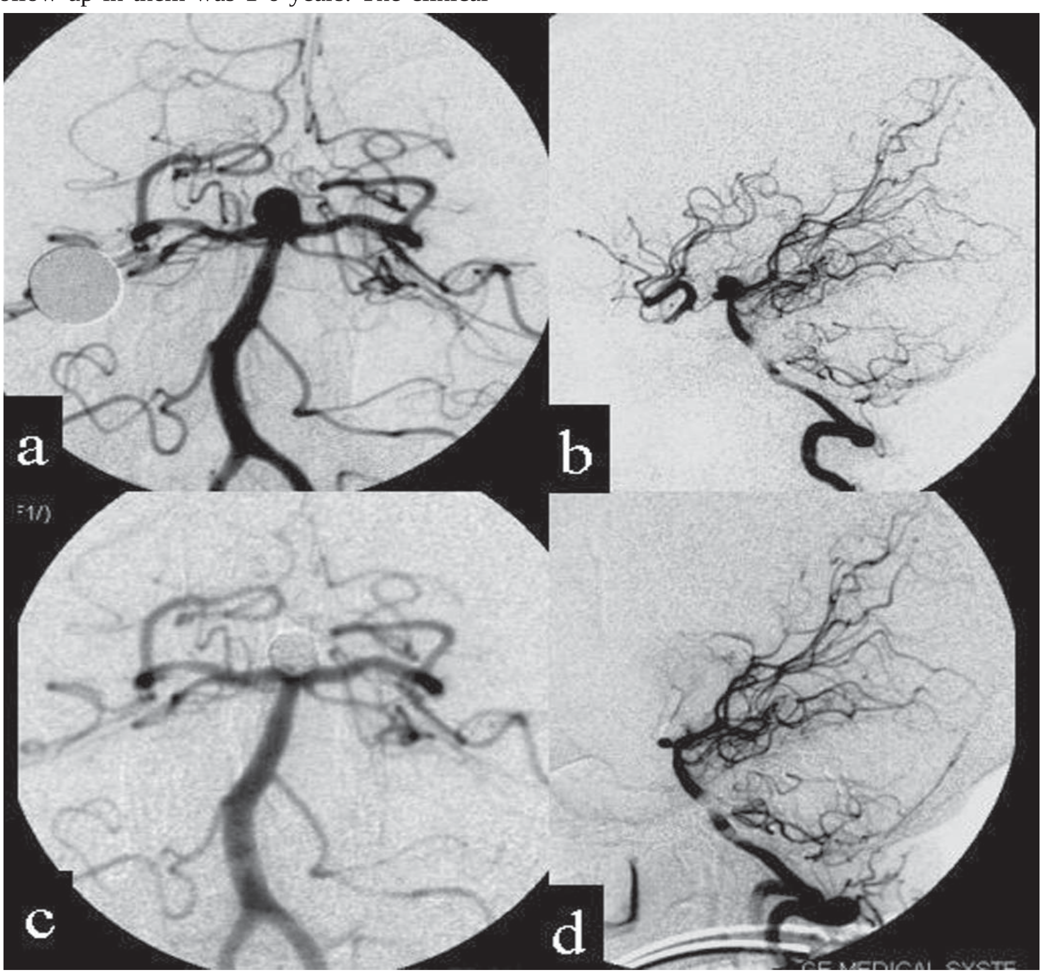

Figure 3: (a,b) Left vertebral artery injection anteroposterior and lateral views show a wide necked basilar top aneurysm. (c,d) Post coiling angiogram shows complete packing and total obliteration of the aneurysm. This was done with balloon remodeling technique. Note total luminal preservation of both posterior cerebral arteries

Table 5: ***Relationship Between Severity Of SAH , FISHER GRADE on CT and Clinical Outcome at Discharge***

HUNT & HESS	No of patients	Glasgow outcome scale	No of patients
Grade 1	15	1	12 (80%)
		2	2 (13.33%)
		5	1 (6.66%)
Grade 2	5	1	3 (60.00%)
		2	4 (80.0%)
Grade 3	7	1	3 (42.85%)
		2	2 (28.57%)
		4	1 (14.28%)
		5	1 (14.28%)
FISHER CT GRADE	No of patients	Glasgow outcome scale	No of patients
Grade 1	3	1	1 (33.33%)
		2	2 (66.66%)
Grade 2	16	1	10 (62.50%)
		2	5 (31.25%)
		5	1 (6.25%)
Grade 3	1	5	1 (100%)
Grade 4	7	1	5 (71.42%)
		2	1 (14.28%)
		4	1 (14.28%)

activities) and major (leaving persistent neurological deficit or death). Patients having minor complications were successfully thrombolised and had no deficit. Aneurysm rupture during coiling was noted in 1 patients leading to death. Another patient developed post coiling thromboembolism and massive MCA infarct and died subsequently. Rest one patient had coil prolapse and partial occlusion of parent artery and had aphasia and hemiparesis. All the complications happened in our early cases.

DISCUSSION

The goal of aneurysm treatment remains exclusion of aneurysm sac and neck from circulation and endovascular treatment is being increasingly used for this purpose. After introduction of endovascular treatment of intracranial aneurysms, there was a tendency to refer posterior circulation aneurysms for coiling in many centers considering the difficulty in treating those aneurysms by open surgery[16,17,18]. However, with refinement in endovascular techniques and better outcomes, the referral base has widened so that the subsequent studies showed inclusion of more number of anterior circulation aneurysms[14,19,20]. This coincided with the frequency found in our series for the anterior and posterior circulation aneurysms with the frequency of basilar bifurcation aneurysms and ICA aneurysms that were selected for coiling being 37.03% and 62.96% respectively.

In 2002, the American Heart Association formed a strict protocol for follow-up of endovascularly treated aneurysms[21]. Sluzewski et al found no benefit of 18 month follow up angiography in patients with complete or near complete aneurysm occlusion at 6 months[22]. In our patients, follow up angiography was advised for each patient between one to six months followed by one at two years in cases with complete occlusion and yearly for those with residual neck. Earlier follow up angiograms were done in case of an enlarging residual neck. Various imaging modalities are tried for following up these aneurysms, but DSA remains best to detect regrowth[24,25,26,27].

The narrow necked aneurysm showed good immediate result (90-100% packing) in all the cases (18/18-100%) with complete occlusion in 15/18 (83.33%) cases. Amongst the wide necked aneurysms, good packing (90-100%) was achieved in 7/9 (77.77%) cases with complete occlusion in 4/9 (44.44%) cases. A statistically significant relationship was noted between the neck size and the degree of packing and immediate angiographic outcome. These results are well established and correspond to that of Zubilaga et al and Bavinzski et al[23,28,29]. Hope et al attempted to identify factors that might be important in predicting success both at the time of treatment and at the time of follow up angiography. They found that the only factor to achieve significance in predicting success at the time of treatment was neck size (P = 0.002, with 86% success for aneurysm neck <=4mm and

50% success for aneurysm neck >4mm)[30].

In our study complete occlusion on follow up angiogram at 1 year was noted in 16/19 (84.21%) small sized aneurysms and 4/8 (50%) large and giant aneurysms. Satisfactory degree of occlusion (90-100%) was achieved in 15/19 (78.94%) cases of small sized aneurysm and 4/8 (50%) cases of large sized aneurysms in the immediate post procedure period. A statistically significant relation was established between the size of the aneurysm and the immediate angiographic result with a Pearson chi square value of 0.004. These results are comparable to that of Kuether et al. and Vineula et al.[5,6]

Initial and long-term follow up angiograms were compared in 19/25 (76.0%) cases of coiled intracranial ruptured aneurysms. Complete and near complete occlusion was seen in 14/19 (73.68%) cases with a stable result in 50% cases and recanalization seen in 26.31% cases over the follow up period. The results were comparable to other previous studies[6,11,31,32].

Shin et al. retrospectively reviewed 18 consecutive patients who presented with acutely ruptured aneurysms and were in very poor neurological condition and who were treated with one-stage embolization and achieved promising results by using one-stage embolization to prevent ultra-early rebleeding[34]. Birchall et al. analysed the technical and clinical outcome in elderly patients receiving endovascular treatment for acutely ruptured intracranial aneurysms and concluded that endovascular coiling is an effective means of treating acute subarachnoid hemorrhage in grade I and II elderly patients[35].In our series, no case of rebleed was seen in the followed up cases of treated aneurysms, however, it is the major concern for interventional treatment[19]. The International Subarachnoid Aneurysm Trial (ISAT) had compared randomly the surgically treated versus endovascularly treated ruptured intracranial aneurysms**.** The relative and absolute risk reductions in dependency or death in that trial after allocation to an endovascular versus neurosurgical treatment were 22.6% and 6.9% respectively. Rebleeding occurred in 2.6% of patients who underwent coiling or attempted coiling and in 1.0% of those who underwent surgery or attempted surgery[19]. But, with expertise we can prevent rebleed in all the endovascularly treated aneurysms as we have seen in this series.

Raymond et al evaluated retrospectively 501 aneurysms in 466 patients treated using detachable coils over a period of ten years for long-term angiographic recurrences. Recurrences were found in 33.6% of treated aneurysms that were followed up. Variables determined to be significant predictors ($P<0.05$) of a recurrence-included aneurysm size $\geq$10 mm, treatment during the acute phase of rupture, incomplete initial occlusions, and duration of follow-up[23]. Thornton et al presented a meta-analysis of 1397 patients, of who 1370 underwent postoperative angiography demonstrating 1569 clipped aneurysms Residual filling was found in 82 aneurysms (5.2%) on immediate postoperative angiography[33]. Our result is comparable to them. All our complications were seen in our early cases and that reflects our learning curve in treating these lesions. The long-term angiographic recurrences were found more often in large sized aneurysms than small sized ones. The long-term stability of the coiled mass is also related to the neck size, presumably because hemodynamic forces are able to act on a larger surface area of the coil ball at the neck of the aneurysm. Although our study represents the effectiveness of endovascular treatment in ruptured aneurysms, it has its limitations. It lacks the prospective randomization of a clinical trial and the limited patient population in each group may lack the power to demonstrate the real effectiveness and complication rate of the procedure in them. In our study experienced operators have performed the procedures. It may be a clinically relevant limitation as in practice, the level of experience varies dramatically. Finally, prospective randomized controlled trials may assist in clarifying the uncertainties that continue to surround the techniques and effectiveness of the procedure in different types of lesion.

CONCLUSION

A positive relationship was noted between the neck size and the immediate and long-term angiographic outcome. Long-term angiographic recurrences were found more often in large sized aneurysms. No case of rebleed was seen in the followed up cases of coiled aneurysms. Endovascular treatment of intracranial ruptured aneurysms is a safe and effective treatment modality and even partial occlusion gave good protection from rebleed.

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REFERENCES

1. *Schievink W I. Intracranial aneurysms. New England journal of Medicine 1997; 336:28-40.*
2. *Kapoor K, Kak VK. Incidence of intracranial aneurysms in north-west Indian population. Neurology India 2003; 51-1:22-26.*
3. *Hop JW, Rinkel GJ, Algra A, Van Gijn. Case fatality rates and functional outcome after subarachnoid hemorrhage: a systematic review. Stroke 1997; 28:660-64.*
4. *Bouthillier A, Van Loveran HR, Keller JT. Segments of the Internal carotid artery: a new classification. Neurosurgery 1996; 38:422-29.*
5. *Vineula F, Duckwiler G, Mawad M. Guglielmi detachable coil embolization of acute intracranial aneurysms: perioperative anatomical and clinical outcome in 403 patients. J Neurosurgery 1997; 86: 475-82.*
6. *Kuether TA, Nesbit GM, Barnwell SL. Clinical and Angiographic Outcomes, with Treatment Data, for Patients with Cerebral Aneurysms Treated with Guglielmi Detachable Coils: A Single-Center Experience. Neurosurgery 1998; 43: 1016-25.*
7. *Gruber A, Killer M, Bavinzski G, Richling B. Clinical and Angiographic Results of Endosaccular Coiling Treatment of Giant and Very Large Intracranial Aneurysms: A 7-year, Single-center Experience. Neurosurgery 1999; 45: 793-804.*
8. *Bavinzski G, Killer M, Gruber A, Reinprecht A, Gross CE, Richling B. Treatment of basilar artery bifurcation aneurysms by using Guglielmi detachable coils: a 6-year experience. J Neurosurg 1999; 90:843-52.*
9. *Zubilaga AF, Guglielmi G, Vinuela F, and Duckwiler GR. Endovascular occlusion of intracranial aneurysm with electrically detachable coils: Correlation of aneurysm neck size and treatment results. AJNR Am J Neuroradiol 1994; 15: 815-20.*
10. *Hayakawa M, Murayama Y, Duckwiler G, Gobin P, Guglielmi G, Vinuela F. Natu-*

ral History of neck remnant of a cerebral aneurysm treated with the Guglielmi detachable coil system. J Neurosurgery 2000; 93: 561-8

11. Murayama Y, Nien YL, Duckwiler GR, Gobin Y, Jahan R, Frazee J, et al. Gugleilmi detachable coil embolization of cerebral aneurysms: 11 years experience. J Neurosurgery 2003; 98:959-66.
12. Hunt W E, Hess R M. Surgical risk as related to time of intervention in the repair of intracranial aneurysms. J Neurosurgery 1968; 28: 14-20.
13. Jennett B, Bond M. Assessment of outcome after severe brain damage. Lancet 1975; 1: 480-84.
14. Henkes H, Fischer S, Weber W, Miloslavski E, Felber S, Brew S, Kuehne D. Endovascular coil occlusion of 1811 intracranial aneurysms: Early angiographic and clinical results. Neurosurgery 2004; 54:268-85.
15. Lubicz B, Leclerc X, Lejune JP, and Pruvo JP. Endovascular treatment of ruptured intracranial aneurysms in Elderly people. AJNR Am J Neuroradiol 2004; 25: 592-5.
16. Aymard A, Gobin YP, Hodes JE, Bien S, Rufenacht D, Reizine D, et al. Endovascular occlusion of vertebral arteries in the treatment of unclippable vertebrobasilar aneurysms. J Neurosurg 1991; 74: 393–8.
17. Raymond J, Roy D, Bojanowski M. Endovascular treatment of acutely ruptured and unruptured aneurysms of the Basilar bifurcation. J Neurosurgery 1997; 86: 211-19.
18. Eskridge JM, Song JK. Endovascular embolization of 150 basilar tip aneurysms with guglielmi detachable coils: Results of Food and Drug administration multicenter clinical trial. J Neurosurgery 1998; 89: 81-6.
19. International Subarachnoid aneurysm trial collaborative group: International Subarachnoid aneurysm trial (ISAT) of Neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomized trial. Lancet 2002; 360:1267-74.
20. Brilstra EH, Rinkel GJE, van der Graaf Y, van Rooij WJJ, Algra A. Treatment of Intracranial aneurysms by embolization with coils, A systematic review. Stroke 1999; 30:470-6.
21. Johnston SC, Higashida RT, Barrow D, Caplan L, Dion J, Hademenos G, et al. Recommendations for the endovascular treatment of intracranial aneurysms; A statement for healthcare professionals from the committee on cerebrovascular imaging of the American Heart association council on cardiovascular Radiology. Stroke 2002; 33:2536-44.
22. Sluzewsk M, van Rooij WJ, Rinkel GJ, Wijnalda D. Endovascular treatment of ruptured intracranial aneurysms with detachable coils: Long term clinical and serial Angiographic results. Radiology 2003; 227:720-4.
23. Raymond J, Guilbert F, Weill A, Georganos SA, Juravsky L, Lambert A, et al. Long-Term Angiographic Recurrences After Selective Endovascular Treatment of Aneurysms With Detachable Coils. Stroke 2003; 34:1398-402.
24. Boulin A, Pierot L. Follow-up of Intracranial Aneurysms Treated with Detachable Coils: Comparison of Gadolinium-enhanced 3D Time-of-Flight MR Angiography and Digital Subtraction Angiography. Radiology 2001; 219:108-13.
25. Cottier JP, Bleuzen-Couthon A, Gallas S, Vinikoff-Sonier CB, Bertrand P, Domengie F, et al. Intracranial Aneurysms Treated with Guglielmi Detachable Coils: Is Contrast Material Necessary in the Follow-up with 3D Time-of-Flight MR Angiography? AJNR Am J Neuroradiol 2003; 24:1797-803.
26. Schuknecht B, Chen JJ, Valavanis A. Transcranial color-coded Doppler sonography of intracranial aneurysms before and after endovascular occlusion with Guglielmi detachable coils. AJNR Am J Neuroradiol 1998; 19:1659-67.
27. Turner CL, Higgins JNP, Kirkpatrick PJ. Assessment of Transcranial Color-coded Duplex Sonography for the Surveillance of Intracranial Aneurysms Treated with Guglielmi Detachable Coils. Neurosurgery 2003; 53-4:866-72.
28. Zubilaga AF, Guglielmi G, Vinuela F, Duckwiler GR. Endovascular occlusion of intracranial aneurysm with electrically detachable coils: Correlation of aneurysm neck size and treatment results. AJNR Am J Neuroradiol 1994; 5: 815-20.
29. Bavinzski G, Killer M, Gruber A, Reinprecht A, Gross CE, Richling B. Treatment of basilar artery bifurcation aneurysms by using Guglielmi detachable coils: a 6-year experience. J Neurosurg 1999; 90:843-52.
30. Hope JKA, Byrne JV, Molneux AJ. Factors influencing successful angiographic occlusion of aneurysms treated by coil embolization. AJNR Am J Neuroradiol 1999; 20:391-9.
31. Hayakawa M, Murayama Y, Duckwiler G, Gobin P, Guglielmi G, Vinuela F. Natural History of neck remnant of a cerebral aneurysm treated with the Guglielmi detachable coil system. J Neurosurgery 2000; 93: 561-8.
32. Friedman JA, Nichols DA, Meyer FB, Pichelmann MA, McIver JI, Toussaint LG, III, et al. Gugleilmi detachable coil treatment of ruptured saccular cerebral aneurysms: Retrospective review of a 10 year single center experience. AJNR Am J Neuroradiol 2003; 24:526-33.
33. Thornton J, Bashir Q, Aletich VA, Debrun GM, Ausman JI, Charbel F T. What Percentage of Surgically Clipped Intracranial Aneurysms Have Residual Necks? Neurosurgery 2000; 46:1294-8.
34. Shin YS, Kim SY, Kim SH, Ahn YH, Yoon SH, Cho KH, et al. One-stage embolization in patients with acutely ruptured poor-grade aneurysm. Surg Neurol. 2005; 63:149-54.
35. Birchall D, Khangure M, McAuliffe W, Apsimon H, Knuckey N. Endovascular management of acute subarachnoid haemorrhage in the elderly. Br J Neurosurg. 2001; 15:35-8.

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Fellows and members are aware about the establishment of prestigious Award of IMSA 'Dr. Pinnamaneni Narasimha Rao International Award ' in memory of past President of IMSA Dr. P. Narasimha Rao. This award is established on the line of Dr. B.C.. Roy National Award. Family members of Dr. P.Narasimha Rao have contributed substantially financially for this Award. Fund account of this prestigious Award is open and all Fellows and Members are requested to contribute towards this fund generously to make it a unique Award carrying substantial cash payment to the Awardee besides providing local hospitality.

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Dr. R.R.Thukral
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INTRA-ARTERIAL THROMBOLYSIS IN ACUTE STROKE

Dandu Ravi Varma

Interventional Radiology Services, Department of Radiology, Krishna Institute of Medical Sciences, 1-8-31/1, Minister Road, Secunderabad – 500 003 India.

Abstract: *The landscape of acute ischemic stroke therapies has shown rapid evolution over the last several years. Intravenous thrombolytic therapy has proven to be effective in cerebral arterial recanalization in acute stroke. The significant limitation of this mode of therapy is the limited therapeutic window period of 3 hours from onset of symptoms. Intra-arterial thrombolysis offers an alternative in the management of selected patients beyond 3 hours. This review describes role of intra-arterial thrombolysis in the management of acute ischemic stroke.*

Key Words: Intra-arterial thrombolytic therapy; Acute Stroke; therapeutic window

INTRODUCTION

Cerebro-vascular disease is among the leading causes of mortality and morbidity all over the world. It is the third leading cause of death in the developed world, behind heart disease and cancer.[1] About 80% of strokes are due to ischemic causes, comprising of thrombo-emboli from the carotid or intracranial atherosclerotic disease, or from the heart and great vessels. Owing to the exquisite sensitivity of neural tissues to ischemia, cerebro-vascular occlusions rapidly result in parenchymal infarction and little can be done to salvage the damaged brain.

Conservative management of large vessel ischemic stroke is associated with severe neurological deficits and death in many patients; with mortality rates of 17% and 40%, at 30 days and 5 years respectively[2]. Conventional treatment with anticoagulation and Aspirin after acute stroke does not significantly alter the rates of death and dependency at 6 months[3]. Other therapies involving neuro-protective agents have met with limited success so far. Thus, rapid restoration of adequate perfusion appears to be the only therapeutic strategy that has the potential to prevent or limit the progression of cerebral ischemia to infarct.

INTRA-VENOUS THROMBOLYSIS

In 1995, the National Institute of Neurological Diseases and Stroke (NINDS) published the results of a clinical trial where intra-venous infusion of recombinant tissue plasminogen activator (rt-PA) was used to treat acute ischemic stroke within 3 hours of onset of symptoms[4]. The study consisted of 625 patients who were randomly assigned to placebo or thrombolysis. The agent was infused at 0.9mg/Kg of body weight, subject to a maximum dose of 90mg. Although there was no significant improvement in the clinical status at 24 hours, a statistically significant improvement was seen in the rt-PA group at 3 month follow-up. Patients treated with rt-PA were 30% more likely to have minimal or no disability after 3 months. Though thrombolysis was associated with a higher risk of hemorrhage (6.4% as compared to 0.6% in placebo group), there was no significant increase in risk of severe disability or death (17% in treated patient versus 21% in controls).

This study represented a landmark contribution in favor of this mode of therapy. Subsequent trials such as ECASS-I, ECASS-II and ATLANTIS, proved the ineffectiveness of intravenous thrombolysis in an extended window of 0-6 hours after stroke onset[5]. Although the US – FDA approved the use of rt-PA for the treatment of acute stroke in 1996, even in the United States, only 2 – 3 % of patients currently receive this treatment – largely due to the limited therapeutic window of 3 hours from onset of symptoms[6].

Correspondence : Dr.D.Ravi Varma, DM (Neuroradiologist) Fax: +91-(0)40-27840980 **Email**: varmaji@rediffmail.com

INTRA-ARTERIAL THROMBOLYSIS

Intra-arterial thrombolysis provides an alternative mode of therapy in selected patients with acute ischemic stroke. Intra-arterial thrombolytic therapy for acute stroke was first described by Zeumer et al in 1983[7]. Since then, multiple short series and large non-randomized studies have supported the role of intra-arterial thrombolysis in acute stroke.

Direct intra-arterial infusion of the thrombolytic agent has several advantages over intra-venous thrombolytic therapy. The technique delivers the thrombolytic agent directly at the site of vascular occlusion. Often, it is possible to position the tip of the micro-catheter distal to the clot; and after delivery of a small quantity of agent into the distal circulation, the micro-catheter tip is withdrawn into the clot and rest of the agent is infused. This maximizes the local concentration of the agent, while minimizing the activation of systemic thrombolysis. The efficacy of thrombolysis may be improved by careful mechanical disruption of the thrombus with the micro-guidewire. Since the procedure is carried out under guidance of periodic check angiograms, the delivery catheter can be repositioned distally in the vessel as the clot lyses and migrates distally. Infusion of the agent can be terminated once patency of the vessel is restored, thereby minimizing the rate of associated complications.

The efficacy and safety of intra-arterial thrombolysis has been demonstrated by the PROACT – II trial[8]. This was a randomized control trial of intra-arterial thrombolysis for acute stroke within 6 hours of onset of symptoms. One hundred and eighty patients with proximal middle cerebral artery occlusions were randomized to receive intra-arterial

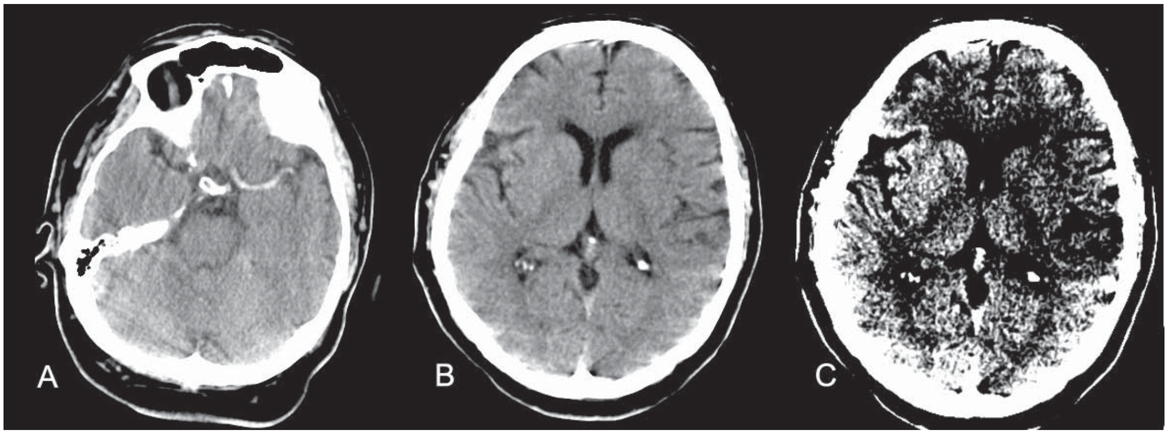

Figure 1: CT signs of acute stroke. Hyperdense middle cerebral artery (A) on the left side; Obscuration of left lentiform nucleus (B) is more pronounced on "narrow window" CT (C)

pro-urokinase (9mg infused over 4 hours) combined with intra-venous low dose heparin, or intravenous heparin alone. Arterial recanalization was achieved in 67% of patients in the pro-urokinase group and in 18% in the heparin group. Despite an increase in rate of early intracranial hemorrhage (27.8% in the pro-urokinase group versus 5.5% in the heparin group within 24 hours), there was no significant difference in mortality between the two groups (24% versus 27% respectively). This was the first study to show benefit with thrombolysis beyond 3 hours of symptom onset.

The rate of arterial recanalization with intra-arterial thrombolysis varies with the site of arterial occlusion as well as the techniques used. Recanalization rates are consistently higher with intra-arterial thrombolysis as compared to intra-venous thrombolysis (70% for intra-arterial compared with 34% with intra-venous thrombolysis). These differences are especially evident in large vessel occlusions such as the internal carotid artery, the terminal carotid segment and M1 segment of middle cerebral artery[9].

The prognosis of infarction in the vertebro-basilar circulation is extremely poor, with mortality and morbidity in 70-80% of the patients. Use of intra-arterial thrombolysis in these patients significantly improves the prognosis. Successful recanalization is associated with a survival rate of 55 – 75% as opposed to 0 -10% in untreated patients or failed recanalization[10,11].Recanalization with intra-arterial thrombolysis is the only life-saving technique that has demonstrated benefit in this group of patients. The time window for thrombolysis in the posterior circulation has not been established, but may be up to or even exceed 12 hours[12]. Based on current evidence, intra-arterial thrombolysis may be offered as a therapeutic option in selected patients who present between 3-6 hours of onset of symptoms in anterior circulation strokes and within 12 hours of onset of symptoms in posterior circulation strokes.

PROCEDURE OF INTRA ARTERIALTHROMBOLYSIS

When a patient who is a candidate for thrombolytic therapy, presents to the emergency department within the window period, rapid initiation of the stroke protocol must be done to minimize the delays in management. A baseline neurological assessment is performed, along with documentation of the NIH stroke scale. Temperature, pulse, blood pressure and respiratory rate are recorded. Samples of blood are drawn for laboratory evaluation of the complete blood picture, platelet counts, and serum electrolytes, blood glucose, parameters of renal function, liver function and coagulation pathways. A 12- lead ECG is also obtained[9].

The role of imaging in a patient with acute stroke is to confirm the presence of ischemia, to rule out other stroke mimics, to rule out established infarction and other contraindications for thrombolytic therapy. The two major neuro-imaging modalities that are used in acute stroke are CT scan and MRI. CT scan remains the most widely used imaging modality in the evaluation of acute stroke. The chief advantages of CT scan are its ready availability, speed of imaging and familiarity of the treating emergency physician with image interpretation. It has high sensitivity and specificity in the identification of intra-cerebral and sub-arachnoid hemorrhage, which represents contraindications to thrombolytic therapy. Widespread presence of signs of early infarct such as the loss of the insular grey matter ribbon, obscuration of the lentiform nucleus, sulcal effacement may be associated with a higher risk of hemorrhagic transformation following thrombolysis. CT angiography and Dynamic perfusion CT can also be performed on most CT units, to demonstrate the site of vascular occlusion and to delineate the extent of hypo-perfused brain[12].

The introduction of advanced MRI techniques such as diffusion and perfusion weighted imaging has revolutionized imaging in acute stroke. Diffusion weighted imaging (DWI) is extremely

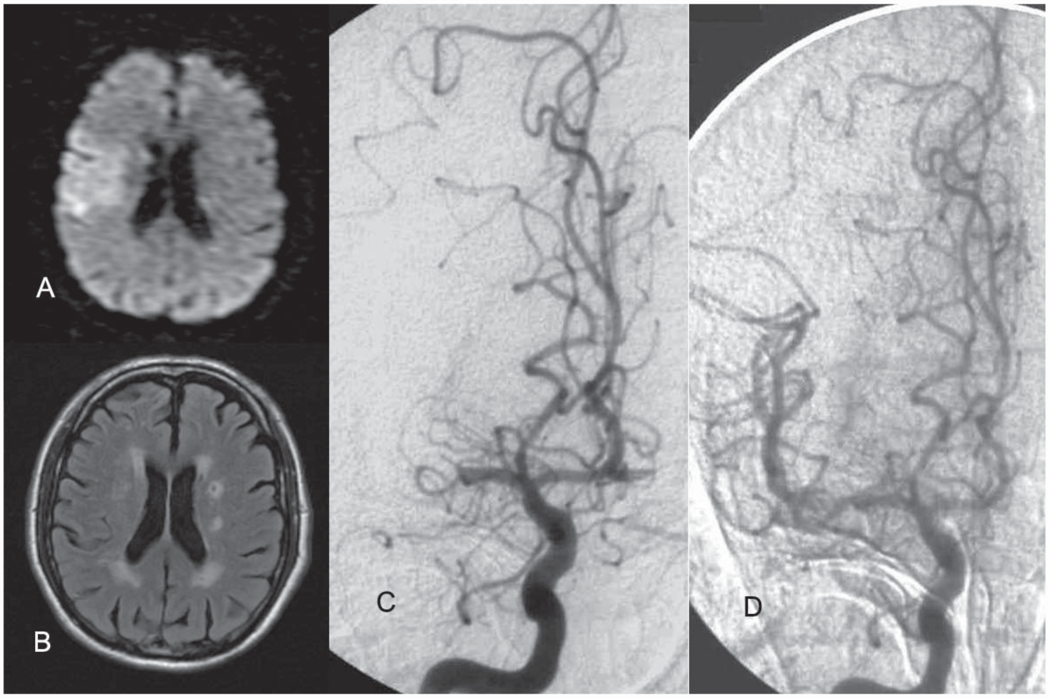

Figure 2: Intra-arterial thrombolysis in acute stroke. Diffusion weighted MRI performed 4 hours after onset of symptoms reveals restricted diffusion in the right perirolandic region (A), though FLAIR study (B) does not reveal any abnormality. Angiogram reveals right middle cerebral artery occlusion (C), that was recanalized using intraarterial urokinase infusion (D).

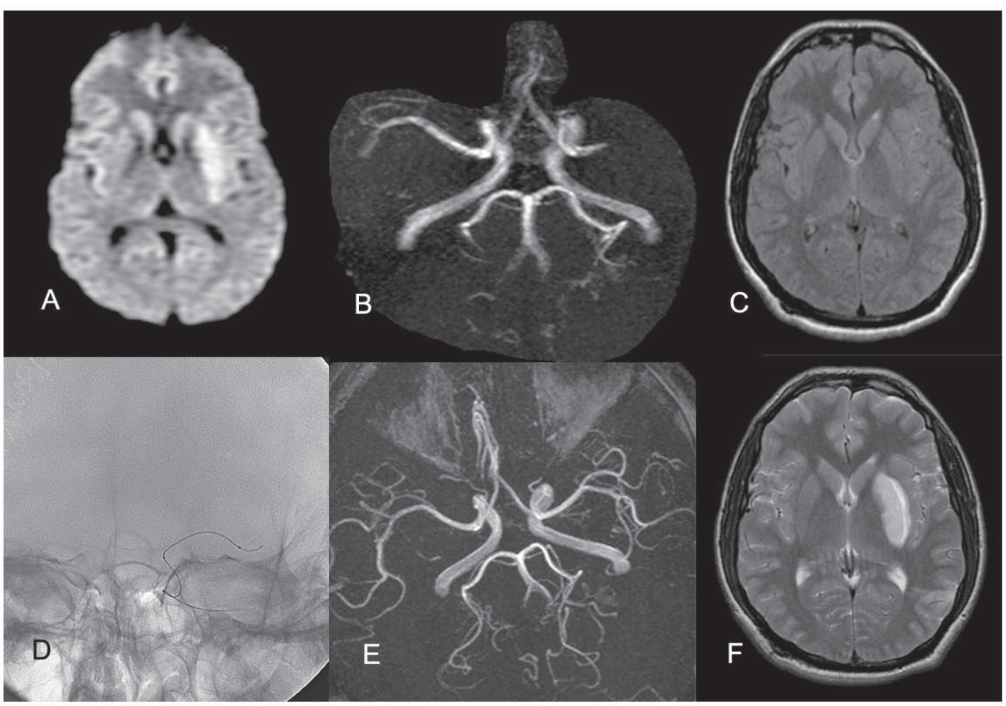

Figure 3: *Acute stroke. Diffusion weighted image and MR angiogram show acute infarct in left lentiform nucleus due to middle cerebral artery occlusion (A, B & C). Intra-arterial thrombolytic therapy (D) with micro-catheter and micro-guidewire positioned across the occlusion. Follow up MRI and MR angiogram (E & F) reveal complete recanalization of left middle cerebral artery and infarction limited to the lentiform nucleus.*

sensitive to ischemia and is generally delineates the infarcted brain. Perfusion weighted imaging (PWI) defines the areas of poor cerebral perfusion. Thus comparing the DWI and PWI images, it is possible to identify areas of ischemic brain that is at risk of irreversible infarction (Diffusion-perfusion mismatch). Several new MR techniques such as susceptibility weighted imaging have been developed to exclude hematoma, hemorrhagic conversion of infarcts and presence of microbleeds, which would represent contraindications to thrombolytic therapy. The versatility of MRI may soon see this modality playing the role of a "Brain clock" to decide whether to initiate thrombolytic therapy rather than the "Epidemiological time clock" that is in use today[12,13].The role of various clinical, laboratory and imaging parameters in decision regarding institution of thrombolytic therapy were summarized by Higashida et al.[9]

The procedure of thrombolysis starts with a diagnostic angiogram of the cranio-cerebral circulation to document the site of occlusion, status of potential collateral pathways, and to exclude other contraindications to thrombolysis. The target vessel is catheterized using a micro-catheter, which is deployed co-axially through a guiding catheter. Systemic heparinization is carried out with administration of 5000 IU bolus of heparin followed by hourly administration of 1000 IU. Most experience of intra-arterial thrombolysis has been obtained with urokinase as the thrombolytic agent. After the clot is gently macerated using the micro-guidewire, Urokinase is infused through the microcatheter into the clot. End points of infusion are complete recanalization, infusion of 1 million units of urokinase, or 6 hours elapsed since onset of symptoms. Periodic check angiograms are obtained and the micro-catheter is repositioned as required.

LIMITATIONS OF INTRA-ARTERIAL THROMBOLYSIS

The major problem with intra-arterial thrombolysis is that this mode of therapy requires ready access to an interventional radiologist and other ancillary staff, trained in intra-arterial thrombolysis, at all times. This is a major limitation and such availability is limited to a few academic institutions. This mode of therapy also requires additional time for catheterization of the cranio-cerebral vessels and accessing the site of occlusion. Though the hemorrhagic complications are commoner with intra-arterial thrombolysis, there was no significant difference in the outcome.

PATIENT EDUCATION

Perhaps the greatest impediment in the emergency management of acute stroke is the lack of awareness amongst the general public regarding the importance of early treatment. Most members of the general public fail to correctly recognize the symptoms of stroke or are unaware that stroke is a medical emergency. Thus most stroke patients present for medical care outside the therapeutic "window period" where thrombolytic therapy can reverse the neurological deficits. Lack of accessibility to specialized stroke centers with facilities and expertise for rapid imaging and endovascular recanalization is another issue that needs to be addressed by health care administrators.[14,15]

REFERENCES

1. *American Heart Association. 1997 Heart and Stroke statistical Update 1997; 13 – 14.*
2. *Chambers BR, Norris JW, Shurvell BL, et al. Prognosis of acute stroke. Neurology 1987; 37: 221 – 225.*
3. *International Stroke Trial Collaborative Group. The International Stroke Trial (IST): A randomized trial of aspirin, subcutaneous heparin, both, or neither among 19435 patients with acute ischemic stroke. Lancet 1997; 349: 1569 – 1581.*
4. *The National Institute of Neurological Disorders and Stroke rt-PA Stroke Study Group. Tissue plasminogen activator for acute ischemic stroke. N Engl J Med 1995; 333: 1581 - 1587.*
5. *Ringleb PA, Schellinger PD, Schranz C, et al. Thrombolytic therapy within 3 to 6 hours after onset of ischemic stroke: Useful or Harmful? Stroke 2002; 33: 1437 - 1441.*
6. *Katzan IL, Furlan AJ, Lloyd LE, et al. Use of tissue-type plasminogen activator for acute ischemic stroke: the Cleveland area experience. JAMA 2000; 283: 1151–1158.*
7. *Zeumer H, Hacke W, Ringelstein EB. Local intra-arterial thrombolysis in vertebro-basilar thrombo-embolic disease. AJNR Am J Neuroradiol 1983; 4: 401- 404.*
8. *Furlan A, Higashida R, Wechsler L, et al. Intra-arterial prourokinase for acute ischemic stroke. The PROACT II study: a randomized controlled trial. Prolyse in Acute Cerebral Thromboembolism. JAMA 1999; 282 : 2003 – 2011.*
9. *Higashida RT, Furlan AJ. Trial design and reporting standards for intraarterial cerebral thrombolysis for acute ischemic stroke. Stroke 2003; 34: e109 – e137.*
10. *Brandt T, von Kummer R, Muller Kuppers M, Hacke W. Thrombolytic therapy of acute basilar artery occlusion: variables affecting recanalization and outcome. Stroke 1996; 27: 875–881.*
11. *Hacke W, Zeumer H, Ferbert A, Brückmann H, Del Zoppo G. Intraarterial thrombolytic therapy improves outcome in patients with acute vertebrobasilar occlusive disease. Stroke 1988; 19: 1216–1222.*
12. *Schellinger PD, Fiebach JB, Hacke W. Imaging-based decision making in thrombolytic therapy for ischemic stroke - Present status. Stroke. 2003; 34: 575 – 587.*
13. *Hjort N, Butcher K, Davis SM, et al. Magnetic resonance imaging criteria for thrombolysis in acute cerebral infarct. Stroke. 2005; 36: 388 - 397*
14. *Nandigam K, Narayan SK, Elangovan S, et al. Feasibility of acute thrombolytic therapy for stroke. Neurology India 2003; 51: 470 – 473.*
15. *Pandian JD. Feasibility of acute thrombolytic therapy for stroke: Comments. Neurology India 2004; 52: 126 – 127.*

INTERVENTIONAL MANAGEMENT OF INTRACRANIAL ARTERIO-VENOUS MALFORMATIONS

Arun Kumar Gupta, Sukalyan Purkayastha and Narendra K Bodhey
Department of Imaging Sciences and Interventional Radiology,
Sree Chitra Tirunal Institute for Medical Sciences and Technology,Trivandrum – 695 011INDIA

Abstract: *Arteriovenous Malformations (AVMs) are a complex network of abnormal vascular channels that consist of arterial feeders, arterial collaterals, the AVM nidus and the enlarged venous outflow channels. All AVMs have three components a) feeding arteries; b) nidus and c) draining vein.Majority of the symptoms of AVMs are due to abnormal homodynamic situation causing hemorrhage, seizure or increasing neurological deficit. More than 50% of AVMs present with spontaneous intracranial hemorrhage. Intracerebral hemorrhage occurs more commonly, although subarachnoid hemorrhage and intraventricular hemorrhage can also occur. The possible sites of hemorrhage in AVMs include nidus, proximal arterialized vein, intranidal aneurysm and feeding artery aneurysm.The goal of treatment is complete obliteration of nidus to get the cure. The pre-procedural imaging in Cerebral AVMS relies on Digital Subtraction Angiography (DSA), which is still the gold standard for diagnosis and management. CT demonstrates serpigeneous iso or hyperdense tangled mass of vessels which show intense enhancement. There may be evidence of hemorrhage, calcification, gliotic scar and ischemic changes in the surrounding brain. MRI and MRA are superior to CT in demonstrating the topography of the AVM. MR is more accurate than CT in determining the overall size of the nidus. It is also better suited to demonstrate subacute and chronic hemorrhage and secondary changes in the adjacent brain. Spetzler and Martin Grading of AVMs is based on size, location and deep venous drainage.*

The treatment options for cerebral AVMs include Surgical excision, Endovascular embolization, Stereotactic radiotherapy or a combination of above. The current understanding of hemodynamics of AVM is focused on 'nidus', with endovascular embolization aimed at its obliteration. Surgery is generally done as an elective procedure. The factors to be considered for surgical excision of cerebral AVM includes: location, type of lesion, larger sized malformation. Stereotactic Radiotherapy irradiates blood vessels of the AVM to cause progressive luminal obliteration & thereby preventing hemorrhage. A multidisciplinary approach provides the best outcome.

Key Words : Arteriovenous Malformations (AVMs): Nidus: Endovascular embolization

INTRODUCTION

Arteriovenous Malformations (AVMs) are a complex network of abnormal vascular channels that consist of arterial feeders, arterial collaterals, the AVM nidus and the enlarged venous outflow channels. Presence of a shunt between the arterial and the venous system is essential for diagnosis. All AVMs have three components a. Feeding arteries b. Nidus c. Draining Vein. Intracranial arteriovenous malformations (AVMs) are generally of two types I. AVM with plexiform Nidus – A collection of multiple small vessels with AV Shunt. II. A fistula- A single direct communication between one artery & vein. Approximately 83% to 93% AVMs are supratentorial.

Majority of the symptoms of AVMs are due to abnormal homodynamic situation causing hemorrhage, seizure or increasing neurological deficit. Autopsy data suggest that there is an overall frequency of detection of AVMs in 4.3 - 6% of population[1]. In another autopsy series an incidence of 1.4% was reported, 46 AVMs among 3200 brains; and 12.2% were symptomatic[2]. In a population-based study in Olmsted County, Minnesota, the detection rate was 1.1 per 100 000 for AVMs when autopsy cases were excluded and 2.1 per 100 000 for all cases. The detection rate for symptomatic cases was 1.2 per 100 000 person-years[3]. The most common type of vascular malformation detected was AVM, followed by venous malformation and cavernous malformation. Incidence of AVMs is generally considered to be 1/7th to 1/10th of aneurysms.

Correspondence : Dr. Arun Kumar Gupta, Professor and Head,Department of Imaging Sciences and Interventional Neuroradiology, Sree Chitra Tirunal Institute for Medical Sciences and Technology Trivandrum – 695 011, India
e-mail: gupta209@yahoo.com.

NATURAL HISTORY AND CLINICAL PRESENTATION OF CEREBRAL AVMS

Prevalence data suggest that up to 0.1 percent of the population (300,000 persons) in the United States may have an arteriovenous malformation[4]. Autopsy data suggest that only 12 percent of arteriovenous malformations are symptomatic during life. More than 50% of AVMs present with spontaneous intracranial hemorrhage[4]. Intracerebral hemorrhage (41-79%) occurs more commonly, although subarachnoid hemorrhage (10-20%) and intraventricular hemorrhage (5-10%) can also occur. Rarely AVMs can present with subdural haematomas due to its location. Severe vasospasm from AVM-related hemorrhage is distinctly uncommon, although it is occasionally noted[5, 6]. After hemorrhage next most common presentation is seizure, which occurs in 20% to 25% of cases[7]. Seizures can be either focal or generalized and may be an indicator of the location of the lesion. Other presentations include headaches in 15% of patients, focal neurological deficit in fewer than 5% of cases, pulsatile tinnitus and hydrocephalus due to mass effect. Vascular malformation–related steal phenomena causing focal neurological deficit by altering perfusion in the tissue in the region of the AVM are distinctly uncommon[8].

The overall frequency of hemorrhage caused by vascular malformations in stroke registries indicates a 1% occurrence of AVM-related hemorrhage among all strokes[9]. The available natural history studies indicate an overall risk of initial hemorrhage of 2% to 3% per year[7, 8, 9, 10]. Mortality from the first hemorrhage is between 10% and 30%, although some data suggest that the mortality rate may be lower[11], and 10% to 20% of survivors have long-term disability[7,8,12]. In one study[12] a cohort of 281 consecutive, prospectively enrolled patients was investigated to evaluate the risk for hemorrhage. If one assumes an annual hemorrhage risk among people with previously unruptured AVMs of 2% to 4% per year, the lifetime risk of intracranial hemorrhage in a person with an AVM is approximated by the following formula[13, 14]: *'Lifetime risk (%) = 105- the patient's age in years'*.

In a study the risk during the first year after initial hemorrhage was 6% and then dropped to the baseline rate of 2-4% and became similar to symptomatic patient without bleed; whereas in another study[9], risk of recurrence of bleeding during the first year was 17.9%. Permanent disability is twice of mortality per episode of hemorrhage - 20% to 30%[10]. In a prospective study [12], during a short mean follow-up of 8.5 months, the risk of recurrent hemorrhage was 17.8% per year after presentation with hemorrhage. In that study, only 20 patients were still being followed up who were untreated at 1 year after hemorrhage; the risk of recurrent hemorrhage was 32.9% in the first year after hemorrhage and decreased to 11.3% in subsequent years [12]. The increased rate in the first year after initial hemorrhage has not been noted consistently[10].

Evidence obtained from imaging studies suggesting that radiological parameters may be predictive of hemorrhage risk. There are data that suggest that prior hemorrhage is a strong predictor of hemorrhage[11]. The other parameters which help in predicting the higher risk of bleeding are small AVM size in terms of maximal diameter or volume of AVM[15]; however it has not been noted consistently[11]. High feeding artery pressures may also be related to bleeding risk. AVMs in a periventricular or intraventricular location may also be at increased risk[16], although this has not been found in all studies[17].

The possible sites of hemorrhage in AVMs include nidus, proximal arterialized vein, intranidal aneurysm and feeding artery aneurysm. Characteristics of the venous drainage system, including presence of deep venous drainage, have been reported to be a predictor of presentation with hemorrhage[18] or occurrence of hemorrhage during follow-up in cases initially presenting with or without hemorrhage [11]. In one retrospective study independent predictors of presentation with hemorrhage included central venous drainage, intranidal aneurysm, and periventricular or intraventricular location[16]. In another study, univariate analysis predictors of presentation with hemorrhage included deep venous drainage, arterial supply via perforators, intranidal aneurysms, multiple aneurysms, vertebrobasilar supply, and basal ganglia location. Single draining vein, impaired venous drainage, and deep venous drainage alone were factors in another study[18]. Impaired venous drainage was not an important factor in 2 other studies[16], nor was a single draining vein. Presence of a venous varix was also not predictive of hemorrhage[18]. The nature of the arterial system may also be important; detection of intranidal or sacular aneurysms appears to be an important finding[16, 19]. A low-risk group (risk of 1.0% per year) had no history of prior hemorrhage and >1 draining vein in a compact nidus, whereas a highest-risk group (8.9% per year) comprised those who had a prior hemorrhage, a single draining vein, and/or a diffuse nidus. The factors that determine hemorrhage in a case of AVM is given in Table 1.

Table1: *Morphological Features associated with Hemorrhage*

1. Central venous drainage or single draining vein
2. Periventricular / Intraventricular / Basal ganglionic location
3. Arterial supply from perforating vessels Vertebrobasilar system
4. Intranidal aneurysm
5. High intranidal pressure translated to feeding arteries
6. Venous outflow stenosis
7. Smaller sized AVM (<2.5cm)
8. Feeding artery aneurysm – 10-15%
9. Presence of Hypertension

MANAGEMENT OF CEREBRAL AVMS

The goal of treatment is complete obliteration of nidus to get the cure. For management comprehensive evaluation of a patient with an AVM includes a detailed clinical examination and radiological evaluation of the anatomy with MRI scanning and arteriography. After the comprehensive evaluation has been performed, decisions can be made regarding the best management approach by comparing the natural history of the lesion with the intervention-related morbidity and mortality.

PRE-PROCEDURAL IMAGING IN CEREBRAL AVMS

The pre-procedural imaging in Cerebral AVMS relies on Digital Subtraction Angiography (DSA), which is still the gold standard for diagnosis and management. Superselective DSA in various phases, using microcatheter is absolutely essential for delineation of complete angioarchitecture of AVMs (Fig 1 and 2). Arterial phase shows wedge shaped nidus with broad base towards the cortex and apex towards

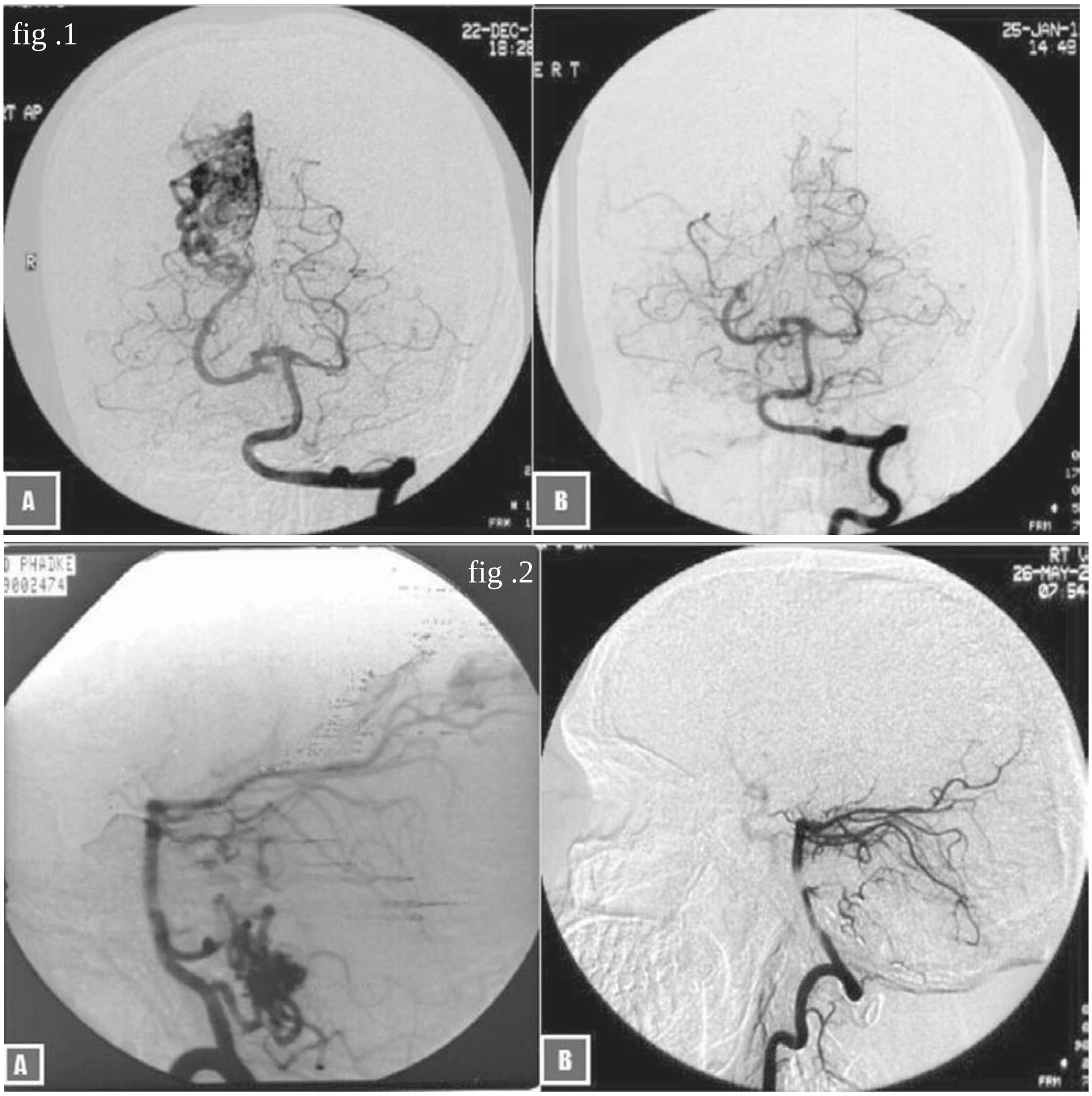

Figure 1& 2 : *Superselective DSA in various phases, using microcatheter is absolutely essential for delineation of complete angioarchitecture of AVMs. Arterial phase shows wedge shaped nidus with broad base towards the cortex and apex towards the ependymal surface. AV shunting is characteristic of AVM but not pathognomonic. Draining veins are dilated and tortuous.Fig. 1A & 2A are pre embolisation; Fig. 1B & 2B are post embolisation angiogram images.*

the ependymal surface. AV shunting is characteristic of AVM but not pathognomonic. Draining veins are dilated and tortuous. The delineation of both the superficial & deep venous system is essential as drainage may occur in varying combination. Identification of other risk feature like venous stenosis, venous varix and venous aneurysm is essential. Angioarchitecture must be completely analysed for effective interventional treatment strategy as outlined in Table 2.

CT Scans entails performing both plain and contrast enhanced brain CT. CT demonstrates serpigeneous iso or hyperdense tangled mass of vessels which show intense enhancement. There may be evidence of hemorrhage, calcification, gliotic scar and ischemic changes in the surrounding brain. Mass effect is also seen due to large

Table 2 *: Comprehensive Angioarchitecture Study*

	Parameter
1.	Number of feeding vessels
2.	Territory of feeding vessels
3.	Nidus
4.	Draining Vein
5.	Feeding artery aneurysm
6.	Intranidal aneurysm
7.	Intranidal fistula
8.	Venous stenosis/venous ectasia
9.	Presence of large venous sac
10.	Number of feeders opening in sump
11.	Draining veins arising from venous sac
12.	Nidus and fistulas opening orientation at sac

tortuous draining veins and size of nidus. There may be hydrocephalus either due to mass effect or due to venous high pressure. CT angiography may help in demonstrating nidus, feeding artery aneurysm and assessment of nidus volume. CT is also valuable in planning of Stereotactic Radiotherapy.

MRI and MRA are superior to CT in demonstrating the topography of the AVM. MR is more accurate than CT in determining the overall size of the nidus. It is also better suited to demonstrate subacute and chronic hemorrhage and secondary changes in the adjacent brain. The increased signals within the vessels may be due to thrombosis, slow flow or turbulence. MRA may help in identifying dural feeders, size of the nidus, feeder and intranidal aneurysm. Functional MRI using Bold technique are useful to localize the cortical functions which will help in planning of treatment of AVM and also in follow up after treatment particularly after Stereotactic Radiotherapy.

Spetzler and Martin Grading of AVMs[21] is based on size, location and deep venous drainage. Analysis of size yields scores of 1,2 and 3 for sizes 0 to 3 cm, 3.1 to 6 cm and greater than 6 cm. Non eloquent location are given a score of 0, while eloquent location are given a score of 1. Eloquent Areas comprise sensory motor cortex, language area, visual cortex, hypothalamus, thalamus, internal capsule, brainstem, cerebellar peduncles and deep cerebellar nuclei. Deep venous drainage absence or presence is valued as 0 or 1resepctively. Inoperable AVMs are put in grade VI. One grade is added in presence of acute hemorrhage. A subclassification of A, B, C is added as necessary, to associate three common conditions associated with increase the risk of bleed, with A denoting constriction or stenosis of venous drainage, B indicating presence of incidental feeder or intranidal aneurysm, and C suggesting periventricular location, The treatment options for cerebral AVMs include Surgical excision, Endovascular embolization, Stereotactic radiotherapy or a combination of above. No active intervention is an important option in select cases. The factors to be considered before making a decision to treat the AVMs include a) natural history, b) age of the patient, c) general health and clinical condition, d) identifying elderly patient with cardiac problem where stereotactic radiotherapy may be preferred or no treatment and e) occupation and lifestyle.

EMBOLISATION FOR CEREBRAL AVMS

The current indications for embolisation include a) patient presenting with intracranial hemorrhage or subarachnoid hemorrhage; b) progressive neurological deficit; c) uncontrolled seizure due to AVM; d) young patient with bleed or deficit or seizure; e) presurgical / pre-RT embolization and f) as a palliative measure. Endovascular Treatment may be done as a) definitive therapy in 20 -40% cases (Fig 3); b) preoperative embolization before surgical excision or Stereotactic Radiotherapy to reduce the size of AVM; c) in large AVM located on eloquent areas and fed by branches of all three cerebral vessels; d) feeders not accessible for surgery –intraventricular, basal ganglionic, thalamic & brainstem; e) deeply located feeders e.g. ACA feeders in parasagittal AVMs, ACA / PCA feeders in posterior frontal and parietal AVMS, PCA feeders in paratrigonal /posterior temporo-occipital AVMs. The optimum time of embolization is generally after an episode of hemorrhage while most authorities recommend a waiting period of 4 to 6 weeks.

The goals of treatment are a) complete obliteration of AVM nidus for complete cure; b) reduction in the size of the nidus before surgery or Stereotactic Radiotherapy; c) obliteration of surgically inaccessible and deep location of AVMs; d) embolisation of feeding arteries from PCA branches, choroidal arteries, anterior/posterior perforating arteries; e) occlusion of Intranidal aneurysm and e) occlusion of high flow fistulas.

The current understanding of hemodynamics of AVM is focused on ‘nidus’, with endovascular embolization aimed at its obliteration. A hemodynamic profile of AVM is a function of number, position & caliber of feeding pedicles, length of feeding pedicles, resistance of the nidus, venous drainage and associated fistulae. Typically flow in an AVM ranges between 150 to 900 ml with an average of 490ml/min. The intraluminal pressure of feeding pedicle in small AVMs is high while large AVMs have low feeding artery pressure. AVM embolization should be done as staged procedure range from 48 hours to 2 wks to 2 months. This selection aims to avoid effects of ‘Normal Perfusion Pressure Breakthrough’ (NPPB) because hemodynamics get normalized in 10 days to 2 weeks time. Typically one to four pedicles per session may be embolised. Feeding artery pressure measurement is important, since pressure in the feeding pedicle has been correlated with risk of hemorrhage. Furthermore, the reliability with microcatheter has been confirmed. Pedicle pressure tends to rise during embolization and approach systemic MAP and greater than 75% MAP in the pedicle may be associated with development of Normal Perfusion Pressure Breakthrough (NPPB). Common complications of glue embolisation include a) hemorrhage which can be *acute* due to vessel perforation or *delayed* due to NPPB or venous occlusion due to glue; b) Stroke which can be attributable to catheter induced thromboembolism or reflux of glue in normal vessels and c) gluing of microcatheter.

Ethanol embolisation uses ethanol which is a very potent but dangerous embolic material[22]. It causes intense vasospasm and can cause infarcts if reflux in normal vessels. The mechanism of action is denudation of endothelial cells, precipitation of protoplasm, fracturing of blood vessel wall up to the level of internal elastic lamina all leading to intense vasospasm which gradual causes thrombosis of the AVM. The incidence of NPPB with ethanol is less due to gradual thrombosis & occlusion of AVM. Upper safe limit of ethanol is not known but a dose of 0.5ml/kg body weight may be safe. The maximum recommended of Ethanol is up to 1ml/kg body weight.

SURGERY FOR CEREBRAL AVMS

Surgery is generally done as an elective procedure. The

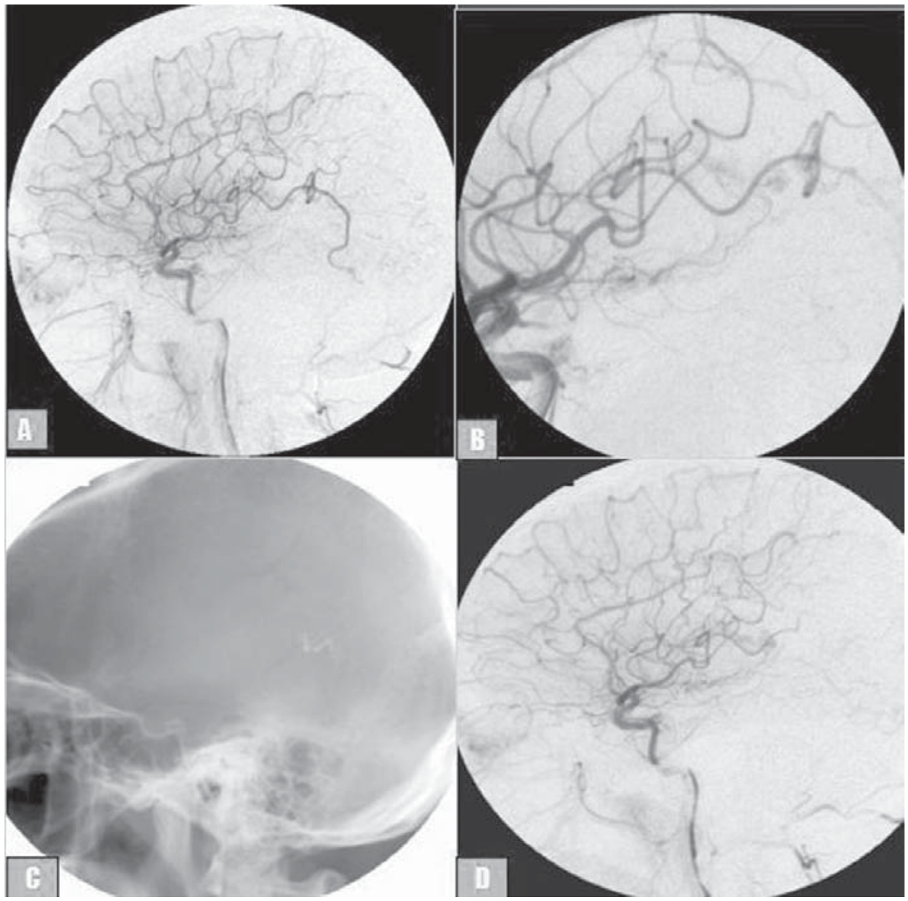

Figure 3 : *Endovascular Treatment sharing complete obliteration of AVM nidus indicately complete cure; reduction in the size of the nidus; occlusion of Intranidal aneurysm*

factors of to be considered for surgical excision of cerebral AVM includes: location, type of lesion, larger sized malformation. Location such as brainstem, posterior limb of internal capsule and deep gray matter nuclei are considered as surgically challenging.

STEREOTACTIC RADIOTHERAPY FOR AVMS

Stereotactic Radiotherapy irradiates blood vessels of the AVM to cause progressive luminal obliteration & thereby preventing hemorrhage. It is currently indicated in following situations : a) most appropriate for small AVMs in eloquent areas, giving satisfactory results with less complications, and b) lesions with volume less than ten cubic centimeter and maximum diameter <3cm. The thrombosis rates in patients undergoing stereotactic radiotherapy by gamma or x-knife[23], is expressed as first and second year occlusion rates. Literature evidence supports the following occlusion rates: 1st and 2nd year occlusion rates of 33.7%-39.5% 79% to 86.5% from Steiner et al, 2nd year occlusion rate at 64% from Yamamoto et al and 80% from Lunsford et al.

Clinical experience reveals that stereotactic radiotherapy in properly selected small AVMs can leads to complete AVM obliteration in ~80% of patients within 2 years. In MRI, the indicator of successful treatment after stereotactic radiotherapy is denoted by a decreased size of the nidus, a decreased number of flow voids, presence of hyperintense signals on T2 images and a persistent contrast enhancement in the area of nidus. Complications of Stereotactic Radiotherapy for AVMs comprise a) hemorrhage with an incidence of 2% to 3% per year, since there is no protective effect against hemorrhage and b) Radiation induced complications like necrosis that occur after 12 to 18 months. The incidence of Post radiotherapy syndrome may be under estimated, but uncommonly they can exacerbate seizure.

CONCLUSION

The main goal of treatment of cerebral AVM is complete obliteration of the nidus or AVM per se. To achieve this goal a careful judgment influencing the outcome based on various factors should be taken. A multidisciplinary approach is provides the best outcome. It is still not clear whether partial obliteration of the lesion in an attempt to reduce mass effect and steal in patients with progressive neurological deficit or medically uncontrolled seizures is beneficial. Thus management of AVMs is still a challenge for medical professionals.

REFERENCES

1. Michelson WJ. Natural history and pathophysiology of arteriovenous malformations. Clin Neurosurg. 1978;26:307–313.
2. The Arteriovenous Malformation Study Group. Arteriovenous malformations of the brain in adults. N Engl J Med. 1999;340:1812–1818.
3. Brown RD, Wiebers DO, Torner JC, et al. Incidence and prevalence of intracranial vascular malformations in Olmsted County, Minnesota, 1965 to 1992. Neurology. 1996;46:949–952.
4. Brown RD Jr, Wiebers DO, Torner JC, O'Fallon WM. Frequency of intracranial hemorrhage as a presenting symptom and subtype analysis: a population-based study of intracranial vascular malformations in Olmsted County, Minnesota. J Neurosurg 1996;85:29-32.
5. Maeda K, Kurita H, Nakamura T, et al. Occurrence of severe vasospasm following intraventricular hemorrhage from an arteriovenous malformation. J Neurosurg. 1997;87:436–438.
6. Kothbauer K, Schroth G, Seiler RW, and Do DD. Severe symptomatic vasospasm after rupture of an arteriovenous malformation. AJNR Am J Neuroradiol 1995 16: 1073-1075.
7. Wilkins RH. Natural history of intracranial vascular malformations: a review. Neurosurgery. 1985;16:421–430.
8. Mast H, Mohr JP, Osipov A, et al. "Steal" is an unestablished mechanism for the clinical presentation of cerebral arteriovenous malformations. Stroke. 1995;26:1215–1220.
9. Fults D, Kelly DL. Natural history of arteriovenous malformations of the brain: a clinical study. Neurosurgery. 1984;15:658–662.
10. Ondra SL, Troupp H, George ED, et al. The natural history of symptomatic arteriovenous malformations of the brain: a 24 year follow-up assessment. J Neurosurg. 1990;73:387–391.
11. Hartmann A, Mast H, Mohr JP, et al. Morbidity of intracranial hemorrhage in patients with cerebral Arteriovenous malformation. Stroke. 1998;29: 931–934.
12. Mast H, Young WL, Koennecke HC, et al. Risk of spontaneous haemorrhage after diagnosis of cerebral arteriovenous malformation. Lancet. 1997; 350:1065–1068.
13. Kondziolka D, McLaughlin MR, Kestle JR. Simple risk predictions for arteriovenous malformation hemorrhage. Neurosurgery. 1995;37:851–855.
14. Brown RD. Simple risk predictions for arteriovenous malformation hemorrhage. Neurosurgery. 2000;46:1024. Letter.
15. Duong DH, Young WL, Vang MC, et al. Feeding artery pressure and venous drainage pattern are primary determinants of hemorrhage from cerebral arteriovenous malformations. Stroke. 1998;29:1167–1176.
16. Drummond JC, Patel PM. Cerebral physiology and the effects of anesthetic agents and techniques. In: Miller R, ed. Anesthesia. 5th ed. New York, NY: Churchill Livingston; 2000:695–734.
17. Turjman F, Massoud TF, Vinuela F, et al. Correlation of the angioarchitectural features of cerebral arteriovenous malformations with clinical presentation of hemorrhage. Neurosurgery. 1995;37:856–860; discussion 860–862.
18. Kader A, Young WL, Pile-Spellman J, et al. The influence of hemodynamic and anatomic factors on hemorrhage from cerebral arteriovenous malformations. Neurosurgery. 1994;34:801–807; discussion 807–808.
19. Pollack BE, Flickinger JC, Lunsford LD, et al. Factors that predict the bleeding risk of cerebral arteriovenous malformations. Stroke. 1996;27:1–6.
20. Brown RD, Wiebers DO, Forbes GS. Unruptured intracranial aneurysms and arteriovenous malformations: frequency of intracranial hemorrhage and relationship of lesions. J Neurosurgery. 1999;73:859-863.
21. Spetzler RF, Martin NA. A proposed grading system for arteriovenous malformations. J Neurosurg. 1986;65:476-483.
22. Yakes WF, Hass DK, Parker SH, et al. Symptomatic vascular malformations: ethanol embolotherapy. Radiology. 1989;170:1059-1066.
23. Yamamoto Y, Coffey RJ, Nichols DA, et al. Interim report on the radiosurgical treatment of cerebral arteriovenous malformations: the influence of size, dose, time and technical factors on obliteration rate. J Neurosurg. 1995;83:832-837.

DRUG PROFILE

SOLIFENACIN SUCCINATE

Solifenacin succinate is a muscarinic receptor antagonist. Chemically, it is butanedioic acid, compounded with (1S)-(3R)-1-azabicyclo (2.2.2) oct-3-yl3,4-dihydro-1phenyl-2(1H)-isoquinolinecarboxylate (1:1) having an empirical formula ($C_{23}H_{26}N_2C_4H_6O_4$), and a molecular weight of 480.55. **Mechanism of Action** : Solifenacin is a competitive muscarinic receptor antagonist. Muscarinic receptors play an important role in several major cholinergically mediated functions, including contractions of urinary bladder smooth muscle and stimulation of salivary secretion. **Pharmacokinetics** : After oral administration of solifenacin to healthy volunteers, peak plasma levels (C max) of solifenacin are reached within 3 to 8 hours after administration, absolute bioavailability of solifenacin is approximately 90%

Solifenacin is extensively metabolized in the liver. The primary pathway for elimination is by way of CYP3A4; through N-oxidation of the quinuclidin ring and 4R-hydroxylation of tetrahydroisoquinoline ring. One pharmacologically active metabolite (4R-hydroxy solifenacin) and three pharmacologically inactive metabolites (N-glucuronide and the N-oxide and 4R-hydroxy-N-oxide of solifenacin) have been found in human plasma after oral dosing.

***INDICATIONS* [1,2] :**The drugs are indicated for the treatment of overactive bladder with symptoms of urge incontinence.

DOSE The recommended dose is 5 mg daily, may be increased to 10 mg once daily. If required no dose adjustment is necessary for patients with mild hepatic impairment; for severe renal impairment (CLcr<30 mL/min), and serve hepatic derangement a daily dose of greater than 5 mg is not recommended. Safety and effectiveness in children have not yet been established.

CONTRAINDICATIONS: include urinary retention, severe gastrointestinal condition (including toxic megacolon), myasthenia gravis or narrow-angle glaucoma; hypersensitive severe hepatic impairment; severe renal impairment or moderate hepatic impairment patient on a potent CYPA4 inhibitor, e.g. ketaoconazole.

***PRECAUTIONS* [1,2]** : Solifenacin should be used with caution in patients with: bladder neck obstruction hiatus hernia/gastroesophageal reflux; autonomic neuropathy.

Patients with Congenital or Acquired QT Prolongation

The maxium effect of solifenacin can be determined after 4 weeks at the earliest.

DRUG INTERACTIONS

Drugs Metabolized by Cytochrome P450, interaction occurs with

CYP 3A4 Inhibitors : (e.g.Rifampicin, phenytoin, carbamazepine)

Ketoconazole, Oral Contraceptives, Warfarin, Digoxin, *Antichlinergic Agents*: More pronounced therapeutic effects and undesirable effects. *Metoclopramide and Cisapride*: Reduce the effect of medicinal products that stimulate the motility of the gastrointestinal tract.

***ADVERSE EFFECTS* [1,2]** Dry mouth, constipation, blurred vision (accommodation abnormalities), urinary retention and dry eyes. The overall rate of serious adverse events in the double-blind trials was 2%.

BRONCHIAL ARTERY EMBOLIZATION IN LIFE THREATENING HAEMOPTYSIS

C Mohan, IK Indrajit, K Pathak, M Patel, A Chaturvedi, GS Sabhikhi

Department of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi-110010, India

Abstract: *Massive haemoptysis is an alarming event and represents one of the most challenging conditions encountered in medical emergency. Over last few years, bronchial artery embolization (BAE) has emerged as a primary modality for managing severe and life threatening haemoptysis. In 90% of cases, the source of massive haemoptysis is the bronchial circulation whereas in approximately 5% each non bronchial circulation and pulmonary circulation may be responsible for haemoptysis.In the non-Western world, pulmonary tuberculosis and post tubercular bronchiectasis are the most common underlying causes of massive hemoptysis.BAE comprises of an initial thoracic aortogram that shows abnormal bronchial arteries and non bronchial systemic arteries that supply parenchymal lesions in majority of cases. Selective catheterization of bronchial arteries and super-selective catheterization using microcatheter may be performed for safe positioning in the bronchial circulation beyond the origin of spinal cord branches to prevent severe complications. Abnormal angiographic findings in massive hemoptysis include hypertrophic & tortuous bronchial arteries, hypervascularity, shunting into the pulmonary artery or vein or extravasations of contrast medium. A variety of embolic materials are used for BAE. Absorbable gelatin sponge is widely used because it is inexpensive and easy to handle. BAE is effective in controlling acute massive hemoptysis. An initial success rates for BAE have been reported to be 73%–98%. However, long-term recurrence rates have been reported to be 10%–52%. Recurrence rate may also be influenced by the cause of the hemoptysis. Recurrent bleeding is more common in patients with chronic tuberculosis, aspergilloma, or neoplasm. Indeed, massive haemoptysis should be considered as a life-threatening medical emergency. A well co-ordinated strategy involving different medical and surgical specialists is required for successful management.*

Key Words : Massive Haemoptysis : Bronchial artery embolization (BAE) : Recurrent bleeding

INTRODUCTION

Massive haemoptysis is an alarming event and represents one of the most challenging conditions encountered in medical emergency. Definitive treatment depends on the cause and anatomical localization of massive haemoptysis ranging from immediate surgery to conservative approach. Contraindications to surgery may exist due to bilateral advanced lung disease, poor respiratory effort, large transpleural blood vessels, and continued haemoptysis after previous surgery. Conservative management of massive haemoptysis carries a mortality rate of 50%–100% [1]. Death from haemoptysis is mostly caused by asphyxia resulting from flooding of the airways and alveoli with blood rather than by exsanguination. Hence, early management of haemoptysis is essential for successful outcome. Emergency thoracotomy has been replaced by various bronchoscopic interventions and over last few years, bronchial artery embolization (BAE) has emerged as a primary modality for managing severe and life threatening haemoptysis since its use was first reported in 1973 by Remy et al[3]. The efficacy, safety, and utility of BAE in controlling massive haemoptysis have been well documented. Even in surgical candidates, BAE is effective in preparing the patient for elective rather than high-risk emergency surgery[3].

Correspondence : Dr. C. Mohan, M.D.Professor & Senior Advisor Department of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi-110010, India
e-mail : col30@yahoo.com

SOURCE AND CAUSES OF HAEMOPTYSIS

The definition of massive haemoptysis varies from 100 to 600 ml of blood loss per 24 hours[1-3]. Obviously, haemoptysis that jeopardizes respiratory function should be treated as a medical emergency. In 90% of cases, the source of massive haemoptysis is the bronchial circulation whereas in approximately 5% each non bronchial circulation and pulmonary circulation may be responsible for haemoptysis.

Massive haemoptysis may result from various causes, In the non-Western world, pulmonary tuberculosis and post tubercular bronchiectasis are the most common underlying causes of massive hemoptysis whereas bronchogenic carcinoma and chronic inflammatory lung diseases such as bronchiectasis, cystic fibrosis, or aspergillosis are the more prevalent causes of hemoptysis in Western countries[2,3,4]. Other causes include lung abscess, pneumonia, chronic bronchitis, pulmonary interstitial fibrosis, pneumoconiosis, pulmonary artery aneurysm (Rasmussen aneurysm), congenital cardiac or pulmonary vascular anomalies, aorto-bronchial fistula, ruptured aortic aneurysm, and ruptured bronchial artery aneurysm[5].

PATHOGENESIS

Bronchial arteries proliferate and enlarge to compensate for the reduced pulmonary circulation following occlusion of pulmonary arterioles consequent to hypoxic vaso-constriction, vasculitis and intravascular thrombosis[6].These enlarged bronchial arteries in inflamed area may rupture either due to elevated blood pressure or erosion by a bacterial agent. The arterial blood under systemic arterial pressure subsequently extravasates into the respiratory tree, resulting in massive hemoptysis[6,7].

DIAGNOSTIC WORKUP

It is essential to detect the cause and localize source of bleeding prior to bronchial artery embolization in order to perform procedure efficiently and obtain optimum results.

Conventional radiography is helpful in diagnosing and localizing possible causes of haemoptysis such as pneumonia, pulmonary tuberculosis, bronchogenic cancer, or lung abscess[8]. However, radiographic findings are normal or non localizing in 17%–81% of patients with hemoptysis[9-14]. Hirshberg et al[12] reported diagnostic value of radiography in only 50% of cases. Fiber-optic bronchoscopy (FOB) is effective in evaluation of central bronchial lesions and the overall diagnostic accuracy of FOB in haemoptysis is reported to be 10%–43%[8]. However, its usefulness is limited due to presence of blood in the bronchi in acute haemoptysis. However, the risks of FOB include possible airway compromise from sedation, delay in definitive treatment, hypoxemia, and high cost. Moreover, endo-bronchial therapies are not effective in most cases of massive haemoptysis[8].

CT has proved to be of considerable value in diagnosing bronchiectasis, bronchogenic carcinoma, and aspergilloma in patients with massive hemoptysis[8]. CT may demonstrate lesions that may not be visible on conventional radiographs, and contrast enhanced CT may help demonstrate bronchial and non bronchial systemic feeder vessels and vascular lesions that cause massive hemoptysis. CT findings can suggest a specific diagnosis in 50% of patients in whom FOB findings are non diagnostic and in 39%–88% of patients in whom chest radiographs are non diagnostic[10,11,13]. CT can also help localize the site of bleeding in 63%–100% of patients with hemoptysis[9,14]. Moreover, Multislice CT allows rapid scanning,making timely examination feasible in critically ill patients. It has been stated the combined use of FOB and CT yield the best results in evaluating hemoptysis [14]. However, CT should be performed prior to bronchoscopy in all patients with hemoptysis[10,11,13].

ANATOMICAL CONSIDERATIONS

The bronchial arteries supply the trachea, extra- and intrapulmonary airways, bronchovascular bundles, nerves, supporting structures, regional lymph nodes, visceral pleura, and esophagus as well as the vasa vasorum of the aorta, pulmonary artery, and pulmonary vein[10].The bronchial arteries originate directly from the descending thoracic aorta, most commonly between the levels of the T5 and T6 vertebrae[15]. But the bronchial arteries may have variable anatomy as regards their origin, branching pattern, and course.

Cauldwell et al[16] described four classic bronchial artery branching patterns: two on the left and one on the right that presents as an intercostobronchial trunk (ICBT) (40% of cases); one on the left and one ICBT on the right (21%); two on the left and two on the right (one ICBT and one bronchial artery) (20%); and one on the left and two on the right (one ICBT and one bronchial artery) (9.7%). The right ICBT usually arises from the right posterolateral aspect of the thoracic aorta and is seen in 80% of individual. The normal right and left bronchial arteries usually arise separately from the anterolateral aspect of the aorta but right and left bronchial arteries may arise from the aorta as a common trunk.

The reported prevalence of bronchial arteries with an anomalous origin ranges from 8.3% to 35%[7,18]. Aberrant bronchial arteries may originate from the aortic arch, internal mammary artery, thyrocervical trunk, subclavian artery, costocervical trunk, brachiocephalic artery, inferior phrenic artery, or abdominal aorta.

The aberrant origin of bronchial artery should be suspected especially when a significant bronchial arterial supply to areas of abnormal pulmonary parenchyma is not demonstrated during a catheter search, at descending thoracic aortography or in patients with recurrent hemoptysis despite successful embolization and in those in whom the source of bleeding has not been detected[17,19]. In addition, bronchial arteries of anomalous origin should be suspected and investigated angiographically in patients who present with.

Hypertrophic bronchial arteries are easily visualized as enhancing nodular or tubular structures within the mediastinum and around the central airway on contrast-enhanced CT scan[20] The primary locations of enlarged bronchial arteries at CT are the retroesophageal area, retrotracheal area, retrobronchial area, posterior wall of the main bronchus, and aortopulmonary window[21].

TECHNIQUE OF EMBOLIZATION

A preliminary descending thoracic aortogram should be performed prior to bronchial artery embolization (BAE) to evaluate the number and origin sites of bronchial arteries from the aorta. An initial thoracic aortogram is useful in visualizing abnormal bronchial arteries and non bronchial systemic arteries that supply parenchymal lesions in majority of cases[22]. The choice of catheter depends on the operator and either 4Fr or 5 Fr cobra catheter, Shepherd Hook or Simmons-1 can be used for selective catheterization of bronchial arteries. The super-selective catheterization using microcatheter may be performed for safe positioning in the bronchial circulation beyond the origin of spinal cord branches to prevent severe complications.After catheterization of the abnormal bronchial artery, bronchial angiography is performed with manual injection of contrast medium.

After a preliminary bronchial angiogram study is performed, the catheter is securely inserted into the bronchial artery to be embolized. A coaxial catheter may be used for more selective and more distal placement.

ABNORMAL ANGIOGRAPHIC FINDINGS

Abnormal angiographic findings in massive hemoptysis include hypertrophic & tortuous bronchial arteries, hypervascularity, shunting into the pulmonary artery or vein or extravasations of contrast medium (Figure1a,b&c). Although extravasations of contrast medium is considered a specific sign

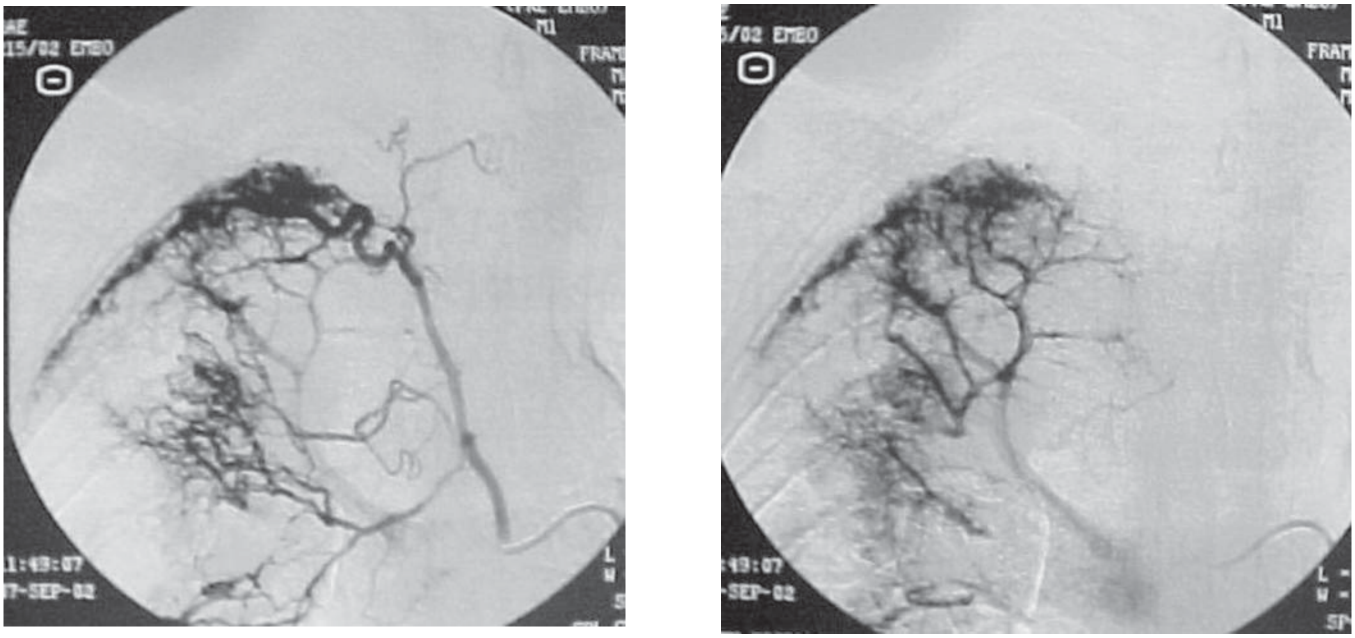

Fig. 1A,B*- Right intercostobronchial trunk supplying marked hypervascularity to upper zone with shunting to pulmonary vein in a case of Pulmonary tuberculosis with pleural thickening*

of bronchial bleeding, this finding is seen in 3.6% to 10.7% of cases only[23]. Thus, the determination of arteries are to be embolized should be based on a combination of CT, bronchoscopic, and angiographic findings with clinical correlation. All angiograms, including intercostal arteriograms, must be carefully scrutinized for opacification of spinal arteries to avoid inadvertent embolization.

EMBOLIC MATERIALS

A variety of embolic materials are used for BAE. Absorbable gelatin sponge is widely used because it is inexpensive and easy to handle. However, disadvantages of absorbable gelatin sponge are its early resolvability and recanalization leading to recurrent haemoptysis[24].

Polyvinyl alcohol particles are non absorbable embolic materials, and particles 350–500 µm in diameter are the most frequently used worldwide[25]. Their use may prevent the early recurrence of hemoptysis due to recanalization of the embolized artery. Polyvinyl alcohol particles of less than 350–500 µm should not be used for BAE to prevent crossing of broncho-pulmonary anastamosis and pulmonary infarction. These particles , however, can be safely used even in the presence of Bronchopulmonary fistula for control of massive hemoptysis.

Liquid embolic agents (eg, isobutyl-2 cyanoacrylate, absolute ethanol) are not currently used because of the high risk complications like tissue necrosis.

Stainless steel/ platinum coils are generally not used for BAE because they tend to occlude more proximal vessels and may preclude repeat embolization in case of recurrence of haemoptysis. However, they may occasionally be used in the internal mammary artery to prevent embolization of a

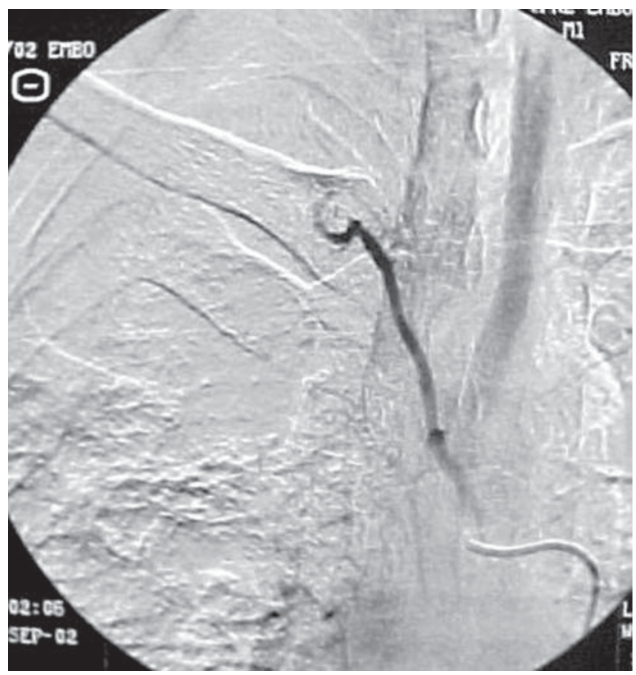

Fig 1C-Post embolization angiogram with total obliteration of hypervascularity

normal vascular territory and development of collateral vessels (Figure 2 a&b).

TECHNICAL SUCCESS

BAE is effective in controlling acute massive hemoptysis. The initial success rates for BAE have been reported to be 73%–

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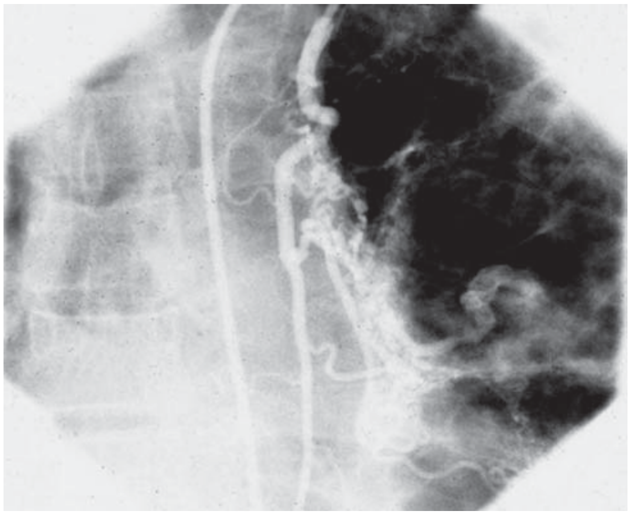


***Figure 2A(Pre)**: Hypertioplived left internal maxillary artery with marked hypervascularity*

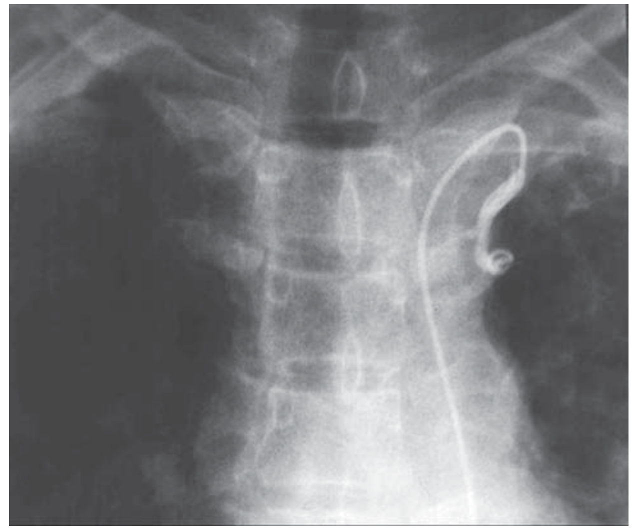


***Figure 2B (Post)**: Successful occlusion with coil & obliteration of hypervascularity*

98%.However, long-term recurrence rates have been reported to be 10%–52%, with a mean follow-up period ranging from 1 to 46 months [(1,3)]. However, the long-term success rate can be improved with repeat BAE. It is important to remember that BAE does not treat the underlying disease and hemoptysis may recur after successful BAE if the disease process is not controlled with drug therapy or surgery. BAE may also be used as a palliative procedure that prepares the patient for elective curative surgery for localized disease[13].

ROLE OF NON BRONCHIAL SYSTEMIC SUPPLY

Non bronchial systemic arteries can be a significant source of massive hemoptysis, especially in patients with significant pleural thickening caused by an underlying disease. In the presence of pleural thickening, non bronchial systemic feeder vessels that originate from intercostal arteries (Figure3 Pre & Post), branches of the subclavian and axillary arteries , internal mammary artery , inferior phrenic artery [20,26,27] and become enlarged as a result of the inflammatory process. Missing the non bronchial systemic arteries at initial angiography may result in early recurrent bleeding after successful embolization of the bronchial artery.

RECURRENCE OF HAEMOPTYSIS

Recurrent bleeding may be caused by recanalization of embolized vessels, incomplete embolization, revascularization by the collateral circulation, inadequate treatment of the underlying disease, progression of pre –existing lung disease, or unembolized non bronchial systemic arterial supply[1,3,27]. Recurrence rate may also be influenced by the cause of the hemoptysis. Recurrent bleeding is more common in patients with chronic tuberculosis, aspergilloma, or neoplasm. In a series by Katoh et al, 75% of patients with aspergilloma experienced recurrence of hemoptysis after undergoing initial embolization[27].

In our institution, BAE is performed as a pre operative measure to facilitate complete resection of extremely vascular aspergiloma. Thus we have been able to reduce the recurrence of haemoptysis considerably. Hayakawa et al[28] reported that BAE failed within 1 month in 42% of patients with neoplasm.

COMPLICATIONS

Several complications of BAE have been reported in the literature. Chest pain is the most common complication, with a reported prevalence of 24%–91%[23]. Chest pain is usually transient phenomenon after embolization. In addition, dysphagia due to embolization of esophageal branches may be encountered, with a reported prevalence of 0.7%–18.2% [28]. Dysphagia also regresses spontaneously. Sub-intimal dissection of the aorta or the bronchial artery during BAE is the other minor complication, with a reported prevalence of 1%–6.3%. There are usually no symptoms or problems related to the sub-intimal dissection. The most disastrous complication of BAE is spinal cord ischemia due to the inadvertent occlusion of spinal arteries. The prevalence of spinal cord ischemia after BAE is reported to be 1.4%–6.5% [28]. This can be prevented by using microcatheter to catheterized bronchial artery well beyond the origin of anterior medullary artery (artery of Adamkiewicz) when this is visualized at angiography or else embolization should not be performed.

Other rare complications that have been reported in the literature include aortic & bronchial necrosis, broncho-esophageal fistula, non–target organ embolization (eg, ischemic colitis), pulmonary infarction, referred pain to the ipsilateral forehead & orbit, and transient cortical blindness [29]. It is hypothesized that cortical blindness develops because of embolism to the occipital cortex, either via a bronchial artery–pulmonary vein shunt or via collateral vessels between the bronchial and vertebral arteries.

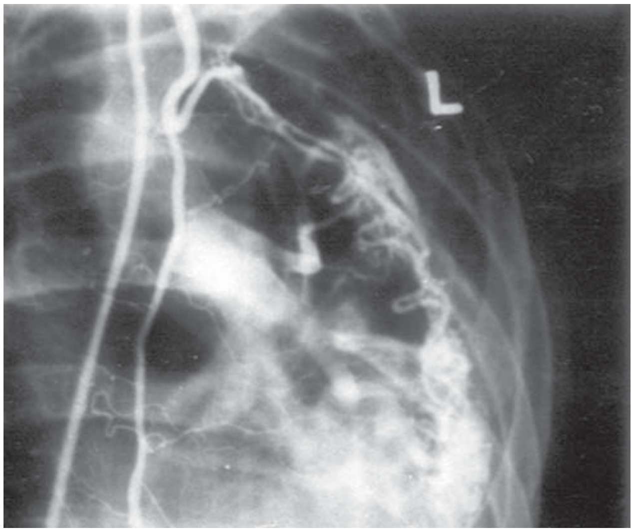


***Figure 3A** : Pre and post left intercostal arteriogram showing abnormal hypervascualrity to diseased peri-hilar region before and after embolization*

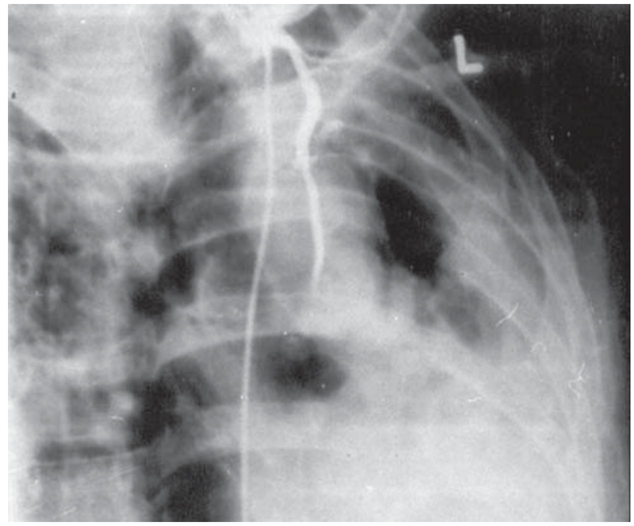


Figure 3B: Post Embolization angiogram showing near complete occlusion of hypervascularity

CONCLUSION

In conclusion, massive haemoptysis should be considered as a life-threatening medical emergency. A well co-ordinated strategy involving different medical and surgical specialists is required for successful management. Control of the respiratory tract is the first priority and should be followed by aggressive measures to identify the source of bleeding, and prompt treatment. Because of the high incidence of recurrent haemoptysis, these patients should not be discharged from hospital before the definitive diagnosis and, if possible, definitive treatment.

REFERENCES

1. Najarian KE, Morris CS. Arterial embolization in the chest. J Thorac Imaging 1998;13:93-104.

2. Remy J, Voisin C, Ribet M, et al. Treatment, by embolization, of severe or repeated hemoptysis associated with systemic hypervascularization. Nouv Presse Med 1973; 2:2060-2068

3. Fernando HC, Stein M, Benfield JR, Link DP. Role of bronchial artery embolization in the management of hemoptysis. Arch Surg 1998; 133:862-866.

4. Tamura S, Kodama T, Otsuka N, et al. Embolotherapy for persistent hemoptysis: the significance of pleural thickening. Cardiovasc Intervent Radiol 1993; 16:85-88

5. Pugnale M, Portier F, Lamarre A, et al. Hemomediastinum caused by rupture of a bronchial artery aneurysm: successful treatment by embolization with N-butyl-2-cyanoacrylate. J Vasc Intervent Radiol 2001; 12:1351-1352.

6. Deffenbach ME, Charan NB, Lakshminarayan S, Butler J. The bronchial circulation: small, but a vital attribute to the lung. Am Rev Respir Dis 1987; 135:463-481.[Medline]

7. Liebow AA, Hales MR, Lindskog GE. Enlargement of the bronchial arteries, and their anastomosis with the pulmonary arteries in bronchiectasis. Am J Pathol 1949; 25:211-231.

8. Naidich DP, Funt S, Ettenger NA, Arranda C. Hemoptysis: CT—bronchoscopic correlations in 58 cases. Radiology 1990; 177:357-362.

9. Hsiao EI, Kirsch CM, Kagawa FT, Wehner JH, Jensen WA, Baxter RB. Utility of fiberoptic bronchoscopy before bronchial artery embolization for massive hemoptysis. AJR Am J Roentgenol 2001; 177:861-867.

10. Naidich DP, Funt S, Ettenger NA, Arranda C. Hemoptysis: CT—bronchoscopic correlations in 58 cases. Radiology 1990; 177:357-362.

11. McGuinness G, Beacher JR, Harkin TJ, Garay SM, Rom WN, Naidich DP. Hemoptysis: prospective high-resolution CT/bronchoscopic correlation. Chest 1994; 105:1155-1162.

12. Hirshberg B, Biran I, Glazer M, Kramer MR. Hemoptysis: etiology, evaluation, and outcome in a tertiary referral hospital. Chest 1997; 112:440-444.

13. Tak S, Ahluwalia G, Sharma SK, Mukhopadhya S, Pande JN. Haemoptysis in patients with a normal chest radiograph: bronchoscopy-CT correlation. Australas Radiol 1999; 43:451-455.

14. Abal AT, Nair PC, Cherian J. Haemoptysis: aetiology, evaluation, and outcome—a prospective study in a third-world country. Respir Med 2001; 95:548-552.

15. Marshall TJ, Jackson JE. Vascular intervention in the thorax: bronchial artery embolization for hemoptysis. Eur Radiol 1997; 7:1221-1227.

16. Cauldwell EW, Siekert RG, Lininger RE, Anson BJ. The bronchial arteries: an anatomic study of 105 human cadavers. Surg Gynecol Obstet 1948; 86:395-412.

17. Sancho C, Escalante E, Dominguez J, et al. Embolization of bronchial arteries of anomalous origin. Cardiovasc Intervent Radiol 1998; 21:300- 304.

18. Cohen AM, Doershuk CF, Stern RC. Bronchial artery embolization to control hemoptysis in cystic fibrosis. Radiology 1990; 175:401-405.

19. McPherson S, Routh WD, Nath H, Keller FS. Anomalous origin of bronchial arteries: potential pitfall of embolotherapy for hemoptysis. J Vasc Intervent Radiol 1990; 1:86-88.

20. Do KH, Goo JM, Im JG, et al. Systemic arterial supply to the lungs in adults: spiral CT findings. RadioGraphics 2001; 21:387-402.

21. Song JW, Im JG, Shim YS, Park JH, Yeon KM, Han MC. Hypertrophied bronchial artery at thin-section CT in patients with bronchiectasis: correlation with CT angiographic findings. Radiology 1998; 208:187-191.

22. Phillips S, Ruttley MST. Bronchial artery embolization: the importance of preliminary thoracic aortography. Clin Radiol 2000; 55:317-319.

23. Ramakantan R, Bandekar VG, Gandhi MS, Aulakh BG, Deshmukh HL. Massive hemoptysis due to pulmonary tuberculosis: control with bronchial artery embolization. Radiology 1996; 200:691-694.

24. Tanaka N, Yamakado K, Murashima S, et al. Superselective bronchial artery embolization for hemoptysis with a coaxial microcatheter system. J Vasc Intervent Radiol 1997; 8:65-70.

25. White RI, Jr. Bronchial artery embolotherapy for control of acute hemoptysis: analysis of outcome. Chest 1999; 115:912-915.

26.Hashimoto M, Heianna J, Okane K, Izumi J, Watarai J. Internal mammary artery embolization for hemoptysis. Acta Radiol 1999; 40:187-190.

27.Katoh O, Kishikawa T, Yamada H, Matsumoto S, Kudo S. Recurrent bleeding after arterial embolization in patients with hemoptysis. Chest 1990; 97:541-546.

28.Hayakawa K, Tanaka F, Torizuka T, et al. Bronchial artery embolization for hemoptysis: immediate and long-term results. Cardiovasc Intervent Radiol 1992; 15:154-159.

29. Liu SF, Lee TY, Wong SL, Lai YF, Lin AS. Transient cortical blindness: a complication of bronchial artery embolization. Respir Med 1998; 92:983-986

INTERVENTIONAL RADIOLOGY IN HEMATURIA

Gurpreet S Gulati*, Tarun Jain, Manpreet S Gulati*****
**Department of Cardiovascular Radiology, All India Institute of Medical Sciences, Ansari Nagar, New Delhi-110029, India*
***Department of Radiodiagnosis, All India Institute of Medical Sciences, Ansari Nagar, New Delhi-110029, India*
****Department of Radiology, Queen Elizabeth Hospital NHS Trust and Guy's and St. Thomas' Hospital, Stadium Road, Woolwich, London SE18 4QH, UK*

Abstract: *Hematuria is a common complaint encountered in surgical practice. When severe and life threatening, it requires emergency intervention. Interventional radiology (IR) techniques, being minimally invasive, are now amongst the mainstay techniques for management of these patients. A multidisciplinary approach involving the surgeon and the interventional radiologist helps in deciding the appropriate form of therapy in a particular patient.Plain CT is the most effective modality to detect small calculi, hemorrhage and tumoral calcification. CT urography demonstrates the pelvicalyceal system and ureters. CT is useful in cases of trauma, detecting small tumors and help in staging advanced cancers. It depicts vascular abnormalities like aneurysms, arteriovenous malformation (AVM) and arteriovenous fistula (AVF). Ultrasound and Color Doppler are also useful. Embolization Procedures are useful in renal cell carcinomas, angiomyolipoma, AVM's, renal trauma, polycystic disease of kidneys, including bladder & prostate carcinoma and widespread gynecological malignancy. Embolization therapy can be performed under local anesthesia and hence patients unfit for surgery can undergo this safely. It can provide permanent relief in conditions like vascular abnormalities, trauma and benign tumors like angiomyolipoma. Embolization therapy plays an useful role in the treatment of massive hematuria in various conditions as outlined above.*
Key Words : Hematuria : Interventional Embolization therapy : Pelvic tumor, trauma and malignancy

INTRODUCTION

Presence of a cloudy or frankly bloody appearance of urine can be a source of significant concern to the patient. Reliable evidence of hematuria is obtained from microscopic examination of urinary sediment, when greater than three red blood cells are seen per high power field. Hematuria is a common complaint encountered in surgical practice. It may result from a variety of causes, ranging from strenuous exercise to extensive malignancy to trauma (Table 1). When severe and life threatening, it requires emergency intervention. Interventional radiology (IR) techniques, being minimally invasive, are now amongst the mainstay techniques for management of these patients. The advances in catheter design and introduction of new embolizing materials have contributed to this trend. In this article, we briefly review the various conditions in which IR can play a role in the management of hematuria.

TESTS FOR HEMATURIA

Tests for presence of hematuria should be performed even if the gross appearance is suggestive, as many drugs and foods can cause urine to appear various shades of orange and reddish-brown. Besides physical examination of urine, hematuria can also be detected by performing the Benzidine test on urine. A quick and simple test for detecting microscopic hematuria is the "dipstick" test for urine. However, it may be associated with a high number of false positives. Immediate microscopy following a positive dipstick test can improve diagnostic efficiency in these situations.

Correspondence : Dr. Gurpreet Singh Gulati, B-3/185, Janak Puri, New Delhi – 110058, India, Fax: 91-11-26588663
e-mail: gulatigurpreet@rediffmail.com

Table 1. *Common causes of Hematuria*

I Nephrologic Causes
Glomerular hematuria [>80% dysmorphic erythrocytes, red blood cell (RBC) casts, proteinuria] –
- Glomerulonephritis
  Non glomerular hematuria (Circular RBC, proteinuria, no casts)
- Tubulointerstitial - Papillary necrosis, Chronic Interstitial nephritis, Irradiation nephritis, Autosomal Dominant Polycystic Kidney Disease (ADPKD)
- Renovascular - Congenital - Arteriovenous Malformation (AVM); Traumatic (including iatrogenic) - Arteriovenous fistula (AVF), pseudoaneurysms; Others -malignant hypertension, Vasculitis
- Systemic – Drugs, Bleeding disorders.

II Urological Causes (Non Glomerular – Surgical)
(Circular RBCs, No Casts, No Significant Proteinuria)
- Tumors- bladder, kidney, prostate, ureter, others (in order of frequency).
- Calculus disease
- Infection- cystitis, tuberculosis
- Benign Prostatic enlargement
- Trauma- Blunt, penetrating, Iatrogenic
- Miscellaneous – Radiation cystitis, Schistosomiasis, endometriosis

ESTABLISHING THE CAUSE AND PLANNING THE MANAGEMENT OF HEMATURIA

A careful physical examination is the first essential step in establishing the cause and extent of the disease leading to hematuria. Patient may give a history of recent procedures being performed [renal biopsy, percutaneous nephrolithotomy (PCNL), percutaneous nephrostomy (PCN)]. History of trauma may be present. Importantly, a multidisciplinary approach involving the surgeon and the interventional radiologist is necessary for deciding the appropriate form of therapy in a particular patient.

RADIOLOGICAL INVESTIGATIONS

CT Scan

The most helpful radiological investigation for hematuria is a CT scan of the abdomen. It is non-invasive, widely available and rapidly performed. A combination of non-contrast and contrast-enhanced CT is generally performed. Where necessary, CT urography is also done to demonstrate the pelvicalyceal system and ureters. Thus, both parenchyma and collecting system can be evaluated in a single sitting. NCCT is the most effective modality to detect small calculi, hemorrhage and tumoral calcification. In cases of trauma, CT can accurately depict visceral and bony injuries, and associated injuries to other organs of the body. CT scan is the modality of choice to detect small tumors. For advanced neoplastic lesions, CT can help to stage the disease. Vascular abnormalities like aneurysms, arteriovenous malformation (AVM) and arteriovenous fistula (AVF) can also be visualized on “multiphase” CT angiography. CT is truly a “one-stop shop” in the setting of hematuria. Multidetector row CT Scanners are even faster (and hence are useful in imaging trauma cases and other unstable patients) and reduce the dose of contrast medium required. Different phases of contrast uptake can be differentiated (arterial, cortico-medullary, nephrographic, and excretory phase). Further, the narrow collimation data sets acquired during a single breath-hold allow reconstruction of high-quality multiplanar reconstruction (MPR) and maximum intensity projection (MIP) images in virtually any plane, which add to the diagnostic information[1].

ULTRASOUND AND COLOR DOPPLER

Ultrasound (US) is a rapidly performed, easy to use and universally available modality for the imaging of the urinary tract. It is useful in evaluating solid renal masses, bladder outlet obstruction, or urethral atresia. Color Doppler US (CDUS) is a good screening modality for the depiction of various vascular abnormalities. However, it is operator dependent, time consuming, and requires patient co-operation. Thus it is not helpful in the setting of massive hematuria. In a hemodynamically stable patient however, CDUS can be useful for demonstrating lesions like AVM and AVF.

CATHETER ANGIOGRAPHY

A high quality angiogram is helpful to depict the vascular anatomy, active contrast extravasation suggesting the culprit vessel and tumor neovascularity. For visualization of fine vascular lesions free of overlap from bones or soft tissue, it is important to acquire images in the digital subtraction angiography (DSA) mode. The initial arteriographic evaluation should begin with aortography. Multiple renal arteries are common, occurring in approximately 30% of patients[2]. These may be missed if direct selective renal artery injections are performed. In trauma patients, injury to the vascular pedicle can be identified on the aortogram, and hence selective catheterization of the injured vessels can be avoided. Selective renal arteriography is performed with a preshaped catheter such as Simmons 1 or Cobra catheter. It may be necessary to obtain multiple views for accurate diagnosis, as evaluation in only the frontal plane may miss the abnormality. An ipsilateral anterior oblique projection shows the renal parenchyma to best advantage.

The major advantage of DSA is that it can be combined with catheter based interventional therapy in the same sitting. Decision to proceed with the intervention is generally based upon the lesion morphology. For example, in cases of pseudoaneurysm or AVM/AVF, particular attention should be paid to the feeding artery/arteries, site of communication/ neck, and draining veins (in cases of AVM/AVF). Delayed images may be necessary to reveal subtle extravasation. Besides serving as a roadmap, the initial angiogram is useful to choose the appropriate embolizing agent.

TECHNIQUE OF EMBOLIZATION

Informed Consent

The procedure should be explained completely to the patient and/or his relatives, outlining the associated risk of complications. Specific attention should be given to describing the risks of post-embolization syndrome and non-target embolization.

Sedation/Analgesia

It is helpful but not mandatory. If required, conscious sedation using Pethidine and Promethazine can be used.

Procedure

It is performed in the angiography suite. The images of CT scan and other radiological investigations should be available for reference. There should be clear understanding between the surgeon and interventional radiologist regarding the triage of the patient. As many of these patients have major blood loss, hemodynamic stability should be maintained using IV fluids and transfusion of blood products as required. After identifying the culprit lesion responsible for hematuria, decision regarding whether to embolize, choice of embolizing agent and the extent of embolization procedure must be made. Important factors to consider before embolizing any vessel include whether the vessel can be sacrificed and the alternative methods of treatment. The kidney is an end-artery organ with small collaterals from capsular branches. Occlusion of renal branch vessels will cause parenchymal infarction congruent to the size of the vessel. Before the advent of the newer coaxial catheters, it was often impossible to catheterize subsegmental branches, and embolization had to be performed more proximally, which resulted in considerable non-target organ damage and loss of function. Improvements in catheter technology and the availability of microcatheters now make it possible to cannulate 1- to 2- mm vessels. Use of the coaxial technique and delivery of microcoils permits precise and localized embolization of bleeding arterial branches with minimal loss of tissue and function. This is the advantage of embolization compared to surgical procedures like partial or total nephrectomy, where a non-affected tissue or organ may get sacrificed[3]. In addition, surgical treatment is much more invasive and has the associated risks and morbidity of a major surgical procedure under general anesthesia.

Table 2: *Materials used for Transarterial embolization (*Most commonly used)*

Material	Comments
Gelfoam*	· Cheapest · Can be used as pledgets to match vessel diameter · Chances of reflux and non- target embolization · Potential for recanalization after 3-4 weeks
Poly Vinyl Alcohol particles	· Quasi-permanent agent · Enable distal embolization (useful for tumor and AVM) · Chances of reflux and non-target embolization
Coils*	· Used to block a major vessel or for vascular lesions like aneurysm and AVF · Less chance of non-target embolization
Glue	· Permanent agent · Used for vascular lesions · Expensive · Experience and careful use required
Detachable Balloons	· Permanent agent · Useful for a large aneurysm, large AVF
Alcohol	· Permanent agent · Used for embolization of tumor neovascularity · Painful · Chances of reflux are greater

The artery to be embolized is selectively cannulated and embolization is performed after placing the catheter as close as possible to the area of interest and the bleeding site/ vascular abnormality. The procedure is performed under strict fluoroscopy control to check for reflux of embolizing material.

A variety of embolization materials are available (Table 2). Their usage depends upon the type of lesion to be embolized and preference of the interventional radiologist. Recently developed devices such as interlocking detachable coils and Guglielmi detachable coils allow for controlled deployment of a coil and its easy retrieval if it is deployed in an unfavorable position. However, their usage may be limited by cost concerns[3]. While using non-detachable coils, it is important to keep retrieval devices such as snares ready in case the coils are deployed suboptimally, enter a non-culprit vessel, or pass through AVFs into the lungs. Different embolic materials can be combined or used sequentially for proximal and distal embolization. Also, while injecting glue and alcohol, use of balloon catheters to prevent reflux into systemic circulation is helpful[4, 5].

Table 3. *Conditions in which Embolization is helpful*

1. **Renal –**
   - Tumors – Renal cell carcinoma, Angiomyolipoma
   - Vascular lesions – pseudoaneurysm, AVM, AVF – Iatrogenic (Post PCNL, PCN or Biopsy), trauma, Congenital
   - Blunt Trauma
   - Autosomal Dominant Polycystic Kidney Disease (ADPKD)
2. **Pelvis –**
   - Trauma (including surgical)
   - Advanced malignancy – Urinary Bladder, Prostate, Gynaecological
   - Miscellaneous – radiation cystitis, pelvic congestion disorders

INDICATIONS FOR EMBOLIZATION PROCEDURES

Various conditions in which IR is useful to control hematuria are listed in Table 3. Salient features regarding each condition are discussed below.

RENAL TUMORS

Renal Cell Carcinoma

Renal Cell Carcinoma (RCC) arises from the proximal tubular epithelium. Symptoms may occur late and as a result upto 30% of patients have distant metastases at presentation, and a further 25% have local spread. The 5-year survival rate for patients with metastases is <20%. The basis of treatment for localized disease is surgical resection, as tumors are relatively resistant to both radiotherapy and chemotherapy.

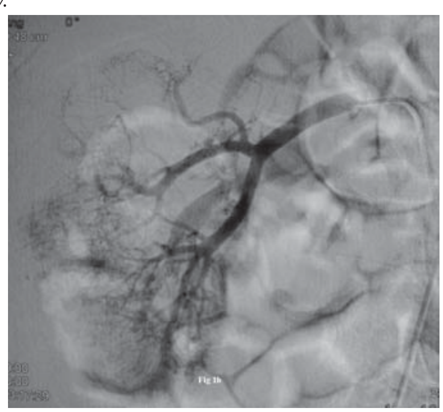
Transarterial Embolization (TAE) of renal tumors was first described in 1973 by Almgard and associates as a preoperative aid to resecting localized RCC and to palliate symptoms in metastatic disease[6]. Presently, TAE in renal tumors is mainly performed for palliation to control hematuria, relieve pain (including that arising from bony metastasis), relieve symptoms of congestive heart failure, control spontaneous perinephric and subcapsular renal hemorrhage and as a preoperative measure[7]. TAE is very useful for controlling hematuria, particularly in inoperable cases, with minimum morbidity and mortality (Fig 1). The most popular embolic agent is ethanol, although PVA particles are also used. While using ethanol, one should place an occlusion balloon in the distal renal artery beyond the adrenal and ureteral branches to avoid reflux of alcohol into the aorta[5]. Success of treatment depends on how completely the tumor and kidney are embolized. It is important that the central and more peripheral branches of the artery are occluded to achieve complete embolization. Several clinical studies have shown beneficial effects, especially in large hypervascular tumors[8], while other investigators have found no benefit[9]. A significant role of TAE in improving patient survival was also found in a large series of 474 patients comparing preoperative embolization followed by radical nephrectomy with radical nephrectomy alone for RCC[10].

TAE for renal tumors can be associated with many complications. A post-embolization syndrome of fever, pain, nausea, ileus and leucocytosis associated with negative urine and blood cultures is well described and can be considered as part of the process of embolization. Renal failure and unintentional embolization of contralateral kidney, bowel and spine are the other common complications after TAE. Renal abscess has also been reported[11]. It is important that there be no active urinary tract infection at the time of embolization that may predispose to abscess formation or sepsis. The target kidney should also be stone-free, since stones are a nidus of infection. After embolization, intrarenal gas may be seen and may be mistaken for abscess or emphysematous pyelonephritis, especially in association with the fever, pain and leukocytosis of the post-embolization syndrome.

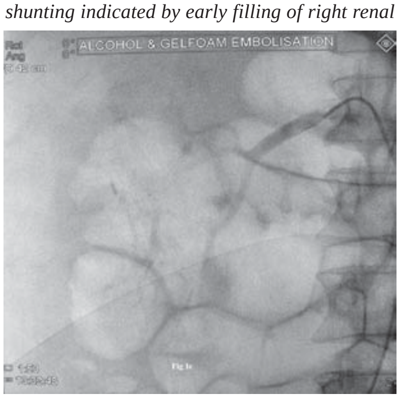
Other complications can be uremia, hyperpyrexia, right heart failure, pleural effusion, skin necrosis, coil dislocation and iliac artery thrombosis. There have been reports of aneurysmal ruptures during embolization with an occlusive balloon[12]. This was attributable to increased intravascular pressure generated by the forced injection of alcohol into a closed system or to erosion of the thin aneurysm wall by the caustic alcohol. In patients with aneurysms in their tumors, embolization should be performed cautiously, and use of fine particles, ethiodized oil, or both without a balloon catheter should be considered.

Figure 1. *59-year-old man with persistent hematuria due to an inoperable Renal Cell Carcinoma.*

A.*T2 weighted MRI image shows the heterogeneous mass in the lower pole of the right kidney. Arrow points to a signal void indicating increased tumor vascularity.*



B. *DSA of the right renal artery shows the tumor neovascularity with arteriovenous shunting indicated by early filling of right renal vein (arrow)*



C.*Palliative embolization was performed using alcohol and gelfoam particles. Post-embolization angiogram image shows complete obliteration of abnormal vascularity. There was significant reduction in hematuria for a period of 4 months following the procedure.*

ANGIOMYOLIPOMA

Renal angiomyolipoma (AML) is a benign tumour (hamartoma) of the kidney composed of mature or immature fat, thick-walled abnormal blood vessels and smooth muscle components in varying proportions. After RCC, AML is the second most common renal cause of retroperitoneal hemorrhage. Incidence of hematuria in AML has been reported to be 40%[13]. Hemorrhagic risk factors of AML are size, multifocality and vascular abnormality.

Most AML can be managed by nephron conserving approaches, including observation, angiographic embolization or partial nephrectomy [14]. For embolization, ethanol, PVA particles and gelfoam particles, with or without coils in combination have all been used. Selective TAE has been used with increasing frequency to manage symptomatic AMLs. The reasons are: tumors are benign, symptoms are usually the result of hemorrhage (including hematuria) and bleeding vessels can be selectively visualized and embolized. Post-embolization, the decrease in tumor size and volume is variable and sometimes very slow in AML. The muscular and vascular components of the tumor are the ones most significantly affected by the procedure[15]. Tumor bleeding most commonly occurs from the microaneurysms involving the tumor vessels, and embolization helps to control this bleeding. The adipose tissue is resistant to embolization because of its hypovsacularity, so the volume of adipose tissue is not highly affected after embolization[15]. On follow-up studies, enhancement or vascularity must be considered an important finding of the possibility of tumor bleeding[15]. Cystic change and liquefactive necrosis are also seen on CT. Complications after TAE for AML are similar to those seen for RCC. However, potential ischemic damage to the limbs or spinal cord due to non-target embolization is not seen in series of embolization of AML[14].

In a recent study to evaluate the long term results of TAE for AML, Kothary et al[16] found that this procedure is highly effective for sporadic AML and none of these patients had recurrence. However, as many as 42.9% (9 out of 21) patients who had AML associated with Tuberous Sclerosis (TS) had recurrence of symptoms. Hence, the authors recommended lifelong surveillance for recurrence after embolization of lesions in patients with TS [16].

RENAL VASCULAR LESIONS

While vascular lesions such as pseudoaneurysm and AVF most commonly arise due to trauma (which may be iatrogenic or inflicted), AVMs are congenital in origin. Ultrasound-guided biopsy is the most common iatrogenic cause of hematuria. Other less frequent traumatic causes of hematuria include procedures like PCNL and PCN and renal trauma. The incidence of significant post-biopsy hematuria (requiring transfusion or intervention) has reduced from 7.7% to 0.36%. Major reason for this is the reduction in biopsy needle size from 14 G to 18 G. Embolization is used to manage the infrequent cases of uncontrolled hematuria following these interventional procedures (Fig 2).

Many case series and studies have been published which document the role of embolization in uncontrolled hematuria resulting from vascular complications of renal trauma, iatrogenic or otherwise[17]. Embolization is also useful for hematuria resulting from biopsy procedures on transplanted kidneys[18].

Various embolization agents have been used alone or in combination (Fig 3). In cases of AVF, coils are preferred as there is a concern that particles and alcohol may pass into the systemic circulation. In AVMs, the nidus should be obliterated using a liquid agent such as cyanoacrylate (glue) or absolute alcohol. One approach described to prevent inadvertent passage of embolizing agent into the systemic circulation is to block the draining vein while injecting the material[4]. The long term results are excellent in all the series [17, 18]. Although non-target embolization may lead to infarction of greater parts of renal parenchyma than desired[17], it is generally not serious enough to cause a significant derangement of renal function tests[18].

RENAL TRAUMA

Blunt renal trauma may result in simple contusion or renal hematoma (Grade I injury), to complete shattering of the organ or avulsion of the vascular pedicle (Grade V injury). They can be well evaluated with a contrast-enhanced CT of the abdomen, as described earlier. In the vast majority of cases, renal injuries are minor and self-limiting. Conservative management is being increasingly preferred for most renal injuries[19]. Aggressive therapy may become necessary in the presence of massive hemorrhage or continuous hematuria in patients with trauma-induced pseudoaneurysm or fistula. Avulsion of the renal pelvis, vascular pedicle injury and life-threatening hemodynamic instability form the indications for surgery[19].

Embolization techniques are useful in hemodynamically unstable patients with the most severe forms of injury (grade IV and V). Surgery can be avoided with this technique.

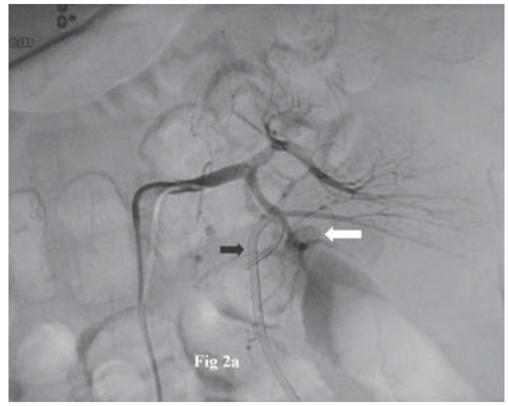
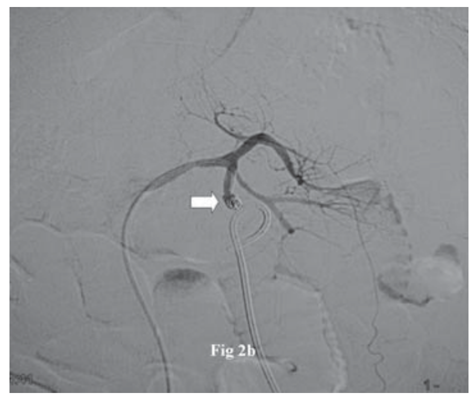


***Figure 2.** 35-year-old man who developed hematuria following Percutaneous Nephrostomy (PCN) of left kidney.*
***A.** DSA of the left renal artery shows a pseudoaneurysm (white arrow) in the lower pole responsible for hematuria. PCN tube is seen in situ (black arrow).*



***B.** The artery giving rise to the pseudoaneurysm was embolized with a steel coil. Post-embolization angiogram does not show any pseudoaneurysm. The patient recovered after the procedure and hematuria stopped.*

Injuries like complete vascular pedicle avulsion or blunt renal artery occlusion confer a poor prognosis, even if they are technically amenable to surgery. It is not feasible to perform complete vascular reconstruction within one hour of injury, the critical warm ischemia time for the kidney. With embolization, viable renal tissue can be salvaged even in cases where open revision would often result in total nephrectomy[3]. TAE is the preferred method in the treatment of vascular complications of renal injury with pseudoaneurysm or active bleeding with excellent tissue preservation[3] (Fig 4). Injury to renal allograft has also been tackled with embolization. Other lesions such as uncontained renal ruptures, shattered kidneys, and pedicle avulsions can also be treated with TAE[3]. For embolization of larger arterial branches, gelfoam pledgets and coils are favored, while for smaller vessels, microcoils are ideally suited.

Some of the patients, who remain stable initially after flank trauma, will develop delayed bleeding due to traumatic arterial pseudoaneurysm or AVF and will present late. These patients constitute another group of patients with renal trauma that is well suited for TAE[3].

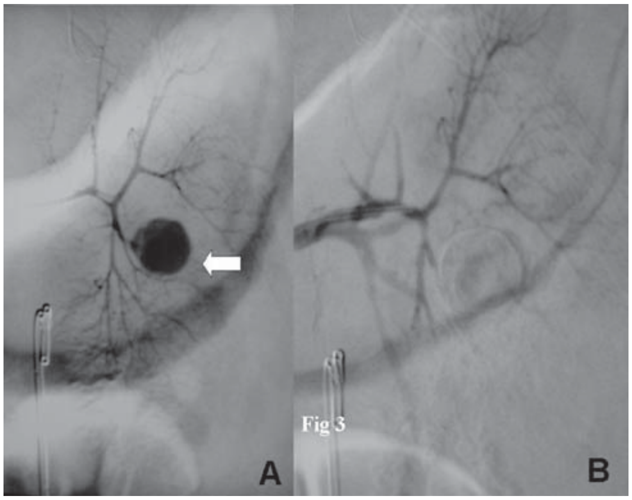


Figure 3. *40 year old man who developed hematuria following Percutaneous Nephrolithotomy (PCNL) in left kidney.*
A.DSA of the left renal artery shows a pseudoaneurysm (white arrow) from an interpolar artery
B.The artery supplying the lesion was selectively cannulated and the lesion was embolized with a silk thread. Post-embolization angiogram shows absence of filling of the pseudoaneurysm.
The patient recovered after the procedure and hematuria stopped. This case also illustrates the variety of embolizing materials that can be used.

AUTOSOMAL DOMINANT POLYCYSTIC KIDNEY DISEASE (ADPKD)

Patients with ADPKD eventually develop renal failure and require dialysis. Even on dialysis, the renal cysts may keep on enlarging in size and cause gastrointestinal complications. Surgical procedures such as nephrectomy and laproscopic procedures are not satisfactory. TAE has been described in this condition to control macroscopic hematuria and markedly distended abdomen safely and effectively. Kidney size is reduced and hematocrit and levels of insulin-like growth factor-I (an index of nutritional status) significantly increase[20]. Thus, TAE improves the quality of life and nutritional status of patients with ADPKD.

PELVIC TRAUMA

Pelvic fractures may lead to severe hemorrhage and injury to bladder or urethra may lead to hematuria. Pelvic fractures resulting in life threatening hematuria and hemorrhage require embolization if resuscitation measures and external fixation are ineffective. A patient with pelvic fracture should be evaluated with contrast enhanced helical CT. Active contrast extravasation indicating ongoing active hemorrhage and site of bleeding may help the angiographer to target the culprit vessels.

It has been suggested that for patients in shock with pelvic fractures, laprotomy should be preferred over angiography if the fractures are stable, as the bleeding focus is more likely to be intraperitoneal. Angiography and embolization should be offered first to patients with unstable fractures[21]. However, pattern of pelvic fractures may not always correlate with the need for embolization and cannot be used to decide the

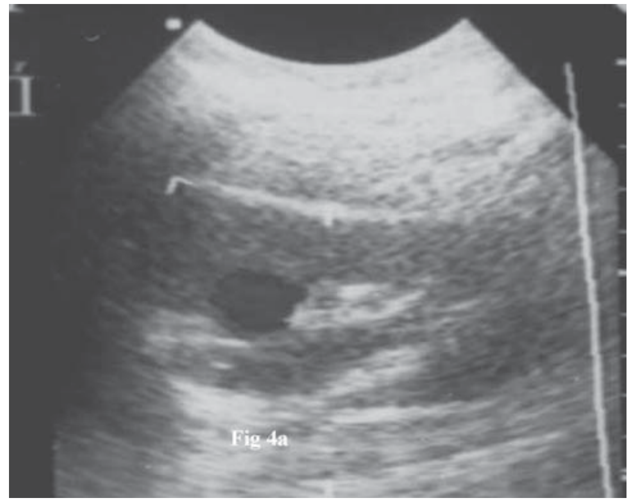
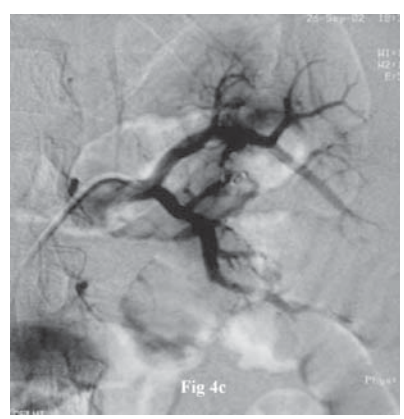


Figure 4. *28-year-old man with hematuria following blunt abdominal trauma in a road accident.*
A. *Color Doppler ultrasound shows a pseudoaneurysm (color fill-in indicated by white arrow) in the mid pole of left kidney.*

B. *Selective injecton of a segmental artery shows the pseudoaneurysm arising from a branch.*



C. *Complete obliteration of the lesion achieved following coil embolization of the branch.*

course of management.

Selective cannulation of bilateral hypogastric arteries should be performed. As there is extensive cross-anastomosis in pelvic vessels, bilateral embolization is performed. If hypogastric arteries are not cannulated, then anterior division of internal iliac arteries can be blocked. Gelfoam pledgets are used as they are effective and also allow for future recanalization. Coils are not preferred as they would block future access in the event of repeat bleeding. Particles of PVA or Gelfoam are not used as they result in distal embolization of small vessels and increase the risk of ischemia of nontarget organs. In patients who have ongoing features of hemorrhage, despite initial embolization or negative angiography, repeat angiography with embolization has been found to be effective[22].

Complications specific to embolization in the setting of pelvic trauma are uncommon, as is non-target embolization. However, gluteal skin necrosis may occur. Embolization does not produce lasting adverse effects on urogenital function. Sexual dysfunction frequently occurs after traumatic pelvic fracture. However it is produced by the injury itself and is not due to embolization procedure per se.

PELVIC MALIGNANCY

Besides bladder and prostate carcinoma, widespread gynecological malignancy can give rise to intractable hematuria. Surgical ligation of both internal iliac arteries for the control of pelvic hemorrhage has a 10% recurrence rate[23]. Internal iliac artery has rich collateral blood supply from several arteries-including gonadal, superior hemorrhoidal, circumflex, and perforating branches of the deep femoral artery, which explains the safety of extensive embolization and the failure of the proximal ligation or embolization (with coils) of this vessel to control bleeding. Hence, particulate matter should be used to achieve distal blockage[24]. Bilateral embolization needs to be performed even if the blood supply is only from one side or bleeding is localized to one part[24].

Efficacy of embolization has been demonstrated in many studies and case series[25]. Relief from hematuria is not only immediate, but also long lasting and may even be life long. Complications are post-embolization syndrome due to tumor necrosis like nausea, vomiting and fever[24]. It can be managed by conservative therapy. Gluteal claudication may also be seen[25].

CONCLUSION

Embolization therapy can play a useful role in the treatment of massive hematuria in various conditions as outlined above. It can be performed under local anesthesia and hence patients who are unfit for surgery can undergo this safely. It can provide permanent relief in conditions like vascular abnormalities, trauma and benign tumors like AML. In cases of wide spread malignancy when curative treatments are not applicable due to the general status of the patient, life expectancy, or advanced tumor stage, it can provide long term palliation and reduces morbidity. It is important to be able to perform the procedure as selectively as possible, to minimize damage to normal structures and avoid complications. Advances in catheter and embolic material design are of advantage in this regard. Helical dynamic contrast enhanced CT of abdomen before the procedure, especially when performed with a multidetector scanner, helps to locate the source of bleeding and also to stage a malignancy.

REFERENCES

1. *Coppenrath EM, Mueller-Lisse UG. Multidetector CT of the kidney .Eur Radiol 2006;Mar 28; [Epub ahead of print].*
2. *Kadir S. Kidneys. In: Kadir S, ed. Atlas of normal and variant angiographic anatomy. Philadelphia: Saunders, 1991:387-434*
3. *Dinkel HP, Danuser H, Triller J. Blunt renal trauma: minimally invasive management with microcatheter embolization—experience in nine patients. Radiology 2002;223:723-730*
4. *Giancarlo MG, d'Onofrio M, Minniti S, Ferrara RM, Procacci C. Therapeutic embolization of idiopathic renal arteriovenous fistula using the "Stop-Flow" technique. J Endovasc Ther 2001;8:210–215.*
5. *Lee W, Kim TS, Chung JW et al. Renal angiomyolipoma: embolotherapy with a mixture of alcohol and iodized oil. JVIR 1998;9:255-261*
6. *Almgard LE, Fernstrom I, Haverling M, Ljungquvist A. Treatment of renal adenocarcinoma by embolic occlusion of the renal circulation. Br J Urol 1973;45:474-479*
7. *Roy C, Tuchmann C, Morel M et al. Is there still a place for angiography in the management of renal mass lesions? Eur Radiol 1999;9:329-335*
8. *Kalman D, Varenhorst E. The role of arterial embolisation in renal cell carcinoma. Scand J Urol Nephrol 1999;33:162-170*
9. *Mebust WK, Weigel JW, Lee KR et al. Renal cell carcinoma – angioinfaction. J Urol 1984;131:231-235*
10. *Zielinski H, Stanislaw S, Zbigniew P. comparison of preoperative embolisation followed by radical nephrectomy with radical nephrectomy alone for renal cell carcinoma. American Journal of Clinical Oncology 2000;23:6-12.*
11. *Christensen K, Dyreborg U, Andersen JF et al. the value of transvascular embolisation in the treatment of renal carcinoma. J Urol 1985;133:191-193*
12. *Zerhouni EA, Schelmanner P, Schaefer JC et al. management of bleeding renal angiomyolipomas by transcathrter embolization following CT diagnosis. Urol Radiol 1984;6:205-209*
13. *Wong AL, McGeorge A, Clark AH. Renal angiomyolipoma: a review of the literature and a report of 4 cases. Br J Urol 1981; 53:406-411.*
14. *Nelson CP, Sanda MG. Contemporary diagnosis and management of renal angiomyolipoma. J Urol 2002;168:1315-1325*
15. *Lee W, Kim TS, Chung JW et al. Renal angiomyolipoma: embolotherapy with a mixture of alcohol and iodized oil. JVIR 1998;9:255-261*
16. *Kothary N, Soulen MC, Clark TWI, et al. Renal Angiomyolipoma: Long-term Results after Arterial Embolization. JVIR 2005;16:45-50*
17. *Takebayashi S, Hosaka M, Kubota Y, Ishizuka E, Iwasaki A, Matsubara S. Transarterial embolization and ablation of renal arteriovenous malformations: efficacy and damages in 30 patients with long-term followup. J Urol. 1998 Mar;159(3):696-701*
18. *Maleux G, Messiaen T, Stockx L, Vanrenterghem Y, Wilms G. Transcatheter embolization of biopsy-related vascular injuries in renal allografts. Long-term technical, clinical and biochemical results. Acta Radiol. 2003;44(1):13-17*
19. *Velmahos GC, Demetriades D, Cornwell EE, III, et al. Selective management of renal gunshot wounds. Br J Surg 1998;85:1121-1124*
20. *Ubara Y, Katori H, Sawa N, et al. Renal contraction therapy for enlarged polycystic kidneys by transcatheter arterial embolization in hemodialysis patients. Am J Kidney Dis. 2002;39(3):571-579*
21. *Eastridge BJ, Starr A, Minei JP, O'Keefe GE, Scalea TM. The importance of fracture pattern in guiding therapeutic decision-making in patients with hemorrhagic shock and pelvic ring disruptions. J Trauma 2002;53:446-450*
22. *Shapiro M, McDonald AA, Knight D, Johannigman JA, Cuschieri J. The role of repeat angiography in the management of pelvic fractures. J Trauma 2005;58:227-231*
23. *Siegel P. Mengest WF. Internal iliac artery ligation in obstetrics and gynecology. JAMA 1961;178:1059-1062*
24. *Pisco JM, Martin JM, Correia MG. Internal iliac artery: embolization to control hemorrhage from pelvic neoplasms. Radiology 1989;172:337-339*
25. *Rodriguez-Patron Rodriguez R, Sanz Mayayo E, Gomez Garcia I, et al. Hypogastric artery embolization as a palliative treatment for bleeding secondary to intractable bladder or prostate disease. Arch Esp Urol. 2003;56(2):111-118*

INTERVENTIONAL MANAGEMENT OF AORTIC ANEURYSMS

C. Mohan*, K. M. Rai, O.P. Mathew****, I. K. Indrajit***, M. Patel***, A Chaturvedi***

*Professor of Radiology,****Commandant & Director & Senior Consultant (Cardiology), **Professor of Vascular Surgery, ***Associate Professor of Radiology

Department of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India

Abstract: *Traditional surgical management of aortic aneurysm is associated with high risk f rupture and complications such as distal embolization, aorto-caval fistula, bowel erosion and compression of adjacent structures. Since the introduction of endovascular aneurysmal repair (EVAR) for treatment of aortic aneurysms by J Parodi in 1991, this minimally invasive technique has gained considerable popularity. EVAR has many distinct advantages over surgical techniques. Complete exclusion of the aneurysm sac is the goal of stent-graft placement and the definition of early clinical success. EVAR uses a stent-graft which is an intraluminal device that consists of a supporting framework (currently made of metal such as stainless steel or nitinol) and a synthetic graft material. Pre procedural imaging of potential abdominal aortic aneurysm stent-graft candidates consists of both, contrast enhanced CT and catheter angiography. The technique of EVAR includes introduction of angiography catheter in aorta to obtain an angiogram to assess the final suitability and anatomical landmarks. Care should be taken to position this stent-graft below the renal arteries in case of abdominal aortic aneurysms (AAA). The contralateral limb can be introduced via the opposite femoral artery and docked with the main device. The device is ballooned thereafter to ensure adequate fixation. Post procedure angiograms are performed to confirm the suitable positioning and to detect any endoleak. Endoleaks are classified by its cause and time of occurrence. Although many early endoleaks disappear within 6 months, reappearance of leaks and delayed appearance of new leaks can occur at any time. The follow-up of patients with stent-grafts requires evaluation of aortic aneurysm sac size, perfusion, stent-graft patency, changes in diameter of the vessels at the sites of endograft attachment, changes in stent-graft morphology, and detection of new aneurysms.*

Key Words : Aneurysms Endovascular aneurysm repair: Endoleak

INTRODUCTION

Management of aortic aneurysms remain a challenging problem for surgeon. It is asscociated with high risk of rupture, and complications such as distal embolization, aorto-caval fistula, bowel erosion and compression of adjacent structures. Mortality from rupture is high in aortic aneurysms more than 5 cm in diameter. Conventional treatment consists of replacing the diseased aneurysmatic segment with a tube or bifurcation graft. This major surgical undertaking is associated with 5-10% mortality and 10-20% complication rate even in the best centers in the world.

Juan Parodi of Argentina is generally credited with the first endovascular aneurysm repair (EVAR) in 1991. He used a metallic stent covered with synthetic graft to exclude the aneurysm. This was introduced through a small cut down in the femoral artery in the groin. This was a quantum advance both conceptually and practically. The mortality and morbidity associated with conventional aneurysm repair was drastically reduced. The technology was refined in the ensuing years, and there are at least 5 commercial devices available for EVAR of abdominal aortic aneurysms (AAA), and two for thoracic aortic aneurysms (TAA). This paper outlines the technique of minimally invasive EVAR technique of aortic aneurysm repair.

DEFINITION AND COURSE

The definition of an abdominal aortic aneurysm is focal enlargement of the abdominal aorta, usually involving the infrarenal portion of the vessel, to more than 50% larger in diameter than the normal aorta or to greater than 3 cm in its largest true transverse dimension[1]. As a rule, even large abdominal aortic aneurysms are asymptomatic until rupture occurs. Prophylactic repair is therefore recommended for aneurysms exceeding -5 cm in diameter[3,4].

STENT GRAFT

A stent-graft is an intraluminal device that consists of a supporting framework (currently made of metal such as stainless steel or nitinol) and a synthetic graft material. Stent-grafts can be either self-expanding or balloon-expandable, depending on the type of metal in the stent. The stent may be located inside, outside, or within the graft material, and it may be along the entire length of the graft or restricted to the ends. To deliver the stent-graft through a small vascular access, the device is compacted onto a catheter or compressed into a sheath. With the use of imaging guidance, the device is advanced into an appropriate location in the aorta from a remote access site and deployed.

ENDOVASCULAR REPAIR

The ultimate goal of endovascular repair of abdominal aortic aneurysm with a stent-graft is the same as for surgical repair ie. depressurization of the aneurysm sac to prevent rupture. In the ideal situation, the stent-graft excludes all blood flow from the aneurysm sac allowing its thrombosis. First step is, determination of the appropriate graft size and configuration for an individual patient. Accurate pre procedural imaging and measurements are therefore paramount. Second, the

Correspondence : Dr. C. Mohan, M.D.Professor & Senior Adviser Department of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India **e-mail** : colcm30@yahoo.com

approximation between the stent-graft and the vessel wall should be good. The ends of the device must push against the inner walls of the vessel with sufficient force to prevent blood from flowing around the device into the abdominal aortic aneurysm. Third, patent branch vessels arising from the aneurysm sac cannot be inspected and occluded directly. Fourth, the skill sets for most of the elements of the procedure, including online interpretation of fluoroscopic images and complex catheter manipulations, are extensions of traditional interventional radiology rather than surgical practice. Lastly, complete exclusion of the aneurysm sac does not occur in all stent-graft procedures, as it does with open surgical repair[5].

GUIDELINES AND TECHNIQUE

Standard guidelines for EVAR are (a) aneurysm diameter of more than 5 cm, (b) suitable portion of proximal aorta (infrarenal segment of at least 1.5 cm for AAA; aneurysm distal to left subclavian artery for TAA)(case 1), (c) a suitable distal landing zone, (d) aneurysm neck angulation of less than 60 degrees, (e) absence of tapering of the aneurysm neck, (f) limited life expectancy or severe co-morbidities precluding open aneurysm repair.

Technique of EVAR. All procedures should be preferably performed in the Operation Theater (OT), under strict aseptic conditions. After draping and pre-op antibiotics, both femoral arteries should be exposed in the groin via vertical incisions. Brachial artery access can be used. The brachial artery catheterization for intraprocedu ral endovascular diagnosis and intervention aids positioning of the proximal end of the stent device, accurate delineation of the renal artery ostia and avoids an additional angiographic catheter in the access and deployment zone. However, the disadvantages being (a) brachial artery pseudo-aneurysms. (b) Subclavian artery thrombosis and embolization. (c) Cubital fossa haematomas, ecchymosis and puncture-site bleeding. (d) Cerebral events: carotid and vertebral embolization.

Angiography catheter is introduced in aorta and an angiogram taken to assess the final suitability and anatomical landmarks. The aortic Stent graft (Talent, AneuRx, or Excluder) can be negotiated over a stiff (Backup Meier/Amplatz) wire to the desired level and released. Care should be taken to position this stent-graft below the renal arteries in case of AAAs. The contralateral limb can be introduced via the opposite femoral artery and docked with the main device. The device is then ballooned thereafter to ensure adequate fixation. Post procedure angiograms are required to be done to confirm the suitable positioning and to detect any endoleak. Few patients may require coil embolization of one of the internal iliac arteries in addition to the primary procedure. The device sheath and catheters can then be removed and the femoral arteriotomy closed with 6/0 prolene. Groin wounds can then be closed in conventional manner. Patients are monitored in the ICU overnight and discharged to home after 48 hours. Groin sutures are better removed on the 10th day.

Patients can be followed up by careful clinical examination (specifically looking for the pulsatility of the abdominal mass), Color Doppler studies, and CT angiograms at 3 or 6 months, at one year, and once a year thereafter.

IDEAL CANDIDATES

Several factors determine whether a patient is a suitable candidate for endovascular repair of abdominal aortic aneurysm: patient demographics, the type of aneurysm, and the type of device. The type of abdominal aortic aneurysm most appropriate for stent-graft repair is open to interpretation. In general, simple unruptured atherosclerotic abdominal aortic aneurysms(case 2) that would otherwise qualify for surgical repair (>4.5 cm in diameter) can be considered for stent-graft repair, although a precise size criterion may vary with sex[8]. Finlayson et al suggested that patients with inflammatory abdominal aortic aneurysm respond well to endovascular repair [9].

The dominant limiting factor in patient selection is the stent-graft itself [10]. Each device has specific and relatively restrictive requirements with regard to the diameter, length, and angulation of the proximal and distal attachment sites and to the ability of the iliofemoral arteries to accommodate the stent-graft delivery systems (case 3). Patients who do not fit the device cannot be treated.

The size of the stent-grafts should be 10-20% greater than the outer diameter of the normal vessel at the proposed attachment sites to maximize the chance of an effective seal. In addition, this allows potential enlargement of the attachment site over time[4,11].

Pre procedural imaging of potential abdominal aortic aneurysm stent-graft candidates consists of both CT and catheter angiography. Unenhanced abdominal—pelvic helical CT to assess vascular calcification is followed by thin-section (2-3 mm) helical CT angiography from the celiac artery to at least the iliac artery bifurcations, but preferably to the groins. Diameter measurements (outer wall-to-outer wall) are obtained from the contrast-enhanced axial sections by either measuring the narrowest dimension, when the vessel appears to be imaged on a bias, or using workstations to create true axial sections. The vessel lumen, particularly at the anticipated attachment sites, is inspected for thrombus, calcification, and atherosclerotic disease. Angiography using a graduated pigtail catheter that has markers over a 20 to 25cm distance is preferred for length measurements. Anteroposterior and lateral views of the aorta, oblique views of the proximal aortic neck, if necessary, and anteroposterior and bilateral oblique views of the pelvis are obtained.

TEAM WORK

Successful endovascular repair of abdominal aortic aneurysm is a multidisciplinary effort, with contributions from several specialties. The degree of participation from each discipline will vary from one institution to another. The following

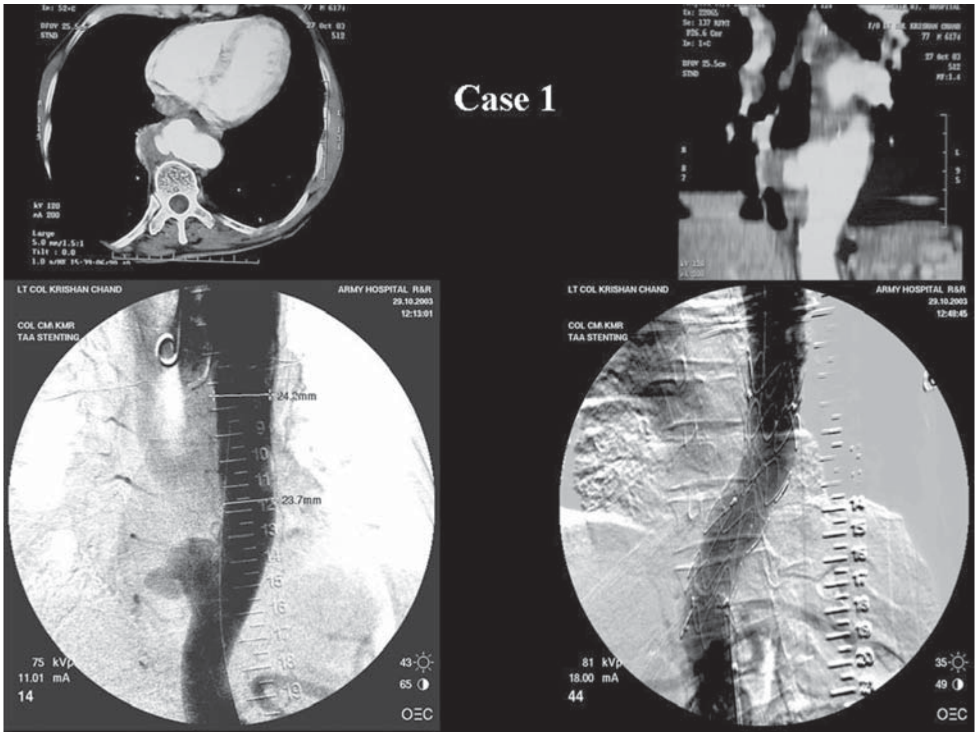


Figure 1 : Case 1(Clockwise) ***1(a)&(b)*** *Contrast enhanced CT scan shows a saccular aneurysm involving lower thoracic aorta.* ***1(c)*** *Digital Subtraction angiography outlines an irregular saccular aneurysm.* ***1(d)*** *DSA after successful exclusion of the aneurysm by inserted stent graft*

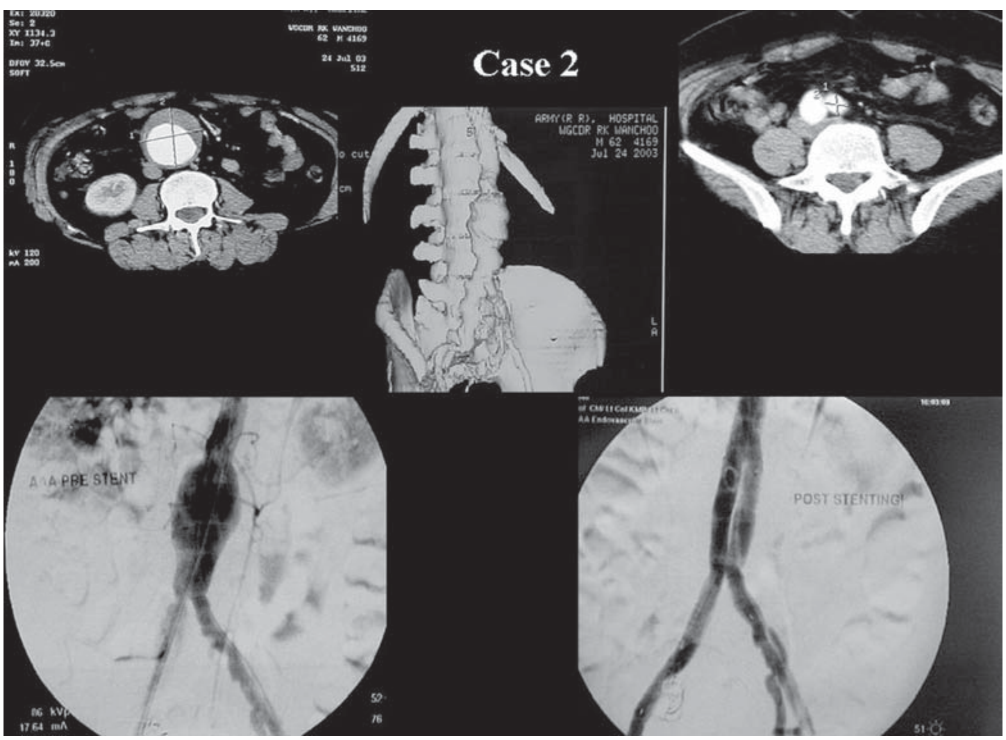


Figure 2 : Case 2 (Clockwise) ***2(a,b,c)*** *Contrast enhanced CT scan shows an athersclerotic aneurysm involving infra renal abdominal aorta involving the aortic bifurcation and proximal right common iliac artery.* ***2(d)*** *Digital Subtraction angiography outlines an infrarenal aneurysm.* ***2(e)*** *DSA after successful exclusion of the aneurysm by bifurcated stent graft and a tubular extension*

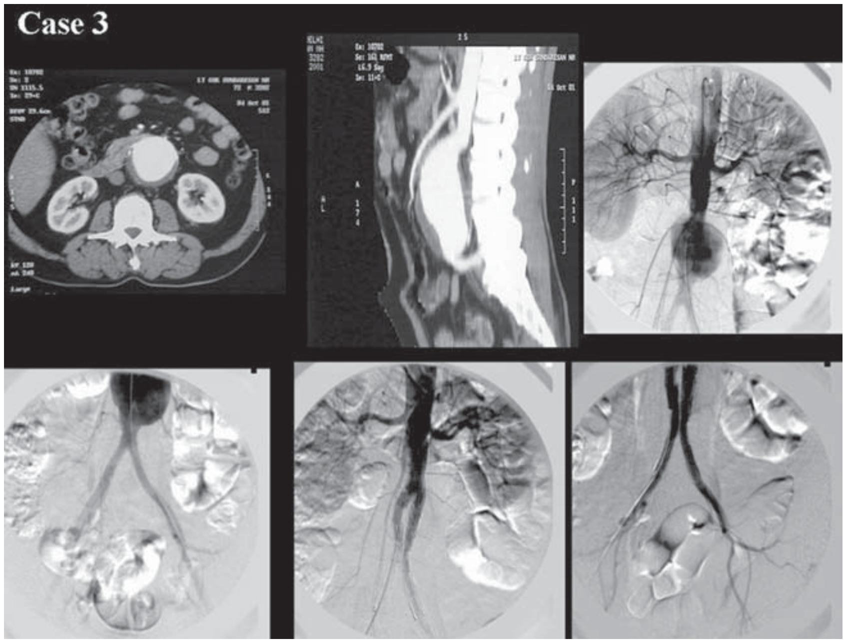


Figure 3 Case 3(Clockwise) 3(a,b) *Contrast enhanced CT scan shows a large athersclerotic aneurysm involving infra renal abdominal aorta involving the aortic bifurcation and tortuous right common iliac artery.* ***3(c,d)*** *Digital Subtraction angiography outlines an infrarenal aneurysm.* ***3(e,f)*** *DSA after successful exclusion of the aneurysm by bifurcated stent graft and a tubular extension*

procedural components are essential: excellent imaging with a 12inch or greater (>30cm) image intensifier, digital subtraction angiography, and the capability to perform aortography (preferably with a power injector) in multiple obliquities; a procedure room that can support open aortic surgery; access to the full range of interventional radiology tools; and a dedicated team who is familiar with the operation of the imaging equipment and the stent-graft delivery system.

ADVANTAGES

Endovascular repair has a number of advantages over open surgical techniques. The stent graft procedure is less stressful to the patient and results in less blood loss and therefore fewer blood transfusions. If general anesthesia is used, the time to extubation is markedly reduced, stays in the intensive care unit are shorter, and ambulation without assistance occurs earlier. In most cases, patients quickly return to a regular diet, and hospital stay is reduced by two thirds, to about 3.4 days[4,12,13]. The 30-day mortality rate in large stent-graft series ranges from 0.7% in low-risk populations to 15.7% in high-risk patients[14]. Death during a stent-graft procedure is rare. Acute intraprocedural rupture of abdominal aortic aneurysm during stent-graft placement with successful outcome has been reported[15]. Multiorgan system failure, myocardial infarction, bowel infarction, stroke, pulmonary embolism, and peripheral arterial embolism have all been described after stent-graft procedures, but most early complications are minor and consist of injuries to access arteries or issues related to groin incisions[16,17].

AIMS OF ENDOVASCULAR REPAIR

Complete exclusion of the aneurysm sac is the goal of stent-graft placement and the definition of early clinical success [18]. Persistent opacification of the aneurysm sac after insertion of a stent-graft is termed an “endoleak” and is classified by cause and time of occurrence[19]. Most early endoleaks are currently types II and IV, because type I leaks can be minimized by careful patient selection and preprocedural measurements[20] Although many early endoleaks disappear within 6 months, reappearance of leaks and delayed appearance of new leaks can occur at any time[21].

COMPLICATIONS

Death during the stent graft procedure is rare, but complications do occur. Delayed rupture of abdominal aortic aneurysm has been a concern. The ultimate goal of stent graft placement is complete exclusion of the aneurysm sac. One criterion for success is the absence of “endoleaks,” which are indicated by persistent opacification of the aneurysm sac after insertion of the stent graft. Type I and III endoleaks are risk factors for subsequent rupture although the significance of type II endoleak remains uncertain. However, there is currently little long-term follow-up information about the clinical significance of this type of problem. Therefore, it is unclear whether further intervention is warranted. In addition, more than 50% of endoleaks diagnosed at the time of initial placement of a stent graft resolve spontaneously and need no further intervention[18,20]. Delayed rupture of abdominal aortic aneurysm after endovascular repair is rare but does occur. The presence of a persistent endoleak is clearly a major contributing factor to delayed rupture.

In addition to aneurysm enlargement or rupture, other late complications of stent-grafts include limb thrombosis, infection, disconnection of modular components, and distortion and fracture of the stent-graft during aneurysm shrinkage[21,22].

FOLLOW UP

The follow-up of patients with stent-grafts requires evaluation of abdominal aortic aneurysm sac size and perfusion, stent-graft patency, changes in diameter of the vessels at the sites of endograft attachment, changes in stent-graft morphology, and detection of new aneurysms. The imaging requirements are quite different from those after surgical repair of abdominal aortic aneurysm, in which imaging is limited in scope and frequency. The single most useful imaging test that allows rapid assessment of patients with stent-grafts is contrast-enhanced helical CT[23].

FUTURE-TRENDS

Although endovascular repair of infrarenal abdominal aortic aneurysms is proving to be helpful in carefully selected patients, there is still much we do not know about stent graft repair of abdominal aortic aneurysms. What are the long-term consequences of persistent endoleaks? What improvements can be made to allow more patients to qualify for stent graft placement? Is this means of repair cost-effective? These are just a few of the questions that have not been answered completely.

Stent graft repair of abdominal aortic aneurysms reduces use of hospital resources during and immediately after the procedure. However, the cost is 10 to 20 times higher than that for surgical repair. Imaging studies for follow-up also are costly. Despite these concerns, patient interest and enthusiasm are likely to continue to drive this technology.

CONCLUSION

Endovascular repair of abdominal aortic aneurysm is a new evolving procedure that is undergoing rapid clinical implementation. As is often the case with new technologies, there is more that we do not know than we do. It is entirely possible that this procedure will undergo major modification as long-term outcomes become known. Even at this early stage, it is evident that a good stent-graft by itself is not enough to make this procedure successful. Persistent perfusion of the aneurysm sac from retrograde flow in branch vessels is a major long-term concern. An additional intervention may be required, such as sac ablation with a thrombogenic substance, to ensure complete depressurization of the aneurysm. Perhaps combined endovascular deployment of the stent-graft with retroperitoneal endoscopic ligation of branch vessels will be required[24].

Patients whose aneurysms begin just below the renal arteries are difficult or impossible to accommodate with current stent-grafts. Experience with the placement of uncovered metal extensions of the stent-graft over the renal artery ostia to obtain a secure proximal seal has been favorable, with no increased incidence of renal dysfunction when compared with infrarenal designs. The development of stent-grafts with side-arms to accommodate critical aortic branches will further increase the applicability of this technology[25].

REFERENCES

1. Hodges TC, Cronenwett J. Abdominal aortic and iliac artery aneurysms: clinical presentation, natural history, and indications for intervention. In: Perler BA, Becker GJ, eds. Vascular intervention: a clinical approach. New York: Thieme, 1998:339 - 350
2. Dardik A, Burleyson G, Bowman H, et al. Surgical repair of ruptured abdominal aortic aneurysms in the state of Maryland: factors influencing outcome among 527 recent cases. J Vasc Surg 1998;28:413 -421.
3. Hallett JJ, Bower T, Cherry K, Gloviczki P, Joyce J, Pairolero P. Selection and preparation of high-risk patients for repair of abdominal aortic aneurysms. Mayo Clin Proc 1994;69:763 -768.
4. John A. Kaufman, Stuart C. Geller, David C. Brewster, Chieh-Min Fan, Richard P. Cambria, Glenn M. LaMuraglia Endovascular Repair of Abdominal Aortic Aneurysms Current Status and Future Directions AJR 2000; 175:289-302
5. Gorich J, Rilinger N, Sokiranski R, et al. Leakages after endovascular repair of aortic aneurysms: classification based on findings at CT, angiography, and radiography. Radiology 1999;213:767 -772.
6. Dotter C. Transluminally-placed coilspring endarterial tube grafts: long-term patency in a canine politeal artery. Invest Radiol 1969;4:329 -332.
7. Parodi J, Palmaz J, Barone H. Transfemoral intraluminal graft implantation for abdominal aortic aneurysms. Ann Vasc Surg 1991;5:491 -499.
8. Finlayson S. Should endovascular surgery lower the threshold for repair of abdominal aortic aneurysms? J Vasc Surg 1999;29:973 -985.
9. Boyle J, Thompson M, Nasim A, Sayers R, Holmes M, Bell P. Endovascular repair of an inflammatory aortic aneurysm. Eur J Vasc Endovasc Surg 1997;13:328 -329.
10. Armon M, Yusuf S, Latief K, et al. Anatomical suitability of abdominal aortic aneurysms for endovascular repair. Br J Surg 1997;84:178 -180.
11. Sonesson B, Malina M, Ivancev K, Lindh M, Lindblad B, Brunkwall J. Dilatation of the infrarenal aneurysm neck after endovascular exclusion of abdominal aortic aneurysm. J Endovasc Surg 1998;5:195 -200.
12. Zarins C, White R, Schwarten D, et al. AneuRx stent graft versus open surgical repair of abdominal aortic aneurysms: multicenter prospective clinical trial. J Vasc Surg 1999;29:292 -305.
13. Buth J, Laheij R. Early complications and endoleaks after endovascular abdominal aortic aneurysm repair: report of a multicenter study. J Vasc Surg 2000;31:134 -146.
14. May J, Schulze K. Successful completion of endoluminal repair of an abdominal aortic aneurysm after intraoperative iatrogenic rupture of the aneurysm. J Vasc Surg 1999;30:901 -906.
15. Brewster DC, Cronenwett JL, Hallett JW, Jr., Johnston KW, Krupski WC, Matsumura JS et al. Guidelines for the treatment of abdominal aortic aneurysms. Report of a subcommittee of the Joint Council of the American Association for Vascular Surgery and Society for Vascular Surgery. Journal of Vascular Surgery 2003;37(5):1106-1117.
16. Thompson M, Sayers R, Nasim A, Boyle J, Fishwick G, Bell P. Aortomonoiliac endovascular grafting: difficult solutions to difficult aneurysms. J Endovasc Surg 1997;4:174 -181.
17. Ahn S, Rutherford R, Johnston K, et al. Reporting standards for infrarenal endovascular abdominal aortic aneurysm repair. J Vasc Surg 1997;25:405 -410.
18. White G, May J, Waugh R, Chaufour X, Yu W. Type III and type IV endoleak: toward a complete definition of blood flow in the sac after endoluminal abdominal aortic aneurysm repair. J Endovasc Surg 1998;5:305 -309.
19. Becquemin J, Lapie V, Favre J, Rousseau H. Mid-term results of a second generation bifurcated endovascular graft for abdominal aortic aneurysm repair: the French Vanguard trial. J Vasc Surg 1999;30:209 -218.
20. Jacobowitz G, Rosen R, Riles T. The significance and management of the leaking endograft. Semin Vasc Surg 1999;12:199 -206.
21. Maleux G, Rousseau H, Otal P, Colombier D, Glock Y, Joffre F. Modular component separation and reperfusion of abdominal aortic aneurysm sac after endovascular repair of the abdominal aortic aneurysm: a case report. J Vasc Surg 1998;28:349 -352.
22. Harris P, Brennan J, Martin J, et al. Longitudinal aneurysm shrinkage following endovascular aortic aneurysm repair: a source of intermediate and late complications. J Endovasc Surg 1999;6:11 -16.
23. Rozenblit A, Marin M, Veith F, Cynamon J, Wahl S, Bakal C. Endovascular repair of abdominal aortic aneurysm: value of postoperative follow-up with helical CT. AJR 1995;165:1473 -1479.
24. Cerveira J, Cohen J. Laparoscopically assisted abdominal aortic aneurysm repair. Surg Clin North Am 1999;79:541 -550.

Duda S, Raygrotzki S, Wiskirchen J, et al. Abdominal aortic aneurysms: treatment with juxtarenal placement of covered stent-grafts. Radiology 1998;206:195 -198.

ENDOVASCULAR MANAGEMENT OF VARICOSE VEINS

Surgeon Commander R Pant*, Wing Commander H Sahni*
** Associate Professor of Radiology*
Department of Radiodiagnosis and Imaging, Armed Forces Medical College, Pune 411 040, India

Abstract: *Lower extremity varicosities are multifactorial in etiology. Management is essentially aimed at correcting the mechanical reasons for the venous insufficiency. The surgical approach with saphenous vein ligation and stripping has been in vogue for many years. Endovenous techniques now achieve similar results in a minimally invasive fashion. These utilise laser or RF energy to ablate the saphenous vein. Smaller veins can also be treated. Procedures are usually done on daycare or OPD basis under local anaesthesia and intravenous sedation. Many series have shown results equivalent to more invasive surgery.*
Key Words: lower extremity varicosities : Endovenous techniques : Endovenous ablation

INTRODUCTION

Varicose veins are a natural consequence of the vertical posture that mankind adopted in its evolutionary development. The three described variants of teleangiectasias, reticular varicosities and true varicose veins are clinically very different in appearance but identical in physiological and etiological mechanisms.

PATHOPHYSIOLGY AND ETIOLOGY

Normal venous return from the lower limbs requires the following to exist:

(i) A patent pathway from the lower limbs upto the IVC. The pathway that the blood goes through to reach the IVC has two parts: Superficial Veins and Deep Veins. Veins called perforators that pass form the superficial to the deep venous system and prevent reflux from the deep to the superficial venous systems link the two venous networks. (Fig 1)

(ii) A force that pushes the blood up against the force of gravity towards the heart. This is provided by the pressure of the arterial flow to some extent, but is mainly due to the contraction of the calf muscles, also called the "Calf Pump" which pushes blood out of the intramuscular sinusoids and back up to the heart. his is also called the hydrodynamic force.

(iii) A mechanism that prevents the blood from literally "falling back downhill" under the influence of gravity towards the lower limbs. This is provided by a system of valves that allows blood to only pass in the direction of the right atrium, and from superficial to deep veins. (Fig 2)

Thus, venous insufficiency is traceable to the absence of one or more of these factors. Failure of valves can be due to congenital absence, and can occur in both the deep veins, causing deep venous reflux or in the perforators causing perforator incompetence. A common acquired cause is venous thrombosis with valves becoming adherent to the vein wall.

Hereditary factors are involved in the causation of varicose veins. Pregnancy and the attendant hormonal changes are another fertile ground on which the hydrostatic pressure (weight of the blood column form the Right atrium to the Lower limbs)

Correspondence : Dr. Surgeon Commander R Pant, Armed Forces Medical College, Pune 411040, India

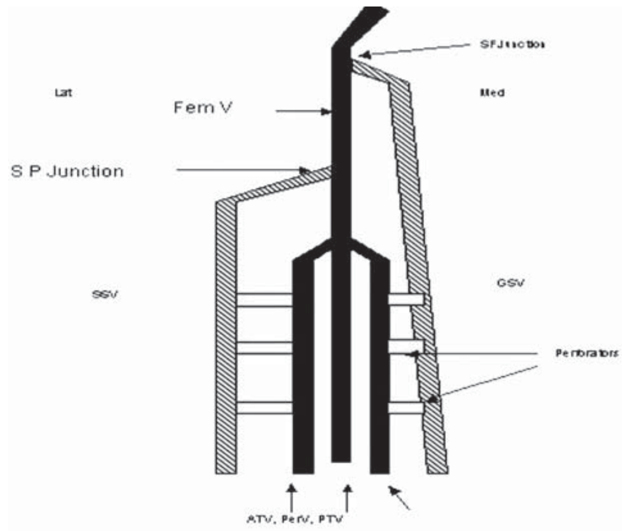


Fig.1 Deep and Superficial Veins. A schematic
FernV= Femoral Vein, SSV= Short Saphenous Vein, GDV= Greater Saphenous Vein, ATV=Anterior Tibial Vein, PerV= Peroneal, PTV= Posterior Tibial Vein, SF Junction= Sapheno-Femoral Junction, S P Function= Sanheno Ponlieal Junction

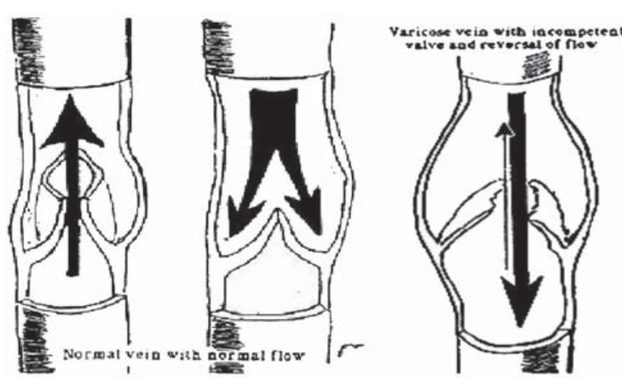


Fig. 2 : Valvular Incompetence

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and the hydrodynamic force (contraction of muscles surrounding the veins) act. In event the valves fail under the hydrostatic force, the hydrodynamic force is transmitted directly to the relatively loosely supported venous elements in the subcutaneous tissues. These enlarge, elongate and become tortuous under the influence of this pressure and thereby give rise to varicose veins. Dilatation and tortuousity occurring in different types of veins gives rise to varying clinical appearances (fig 3).

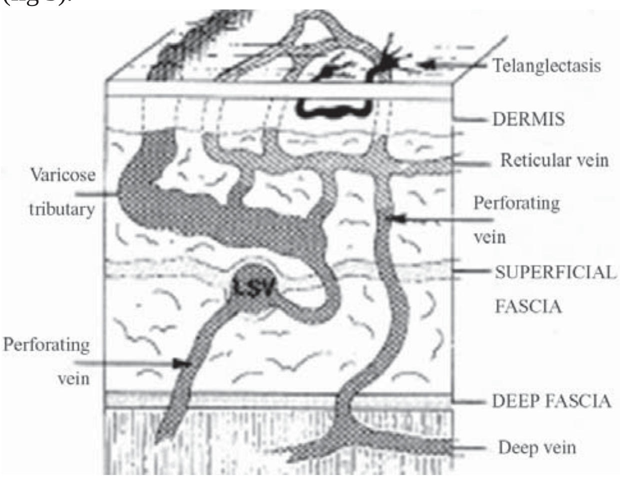


Fig. 3 : Conections from deep to superficial veins showing the various manifestations ofvenous incompetence

Table1: *Indications for Intervention*

	Indications for Intervention
■	Cosmetic indication
■	Aching Pain lower limb
■	Easy Fatiguability
■	Leg Heaviness
■	Superficial Thrombophlebitis
■	External Bleeding
■	Ankle hyperpigmentation
■	Lower Limb Oedema
■	Lipodermatosclerosis

SYMPTOMATOLOGY

Varied symptoms can occur because of venous incompetence, ranging from visible veins, itching and pain, to skin ulceration. Table 1 summarizes indications for intervention in venous incompetence. The varied symptoms and signs may sometimes be difficult to recognise as originating from the venous system. All these symptoms are traceable to dilated veins, increased subcutaneous tissue fluid and stretching of nerves surrounding the veins. Prolonged and severe incompetence causes skin ischemia and breakdown by a variety of factors, leading to ulceration.

MANAGEMENT: BASIC PRINCIPLES

The basic principle of treatment of varicose veins of the lower limb is abolition of the hydrostatic force and isolation of the superficial veins from the transmitted hydrodynamic force. This should be achieved while preserving the venous outflow of the limb. This is conventionally achieved by surgical means. The most commonly implicated area requiring surgical intervention is the sapheno-femoral junction and the further discussions will use this as the illustrative example of the basic principles.

SURGICAL APPROACH

The surgical techniques require an occlusion of the SFJ with removal of the greater saphenous vein (GSV) to achieve reliable long-term results. This is to achieve the objective of removing the hydrostatic force and detaching the tributaries (perforators) of the GSV. This can be achieved by the traditional stripping or by the invagination method; and is now also practiced as an outpatient procedure with groin to knee downward stripping (Fig4). The classical technique recommends removing the below knee portion as well, but this technique is associated with saphenous nerve injury[1].

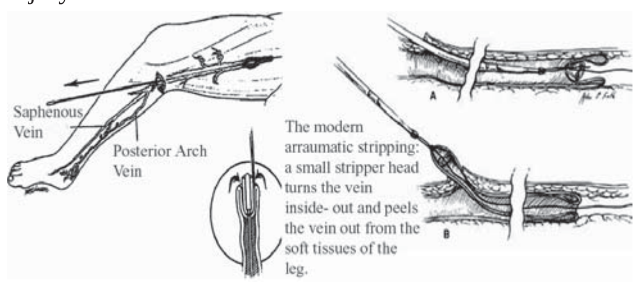


Fig. 4 :Inversion stripping manuver for removing the saphenous vein. The inguinal is about 2cm and the Knee incision is about 3mm

ENDOVASCULAR APPROACH

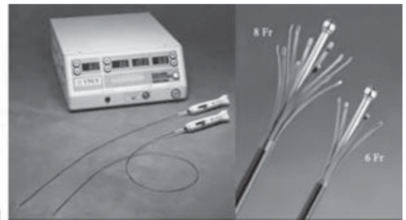
The endovascular procedure achieves the objectives of the surgical technique by using an endovascular application of energy to ablate the saphenous vein. This implies a destruction of the venous wall so that recanalisation is not possible, as opposed to a thrombosis, which can be relatively easily recanalised by natural lytic system[2].

Regarding choices of equipment, saphenous vein ablation is currently carried out with two types of equipment: Laser Ablation Systems and Radiofrequency Ablation Systems

In Laser Ablation systems there is transfer energy to the vein wall by using a 600 or 810 nm wavelength laser through a fibreoptic catheter. The fibre is small enough to pass through a 24-gauge needle and different manufacturers have used both bare and sheathed fibres. The most commonly used system is manufactured by Diomed (Fig 5), though many other manufacturers are now in the market. This laser is absorbed by the surrounding tissue and raises the local temperature sufficiently to destroy the vein wall.

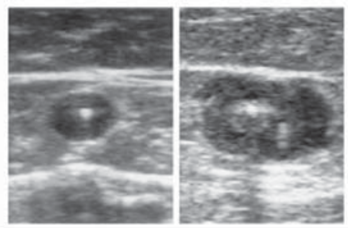
Radiofrequency (RF) ablation systems use radiofrequency energy to create a rise in temperature in the target area and thereby denature the structural proteins. This technology is used in a variety of applications including tumour ablation, nerve ablation, endoscopic gastro esophageal reflux therapy

Diomed Laser system for EVLT Endovenous Laser Thermoablation procedure.



VNUS unipolar system with the Closure catheter

Celon Lab Power Bipolar system with the ProCurve catheter



Tumescent Anesthesia: US Image on the right shows anaesthetic surrounding and collapsing the vein

etc. RF systems are of two types, unipolar and bipolar. These differ in their design. Unipolar systems require a grounding pad to complete the circuit. Bipolar systems do not require any grounding pad (in a fashion similar to bipolar and unipolar surgical electrocauteries). This enables the use of bipolar devices even in patients with pacemakers implanted. There is no fundamental difference in the effects on tissue. These devices have a sensor system that senses the temperature around the probe tip and adjusts the output automatically. The energy output varies as required, and modern devices have microprocessor-controlled systems for this purpose. Unipolar system in common use is the VNUS system using the Closure catheter from VNUS Medical technologies. This has 6F and 8F catheters (fig6). A bipolar system is now available, that is capable of all RF functions including venous ablation. This is manufactured by Celon AG , and has 6 F and 3 F catheters (Fig 7).

TECHNICAL ASPECTS:

Endovenous ablation has the following steps:

1. Access to the target vein (Great Saphenous Vein): This is usually achieved percutaneously, at a level near the ankle. This will require ultrasound guidance in most cases, particularly as the edema and multiple dilated channels make it difficult to accurately localise and puncture the GSV. This is usually better carried out with a micropuncture set (21 G needle, cope dilator, 0.018" wire). The size of the sheath inserted would depend upon the device being used, this may vary from 6 F to 8 F. Bare fibre devices may require just a 21-24 G needle puncture with Teflon cannula placement. A cutdown procedure is also used for this access at times. This may be done at the groin or at the ankle.
2. Cannulation of the Target Vein: Due to the tortuousity of the vein in cases with long standing reflux, this may at times be difficult. If available, an image intensifier or C- arm can be of assistance, though usually US guidance is sufficient. Fibre optic laser systems usually require placement of long sheath upto the SFJ through which the fibre is subsequently passed. The point of ablation is decided upon under US guidance. This is usually 2.5 cm away from the exact SFJ, to avoid causing injury to the deep vein.
3. Removal of blood from the target vein : To achieve consistent and reliable ablation, the vein must be exanguinated. This may be achieved by an esmarch bandage to squeeze out the blood from the vein along with saphenofemoral junction compression. An alternative technique is that of tumescent local anesthesia where a large amount of very dilute local anaesthetic (100–200 mL of 0.2% lidocaine) is injected all along the entire vein, surrounding it and collapsing it over the ablation probe (fig 8). This allows good contact with the vein wall and better transfer of energy. Furthermore, pain relief and prevention of skin burns is achieved.
4. Ablation is generally performed in a manner that achieves adequate heating of the vein wall without skin burns occurring. The exact technique depends on the precise equipment used, but on the whole it consists of pulling back the catheter (probe) at a reasonable velocity while applying energy. The RF ablation systems have a sensor system to control the amount of energy delivered in response to the alteration in tissue resistance. This allows a more precise control with a recorded chart for review purposes (Fig 9).

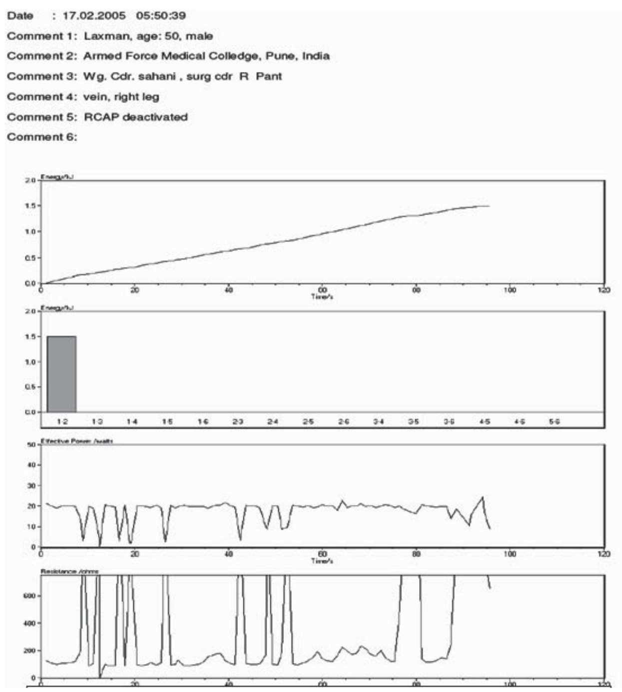


Figure 6: *Chart of Energy Output and Resistance charges during abiation procedure charges during abiation procedure with Bipolar RF system*

5. Post procedurally, haemostasis is generally easily achieved by compression. Most series have reported the use of compression dressing over the treated limb for a week or so. Some practitioners recommend ablation of the subcutaneous track to achieve better haemostasis.

RESULTS FROM REPORTED SERIES

Initial series attempting endovascular RF ablation showed many complications. Burns, nerve injuries, infection etc were reported[3].This has changed with modern technology and precise control of energy output. One of the initial large series (141 saphenous veins) to be reported has shown a high acute closure rate (93%) with clinical cure persisting in 90% cases at 2 years [4]. Series of 499 limbs treated with endovenous ablation showed a recurrence rate of less than 7 % at 2 years. This series also reported extensive use of sclerotherapy for treating tributaries after ablation during follow up[5] .

COMPLICATIONS

Endovenous therapy in saphenofemoral incompetence is not without its share of complications. The obvious ones of haemorrhage and infection are uncommon with current equipment. No definite data exists to show a requirement for prophylactic antibiotics, except in cases of preexisting infection. The use of an intra-procedural antibiotic would depend on individual preference and hospital policy.

Pain is a common problem, more often noted after laser therapy as compared with RF techniques, perhaps because of the less controlled energy application, which may raise the local temperature higher. Ecchymoses have also been more often reported with laser ablation. These are however easily managed with drugs and conservative therapy.

A more serious complication is deep venous thrombosis with pulmonary embolism. This is very uncommon, being reported in 3 out of 522 patients (.57%)in the VNUS registry, with the incidence of pulmonary thromboembolism being even lower at 0.17%. Dysfunction in the territory of the great saphenous nerve can occur, usually manifesting as paraesthesias. This has been reported in upto 3 % of cases at 2 years. %.[6] Later series have reported much lower complication rates, with the series reported above[5] showing a zero incidence of DVT, skin burns or paraesthesias.

FAILURE OF TREATMENT

As noted above, failure is not common with endovascular therapy. There is a theoretical objection to the technique of endovenous therapy. This lies in its failure to address the tributaries joining the femoral vein near the SFJ. These are classically ligated during surgery. However, a study comparing cases done with and without high ligation of saphenous vein has shown that the difference in recurrence rate is not significant, though it is more in cases without high ligation (2% Vs.8%) Both groups showed a 90% freedom from varicosities at 1 year based on actuarial curves[7]. Many cases of recurrence can also be treated with sclerotherapy of the tributaries without undergoing surgery[5].

CONCLUSION

Endovascular saphenous vein ablation is a technique that provides a simple and rapid way of treating cases of saphenous vein incompetence. The procedure can be carried out under local anesthesia with or without intravenous sedation and with proper technique and patient selection has results equivalent to surgical techniques. It has an advantage of being relatively less painful and having a lower complication rate.

REFERENCES

1. *Munn SR, Morton JB, MacBeth WAAG, McLeish AR. To strip or not to stripthe long saphenous vein? A varicose veins trial. Br J Surg 1981; 68:426–428.*
2. *Whiteley MS, Pichot O, Sessa C, KabnickLS, Schuler-Petrovic S, Chandler JG. Endovenous obliteration: an effective, minimally invasive surrogate for saphenous vein stripping. J Endovasc Surg 2000; 7:I1–I7.*
3. *Politowski M, Zelazny T. Complications and difficulties in electrocoagulation of varices of the lower extremities. Surgery 1966; 59:932–934.*
4. *Manfrini S, Gasbarro V, Danielsson G, et al. Endovenous management of saphenous vein reflux. J Vasc Surg 2000; 32:330–342.*
5. *Min RJ, Khilnani N, Zimmet SE. Endovenous Laser Treatment of Saphenous Vein Reflux: Long-Term Results.J Vasc Interv Radiol 2003; 14:991–996*
6. *Bergan JJ, Kumins NH., Owens E L., Sparks S R. Surgical and Endovascular Treatment of Lower Extremity Venous Insufficiency J Vasc Interv Radiol 2002; 13:563–568*
7. *Chandler JG, Pichot O, Sessa C, Schuller-Petrovic S, Osse FJ, Bergan JJ. Defining the role of extended saphenofemoral junction ligation: a prospective comparative study. J Vasc Surg 2000; 32:941–953*

RADIOFREQUENCY ABLATION IN ONCOLOGY: PRINCIPLES, TECHNIQUES AND CURRENT APPLICATIONS

Arvind K Chaturvedi
Department of of Radiology and Imaging,*Rajiv Gandhi Cancer Institute & Research Centre , Rohini, New Delhi, India*

Abstract: *Radiofrequency ablation (RFA) is a technique that causes tissue necrosis by a process of heating, when high frequency current passes through tissue, thereby causing thermocoagulation. It is a relatively new treatment modality where thermal energy is used for destroying tissue. In radiofrequency ablation a high frequency alternating current (400 to 900 KHz) is delivered to the tumor tissue via a needle electrode. By ionic agitation, frictional heating of the tissue and thermal coagulative necrosis occurs causing cell death. Mammalian cells undergoes death within 4-6 minutes at temperatures above 49°C, which is near instantaneous above 60 degree C, while at 105°C the cells boil, intracellular water vaporizes and tissue gets charred. It is an attractive option for local tumor control in patients who are not surgical candidates or who have failed conventional therapies. RFA has been conventionally used to treat metastases from colorectal cancers and HCC. Currently its role is extended in treating primary and secondary lung tumours, bone tumours, early stage breast cancer and small kidney tumours not suitable for surgery. It is the treatment of choice for osteoid osteoma.*
Key words*: Radiofrequency ablation, Tumour ablation*

INTRODUCTION

Heat has been used in ancient Hindu medicine and by the Greeks as heated stones and metal bar to stop bleeding. D'Arsonval in 1891 first introduced radiofrequency current as a clinical tool in the form of electrocautery and medical diathermy. Radiofrequency ablation (RFA) is a technique that causes tissue necrosis by a process of heating, when high frequency current passes through tissue, thereby causing thermocoagulation. It is a relatively new treatment modality where thermal energy is used for destroying tissue. RFA has been conventionally used to treat metastases from colorectal cancers and HCC[1]. Currently its role is extended in treating primary and secondary lung tumours, bone tumours, early stage breast cancer and small kidney tumours not suitable for surgery. It is the treatment of choice for osteoid osteoma.

PRINCIPLE

In radiofrequency ablation a high frequency current (400 to 900 KHz) is delivered to the tumor tissue via a needle electrode. As the current alternates rapidly the ions in the vicinity of the needle tip rapidly change direction (ionic agitation). This causes frictional heating of the tissue, thermal coagulation and cell death by coagulative necrosis. Most mammalian cells do not survive temperature exceeding 42°C. Death begins to occur within 4-6 minutes at temperatures above 49°C and becomes near instantaneous above 60 degree C. At 105°C the cells boil, intracellular water vaporizes and tissue gets charred[2]. This charring and gas formation due to heat deposition near the needle tip is a disadvantage since it drastically reduces the current flow and limits the size of ablation.

Different manufacturers use different techniques to control the charring so as to increase the size of ablation. It can be achieved by perfusion of saline into the tissue to sustain conductivity(Electrotom, Berchtold, Tuttilingen, Germany). Alternatively the needle tip can be kept cool by inflow of chilled saline (Cool tip, Radionics, Burlington,MA). Machines with multiple retractable electrodes which when deployed physically occupy a larger volume of tissue are also in use resulting in a larger ablation zone. (RITA Medical Systems, Mountain View, CA). Combining strategy with concurrent chemotherapy has yielded larger ablation volumes in experimental studies[3,4].

Presence of a large vessel adjacent to the tumour prevents adequate hyperthermia due to rapid heat loss in the flowing blood (the "heat-sink" effect). It explains increased incidence of residual or recurrent disease in the vicinity of a large vessel. Vessels above 3 mm in diameter cannot be coagulated[2]. Proposed standardised terminology for heat sink effect is perfusion mediated cooling[5]. In contrast, encapsulated tumours like hepatocellular carcinoma (HCC) are more amenable to ablation as they allow for greater deposition of heat due to compartmentalization of thermal energy (the "oven effect").

TECHNIQUE

The procedure is safely performed on an outpatient basis under conscious sedation. Prior confirmation of the lesion by biopsy or fine needle aspiration cytology (FNAC) and its localization on an imaging study is necessary. The RF needle is inserted into the lesion under CT (or ultrasound) guidance and an earthing pad is applied on the patient's legs or

Correspondence : Dr. Arvind K Chaturvedi, Professor & Head Deptt of Radiology and Imaging, Rajiv Gandhi Cancer Institute & Research Centre, New Delhi, India

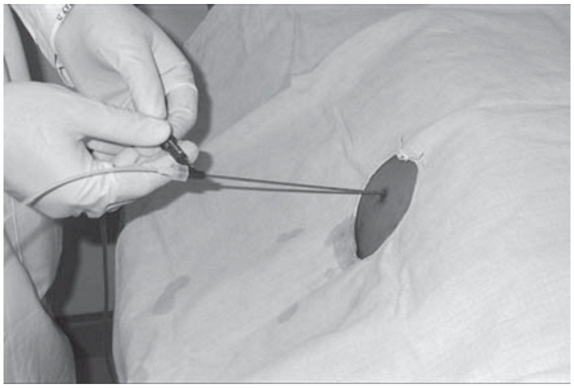


Fig 1. RF needle position during treatment

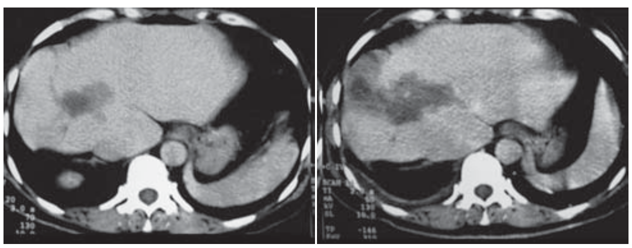


Fig 2. Hepatic metastases from colorectal cancer. Pre and post RFA appearance.
Note the larger ablated zone in the image on right

abdomen (fig 1). The needle electrode and the earthing pad are then connected to the high frequency generator and the patient becomes part of an electrical circuit. The typical ablation session last, for 10-20 minutes, depending on the size of lesions. Lesions with diameter up to 3-5 cm can be treated in a single session. Larger lesions may need multiple insertions. Route of insertion is usually percutaneous although it can also be done laparoscopically or even per-operatively (Open method). Percutaneous approach is preferred as it is least invasive, can be performed on out patient basis and the procedure can be repeated if needed.

Follow-up is done with a CT-scan (or MRI) after 24hours, after a month and then at 3 monthly intervals, along with tumour markers to detect residual disease or recurrence. Post-treatment CT-scan should show a completely non-enhancing hypodense area with diameter larger or equal to the pretreatment diameter and with no enhancing focus (fig 2). Although early in the course, a peripherally enhancing rim may be seen due to inflammatory response of the normal tissue and is referred as benign periablational enhancement [5]. The natural history of treated tumour is slow shrinkage over many months to a year. Residual disease or recurrence is indicated by appearance of abnormal enhancing focus on CT scan or MRI.

CURRENT APPLICATIONS

Current indications for RFA include colorectal metastases to liver, liver only metastases from breast cancer, HCC which is not suitable for surgery, bone metastases for control of pain, osteoid osteoma, small renal tumours particularly in a single kidney or a patient not suitable for surgery due to co morbid conditions, primary and secondary lung tumours usually in association with radiotherapy. RF ablation is also used for nerve ablation to achieve pain relief when tumour infiltrates nerves.

RFA is a safe and quick alternative to surgery with a curative potential. The effectiveness of RFA treatment is significantly dependent on tumour size. Lesions up to 3 cm undergo complete ablation and necrosis while the larger lesion requires multiple RFA treatment to prevent recurrence. For both the local and systemic control of the disease, RFA can be combined with other modalities like chemotherapy.

RF ABLATION IN LIVER

***Liver metastasis**:* Patients with liver metastasis do not survive beyond one year if left untreated, most commonly due to liver failure by extensive hepatic involvement. Reduction in the tumour load in liver prolongs the survival. Long-term survival can be achieved in such patients if the metastatectomy is performed (90% at 1 year and 20-40% at

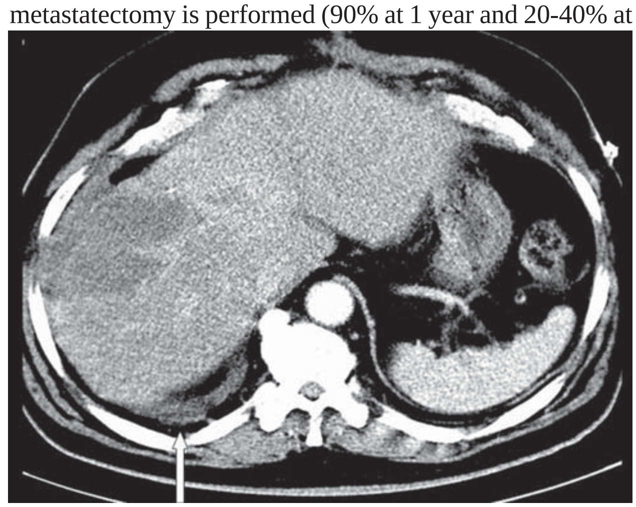


Fig 3. Pleural effusion (white arrow) developed after ablation(black arrow)

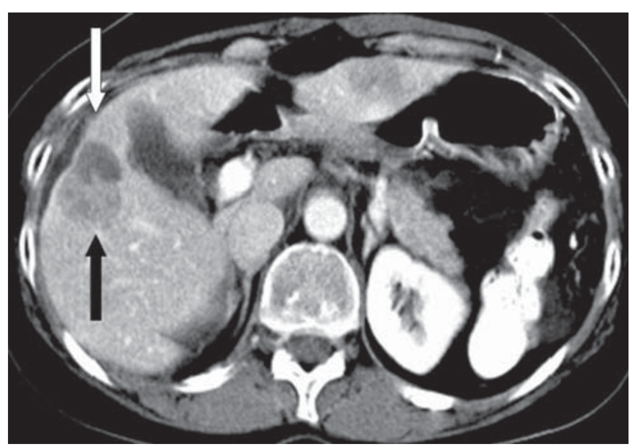


Fig 4. Local recurrence (black arrow) after 12 months at the margin of ablated lesion(white arrow)

5 year). However, only 5-10% of patients are suitable for surgical resection due to the advanced age, extra-hepatic involvement and co morbid conditions. In patients of carcinoid syndrome who have paraneoplastic symptoms, marked symptomatic relief can be achieved after ablation of metastatic deposits in liver. Local recurrence is particularly more common with lesions of diameter larger than 3 cm (fig 4).

RFA of liver lesions is an extremely safe procedure and can be performed on an out patient basis. Some complications of RF ablation are listed below :-

1. Post ablation syndrome: It is a tissue lyses-related phenomenon characterized by transient "flu like" symptoms, low-grade fever, lethargy and sweating[6], usually self-limiting and common after large tumour volume ablation.
2. Thermal Injury: This includes skin burns at ground pad site or collateral damage to internal organs adjacent to the ablation site.
3. Pleural effusion: It is reactive phenomenon and is usually mild and transient. It is commonly seen in lesions close to the diaphragm (fig 3).
4. Haemorrhage: This can be prevented by correcting the coagulation profile and by ablating the needle track.

Hepatocellular Carcinoma (HCC): RFA was primarily developed for treating hepatocellular carcinoma. HCC have poor response to chemotherapy and radiotherapy. Surgical resection has been considered the only potentially curative option but the majority of patients are not amenable to resection due to the large size, location near major intra-hepatic blood vessels, underlying cirrhosis or a multicenteric disease. RFA is a safe and quick alternative to surgery with a curative potential.

After RFA treatment, median survival is 44 months with 10% local recurrence , which is comparable to that found in surgical series. Early recurrences (within 2 years) are due to both local and new lesions while late recurrences (after 2 years) are due to new lesions. Local recurrence rate is less than PEI while the total recurrence is similar to that reported after surgery or PEI. Due to the "oven effect", encapsulated HCC has least recurrence rate among all liver tumors treated with RFA. RFA is particularly indicated in certain special situations like cirrhosis which has friable liver and the multicenteric form of HCC, which largely rules out a surgical intervention. RFA is therefore being used as first line of treatment in HCC patients with cirrhotic background.

RFA has many advantages over a surgery including low complication rate, reduced cost and increased patient compliance[7]. It is simple, safe, and an effective treatment modality. It is less risky and has low morbidity & mortality as compared to surgery. Most of these procedures are performed without general anesthesia on outpatient basis. As compared to percutaneous ethanol injection, RFA produces a more predictable volume of necrosis and is not impaired by hard consistency of metastatic tissue. PEI requires greater number of sessions (approximately 5 to 8) resulting in poor patient compliance and increased morbidity. RFA treats only the macroscopic disease unlike systematic or hepatic arterial infusion chemotherapy and it does not address the microscopic disease or macroscopic tumor other than the one treated. RFA is designed to work in conjunction with surgery, radiotherapy and chemotherapy and is not intended to replace these modalities. RFA can debulk large tumors, which can be treated with chemotherapy. Post RFA chemotherapy prevents recurrences due to occult micrometastates.

RF ABLATION OF LUNG TUMOURS

Lung cancer has long been the most prevalent cause of cause of cancer death in men in the United States, and it has recently become the most common cause of cancer death in women, even surpassing breast cancer[8]. Surgery provides the highest cure rate in patients with non-small cell lung cancer (NSCLC); however, the majority of these patients have advanced disease at diagnosis and are not candidates for a surgical procedure due to advanced disease in the lungs, poor cardiac function, and poor pulmonary function of the patient. Regarding metastasis to the lung from non-pulmonary tumors, the median survival is equally as disappointing. Radiofrequency (RF) ablation of lung cancer is a potential alternative to surgical resection for patients with tumors[9].

The prognosis for most people diagnosed with lung cancer is relatively poor, only 15% of patients are alive five years after diagnosis. RFA in lung cancer is considered for early stage disease in patients who are not candidates for surgery. However some of the complications of RFA in treating lung cancer are pneumothorax (35%), empyema and bronchial fistula.

RF ABLATION IN RENAL CELL CARCINOMA (RCC)

There have been numerous developments in minimally invasive treatments for RCC, as compared with the traditional standard of open complete nephrectomy. These developments include partial nephrectomy, laparoscopic complete or partial nephrectomy, and ablation therapies such as cryoablation and radio-frequency (RF) ablation[10,11]. With respect to tissue characteristics, the kidney is surrounded by fat that serves as a heat insulator; this allows higher ablation temperatures to be achieved and maintained in tumors surrounded at least in part by fat . Consequently, exophytic tumors appear to be more easily treatable[12]. On the other hand, near the renal sinus, the central portion of the kidney contains large vessels that serve as heat sinks, limiting tumor necrosis.

Therefore, on the basis of their size and location, small exophytic RCC tumors are the ideal tumors for treatment with RF ablation. Among tumors larger than 3 cm, those with a central component near large vessels are less likely to be treated with technical success than are those without such a component. Even in the absence of complete ablation, RF ablation may play a role in palliation of disease in patients who find dialysis unacceptable. This palliative role of RF ablation in the treatment of RCC is an interesting area for further study, especially for large tumors with a central component.

RF ablation of RCC is a very promising technique and is most successful in treating small (<3 cm) exophytic tumors, although tumors up to 5.0 cm can be completely ablated. Tumors with a central component in the renal sinus require more ablations but can be successfully treated with multiple visits for repeated ablations. Longer-term studies of RF ablation of RCC left in situ will provide additional guidance for the most appropriate selection of patients for this treatment. Ideal case for RFA in RCC is an exophytic tumour which is less than 3 cm in size and has a safe percutaneous route.

The complications of RFA in kidney can be ureteral stricture formation, bowel injury and haemorrhage. Bowel can be displaced away from the intended ablation site by injecting 5% dextrose solution. Ureteral protection should be considered when RF ablation is to be performed in a tumor near the ureter.

RF ABLATION IN PRIMARY BREAST CANCER

In 1990, the National Institute of Health (NIH), USA, recommended breast conservation as the appropriate form of primary surgery in most women with early stage breast cancer. Current debate is however revolving around the ability of sentinel lymph node biopsy replacing axillary dissection. As and when the need for axillary dissection gets a backseat there would exist an opportunity to treat the primary breast tumor with a minimally invasive percutaneous technique. Currently the most promising of such non invasive techniques is RF ablation [13]. In a study carried out at M.D. Anderson Cancer Centre (Housten, Texas, USA), it has been conclusively established that tumors upto 2cm in the human breast were completely destroyed by RF ablation[14]. Currently, breast cancers upto 1.5cm, with a few exceptions, are treated by RF ablation alone as an alternative to surgery. Core biopsy prior to RF Ablation will be a prerequisite to establish the diagnosis and the prognostic profile. RF ablation would thus be equivalent to a non surgical lumpectomy.

RF ABLATION OF BONE TUMORS

Radiofrequency ablation of bone tumors is potentially applicable for metastatic lesions causing pain. It is performed percutaneously under CT or fluoroscopic guidance. The tumour bone interface is the site that should be treated. RFA is the procedure of choice for treating osteoid osteoma.

SUMMARY

Radiofrequency ablation of tumours is simple, safe, and an effective treatment modality. It has added advantages over a surgery in low complication rate, reduced cost and increased patient compliance. It is less risky and has low morbidity & mortality as compared to surgery. The procedure can be repeated if necessary and can be combined with other available treatment modalities. RFA is preferred over other techniques available for local control of tumours. Since image guidance is the key to a successful RF ablation, radiologists need to play the principal role in its applications and should accept the challenge in an emerging opportunity to be associated with management of patients.

REFERENCES

1. *Solbiati et al, Radiofrequency thermal ablation of hepatic metastases. Eur J Ultrasound 2001;13(2):149–158*
2. *Zagoria,Image guided Radofrequency Ablation of renal masses. RadioGraphics 2004: 24:S59-S71*
3. *Haaga et al. Combined Tumor Therapy by Using Radiofrequency Ablation and 5-FU–Laden Polymer Implants: Evaluation in Rats and Rabbits1.Radiology 2005;237:911-918*
4. *Goldberg et al.Percutaneous tumour ablation:Increased necrosis with combined RF ablation and intravenous liposomal doxorubicin in a rat breast tumour model. Radiology 2002; 222: 797-804*
5. *Goldberg SN, Grassi CJ, Cardella JF et al .Image-guided Tumor Ablation: Standardization of Terminology and Reporting Criteria. Radiology. 2005 Jun;235(3):728-39.*
6. *Wah TM, Arellano RS, Saltalamacchia C, Martino JA, Gervais DA, Mueller P. Image-guided percutaneous radiofrequency ablation and incidence of post-RFA syndrome: A prospective survey. Radiology 2004; 233(P): 655.*
7. *G. Scott Gazelle, Pamela M. McMahon, Molly T. Beinfeld, Elkan F. Halpern, and Milton C. Weinstein Metastatic Colorectal Carcinoma: Cost-effectiveness of Percutaneous Radiofrequency Ablation versus That of Hepatic Resection Radiology 2004; 233: 729-739.*
8. *Kotaro Yasui, Thoracic Tumors Treated with CT-guided Radiofrequency Ablation: Initial Experience. Radiology 2004; 231: 850-857*
9. *Jeong Min Lee, Percutaneous Radiofrequency Ablation for Inoperable Non–Small Cell Lung Cancer and Metastases: Preliminary Report.Radiology 2004; 230: 125-134*
10. *Gervais DA, McGovern FJ, Arellano RS, McDougal WS, Mueller PR. Radiofrequency ablation of renal cell carcinoma: part 1, Indications, results, and role in patient management over a 6-year period and ablation of 100 tumors.AJR Am J Roentgenol. 2005 Jul;185(1):64-71.*
11. *Gervais DA, Arellano RS, McGovern FJ, McDougal WS, Mueller PR. Radiofrequency ablation of renal cell carcinoma: part 2, Lessons learned with ablation of 100 tumors.AJR Am J Roentgenol. 2005 Jul;185(1):72-80.*
12. *Wah T M, Koenig P, Irving HC, Gervais DA, Mueller PR. Radiofrequency ablation of a central renal tumor: protection of the collecting system with a retrograde cold dextrose pyeloperfusion technique. J Vasc Interv Radiol. 2005 Nov;16(11):1551-5*
13. *P.Y. Marcy, A.Chaturvedi, C.Bailet et al. Percutaneous radiofrequency Ablation (RFA) of post menopausal breast cancer. Eurorad – © 2002 by the Europeon Association of Radiology.*
14. *S.Eva Singletary. Feasibility of Radiofrequency Ablation for primary breast cancer. Breast Cancer 10 : 4-9; 2003.*

CT GUIDED NEUROLYTIC COELIAC PLEXUS BLOCK (NCPB) IN ABDOMINAL MALIGNANCIES: EXPERIENCE IN A CANCER HOSPITAL

Arvind K Chaturvedi, Anuj Thakral and Bharti Malhotra
Department of **of Radiology and Imaging,***Rajiv Gandhi Cancer Institute & Research Centre , Rohini, New Delhi, India*

Abstract: *The purpose of this study is to evaluate the efficacy of CT guided neurolytic coeliac plexus block (NCPB) in advanced pancreatic and other abdominal malignancies who become refractory to routine measures of pain relief. A total of nine patients were subjected to the procedure. A diagnostic block using local anaesthetic preceded the injection of alcohol to assess the expected response. Relief of pain was assessed objectively using a visual analog scale for pain (VAPS). There was significant relief of pain in 8 out of 9 patients.* Thus it is concluded that *CT guided neurolytic coeliac plexus block is an effective way to control pain in advanced abdominal malignancies and helps to improve terminal care.*
Keywords: Coeliac plexus block, Neurolytic block, Abdominal malignancy, CT guidance

INTRODUCTION

Celiac plexus is the largest sympathetic innervation of abdominal viscera. It is located antero lateral to the origin of the celiac artery on both sides. Its involvement by disease, particularly in malignancies such as pancreatic and gastric leads to intractable visceral pain. Over time response to analgesics and opiates diminishes and celiac plexus block is an effective and durable way of managing such pain[1]. CT guided NCPB offers accuracy of needle placement and is done with the patient in prone position. Patient should be off any analgesics on the day of the procedure and a diagnostic block using local anesthetics is first undertaken to evaluate efficacy. If there is significant relief in pain absolute alcohol is then injected for neurolysis. Best results are obtained with bilateral blocks and the effect lasts for 4 to 6 months before nerve regeneration occurs. Possible complications are hypotension, diarrhoea, puncture injuries and sexual dysfunction.

MATERIALS AND METHODS

Nine patients with abdominal malignancies were subjected to NCPB. All had inoperable or recurred intraabdominal malignancies & suffered from intractable upper abdominal pain and/or back pain. 7 patients had pancreatic carcinoma and 2 had gastric carcinoma. All were patients with pain severe enough to require frequent administration of intravenous .analgesics and narcotic agents.

Pain was rated by the patient according to a visual analog scale for pain (VAPS) ranging from 0 (minimum) to 10 (maximum) before and after the procedure to objectively assess response. Patient was kept off all analgesics (oral and intravenous analgesics, transdermal patches) for period of 24 hrs prior to the procedure to eliminate the contribution of pain relief from these analgesics. This allowed a more realistic assessment of pain relief solely from NCPB.

Informed consent was obtained with specific attention to complications associated with NCPB. The procedure was performed under supervision of qualified anaesthetist and under monitoring of vital parameters.The CT scans were performed on a spiral dual slice CT Scanner (Siemens Emotion Duo, Erlangen, Germany). Patient was placed prone on the CT table (Fig 1). After analyzing a previously acquired diagnostic CT scan to assess the overall extent of the disease and the approach, a limited guiding scan was performed with application of radio-opaque surface markers. The aorta and celiac artery origin were identified. Intravenous contrast was not considered necessary.

Under all aseptic precautions and after initial local instillation of anaesthetic agent in skin and subcutaneous tissue, a 22 gauge spinal needle was then introduced paraspinally at the chosen marker much like the procedure adopted for a CT guided biopsy. The needle tip was placed antero lateral to the aorta at

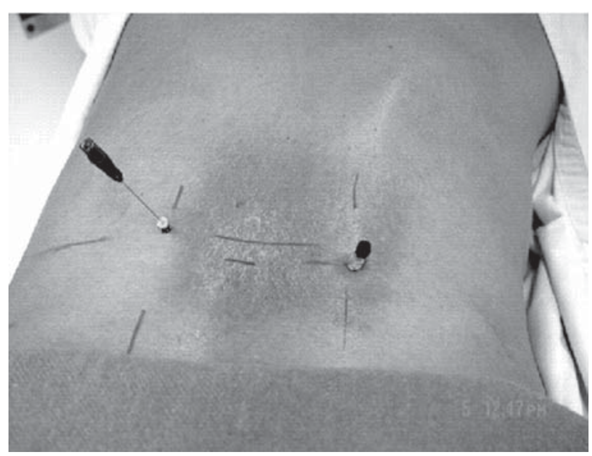


Fig 1. Patient position with needles

Correspondence : Dr. Arvind K Chaturvedi, Professor & Head Deptt of Radiology and Imaging, Rajiv Gandhi Cancer Institute & Research Centre, New Delhi, India

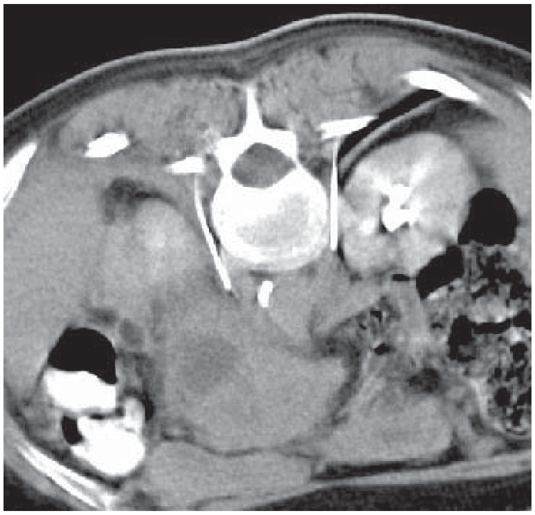


Fig 2. Final needle position

the level of the celiac artery (Fig 2). Needle trajectory was chosen to avoid the transverse process and medial margin of both kidneys. The right side entry point is usually somewhat more lateral than that on the left because optimal placement is between the vena cava and the aorta and requires an wider angle than that on the left.[2] The needle are to be positioned on the right and left sides immediately adjacent to the area of the ganglion. Since the pleura is to be avoided, the needle entry point is more caudal than needle tip. Optimal placement on the right is between the aorta and vena cava, but a tip location adjacent to the posterior margin of the cava is acceptable. For the left side, it is to be adjacent to the superior mesenteric artery, but placement adjacent to the aorta is acceptable[2]. Needle position in either case was confirmed by limited guiding CT scans. 2ml of nonionic intravenous contrast medium (Omnipaque,Iohexol, GE healthcare) mixed with equal amount of local anaesthetic agent (Lignocaine 2% with adrenaline 1:200000). Various workers including Haaga et al also recommend use of air instillation instead of radiographic contrast[2]. However air will not permeate in tissue like alcohol would. After allowing few minutes for the spread of contrast, another limited CT scan confirmed the permeation of contrast around the aorta on either side (Fig 3 and 4). In case the pattern of contrast spread was not as desired, the needle position was accordingly modified. But total non permeation of contrast into the paraaortic region in spite of attempts at changing needle position pointed to the non feasiblity of the procedure. As it happened in one of our patients who had substantial primary disease from carcinoma of pancreas encasing the abdominal aorta on all sides, providing no access for anaesthetic agent to the region of celiac plexus.

After having confirmed needle position, 13 to 15 ml local anaesthetic (bupivacaine 0.25%) mixed with 2ml nonionic contrast (Omnipaque, Iohexol, GE healthcare) was injected slowly on either side through the spinal needles. The VAPS score was then assessed after an interval of around 10 minutes for the effect of bupivacaine to set in. Relief in pain upwards of 50% was considered as measure of adequate response justifying further definitive alcohol ablation. Patient was also shifted to postoperative ward for

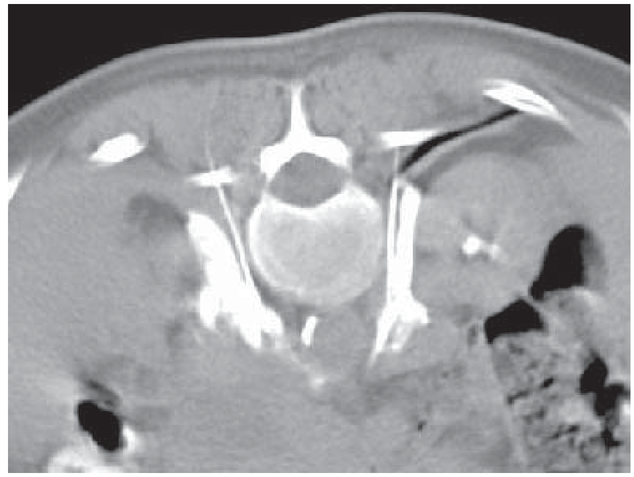


Fig 3. Spread of contrast

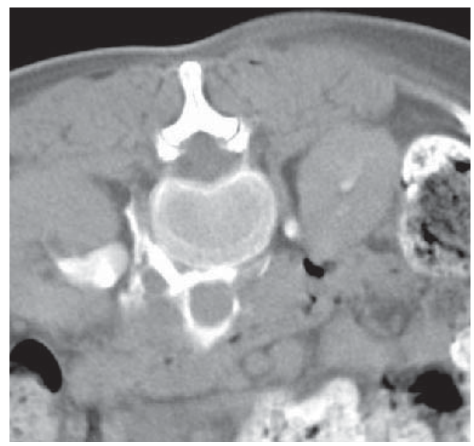


Fig 4. Note that the contrast outlines the aorta

careful observation of immediate and delayed complications if any of the procedure. Our experience in this regard was largely uneventful, with only complaint of pain around the needle insertion site and needle tract in 2 patients.

All patients with significant subjective pain relief and no evidence of complications (8 out of 9) were taken up for definitive alcohol ablation within 24 hrs. This involved placement of needles in the same manner as above. Then 50% v/v of 100% ethanol with 0.25% bupivacaine (total 13 to 15 ml) on either side was instilled to complete the procedure. Patients were again kept under observation overnight to assess pain relief and complications.

RESULTS

Pain relief

Out of 9 patients under review, definitive procedure with alcohol neurolysis was not performed in one due to failure of pain relief after diagnostic block using local anaesthetic. This was due to extensive primary disease encasing the aorta and celiac plexus completely, thereby disallowing permeation of the anaesthetic drug in the vicinity of the plexus. Other 8 patients successfully underwent the procedure and had significant drop in pain score (Table 1). The analgesic consumption of six patients dropped by more than 50% and the remaining two did not need analgesics. All these patients had stopped responding to analgesics prior to NCPB. Two patients died within three months due to progressive disease and hepatic metastases. One patient had recurrence of significant pain after 3 months owing to advanced disease, while on follow up. Another had recurrence of pain after 4 months. Remaining four patients continued to be relatively free of pain upto four months after which they were lost to follow up.

Complications

None of our patients had any significant complication. Transient postural hypotension can result from loss of visceral vascular tone, but was not noted in our experience. Neurologic complications (leg paralysis, sexual dysfunction, urinary difficulty) reported with blind and fluoroscopic techniques have not been reported with CT-guided coeliac ganglion block and were not seen in any of our cases. These encouraging results point to the high efficacy, versatility and safety of our technique.

Discussion

Celiac ganglion blocks have been performed by surgeons or anaesthetists using cutaneous and bony landmarks since the first description by Kappis in 1914. Radiographic guidance for this block was first reported in the 1950s by Bonica. Use of CT for guiding needle placement more specifically has been reported by various radiologists-Hegedus (1979), Haaga et al (1984) [2], Whitemore (1986) and others.

The coeliac block is an established pain relief procedure [3]. The celiac plexus contains the major ganglia for sympathetic and parasympathetic nerves. The coeliac ganglia are the largest of the three pairs of sympathetic ganglia making up the celiac plexus, others being the superior mesenteric and aortico-renal ganglia. The coeliac ganglia are located anterolateral to the aorta at the level of the L1 vertebral body, but may be found from T12 to L2. The celiac ganglia have a more consistent relationship to the origin of the coeliac artery. The right ganglion is an average of 0.6 cm. inferior to the celiac artery origin, and the left is 0.9cm inferior to the coeliac artery origin. Efferent pain fibers serving the pancreas, liver, bowel, and mesentery pass through the plexus. By injecting a neurolytic medication, the plexus or splanchnic nerves are defunctionalised and the pain pathway interrupted.

The unguided method uses the midline, twelfth rib, and needle contact with the vertebral body as landmarks. An unguided technique cannot consider the variations in anatomy that may be encountered. In cases with severe distortion in anatomy making unguided or fluoroscopy guided procedures risk prone, CT provides the only reliable approach. There are case reports where a successful block was performed when the celiac plexus was approachable from one side only due to extensive tumor infiltration[4]. In case of unguided needle placement, there are complications related to improper needle placement, which including paraplegia and transient motor paralysis[5,6], retroperitoneal hemorrhage, adominal aortic dissection[7,8], malposition of the needle into a vessel ,peritoneum or an abdominal viscera.

The test block has been proven useful in establishing the grounds for the definitive alcohol ablation. It can help eliminate three groups of patients who would not benefit from the permanent block – patients with anatomic variations in the location of the ganglia, with disease spread beyond the innervation area of the ganglia (as in one of our patients) and identification of patients with psychogenic pain. Moreover it instills confidence in the patient and attendants about the procedure and reassures the treating interventional radiologist.

There are various approaches to the celiac plexus –the posterior approach (classic retrocrural approach), the anterior approach and transaortic approach. Various workers have shared their experiences with all these approaches[9,10]. All have advocated individual merits and demerits. As per Lee et al.[10], patients with severe pain find the anterior approach more comfortable because they can lie supine on the CT table. The disadvantage of the anterior approach includes the possibility of traversing the stomach or pancreas to reach the celiac ganglia. When the posterior approach is used, there is no danger of traversing the stomach or the pancreas, but the kidney

Table 1: *Visual Analog Pain Scale (VAPS)*
[Maximum pain10, No pain 0]
Pain scores in patients prior to and post test procedure with local anaesthetic (n=9) and following definitive alcohol neurolysis (n=8).

VAPS score	10	9	8	7	6	5	4	3	2	1	0
Pre -procedure	3 (2 Ca pancreas,1 Gastric Ca)	6 (5 Ca pancreas,1 Gastric Ca									
Post test block	1						4	3		1	
Post alcohol neurolysis							4	2	1	1	

may be traumatized. We performed all our procedures using the posterior approach that possibly was the reason for lower complications.

The success of the neurolytic celiac plexus block, despite different approaches and methods used, depends on adequate spread of the injectate in the coeliac area. To evaluate CT patterns of neurolytic (mixed with contrast) spread, the coeliac area was divided on the frontal plane into four quadrants, upper right and left and lower right and left, as related to the coeliac artery. Results were expressed as the number of quadrants into which contrast spread, *i.e.*, four, three, two, or one quadrants with contrast. The patterns of contrast spread according to the number of quadrants with anatomic distortion were analyzed. Findings suggest that, using the single-needle anterior approach, the neurolytic spread in the coeliac area is highly hampered by the regional anatomic alterations. It also appears that only a complete (four quadrants) neurolytic spread in the coeliac area can guarantee long lasting analgesia, and that this picture may be obtained in a very limited fraction of patients with regional anatomic alterations[11].Regardless of the technique used to improve the spread of the injectate in the plexus area, failures are common due to regional infiltration by cancer tissue and anatomy distortion by either previous surgery or radiation therapy-induced fibrosis.

Workers have also gone further to compare conscious sedation with and without coeliac plexus block in patients undergoing thermal ablation of liver metastasis. (Alexander Beck, RSNA 2004). Results reveal that percutanous coeliac plexus block in addition to conscious sedation is a safe and reliable method to significantly decrease the need of pain medication and intervention time. So the future for CT guided coeliac plexus block holds a lot of promise.

REFERENCES

1. *Oscar A. de Leon-Casasola.Critical Evaluation of Chemical Neurolysis of the Sympathetic Axis for Cancer Pain.Cancer Control 2000, 7(2):142-148*
2. *Haaga John R. Kori Shashidhar H. Eastwood DW. Borkowski GP. Improved technique for CT guided celiac ganglia block. Am Journal of Radiology:142, 1984:1201-1204*
3. *Boas RA. Sympathetic blocks in clinical practice. Int Anesthesiol Clin 1978:16:149-182*
4. *Busch Eric H, Kay Dennis, Branting Scott B. Low Volume Neurolytic Celiac Plexus Block with Computed Tomography Guidance. Anesthesiology 2003;99(5):1243-1244*
5. *Jabbal SS , Hunton J. Reversible paraplegia following celiac plexus block.Anaesthesia. 1992;47:857-858*
6. *Davies DD. Incidence of major complications of neurolytic coeliac plexus block. Journal of the Royal Society of Medicine 1993;86(5): 264-266*
7. *Sett SS, Taylor DC. Aortic pseudoaneurysm secondary to celiac plexus block. Ann Vasc Surg 1991;5:88 91*
8. *Kaplan R, Schiff Keren B, Alt E. Aortic dissection as a complication of celiac plexus block. Anesthesiology 1995;83:632 635*
9. *Lee JM. J Korean Med Sci. 2000;15(2):173-8]*
10. *Lee MJ, Mueller PR, van Sonnenberg E, Dawson SL, D'Agostino H, Saini S, Cats AM: CT-guided celiac ganglion block with alcohol. Am J Roentgenol 1993; 161: 633-6*
11. *De Cicco M,Matovic M,Bortolussi R,Coran F,Fantin,Dario ,Fabiani F.Caserta M. Celiac Plexus Block: Injectate Spread and Pain Relief in Patients with Regional Anatomic Distortions. Anesthesiology: 2001; 94(4):561-565*

PERCUTANEOUS CATHETER DRAINAGE OF ABDOMINAL ABSCESSES AND FLUID COLLECTIONS

Sunil Kumar Puri and Y Kavitha
Department of Radiology, GB Pant Hospital and Assoc.Maulana Azad Medical College, New Delhi-110002, India

Abstract: *Percutaneous catheter drainage (PCD) of abdominal abscesses and fluid collections represents a dramatic advance in patient care. The pre-requisite for PCD is an abnormal fluid or pus collection and/or suspicion that the collection is producing symptoms sufficient to warrant drainage. The abscesses or fluid collections are generally discovered by imaging such as US or CT scan. PCD can be performed in almost any organ system after complete preprocedural hematological assessment. During the intervention certain guiding principles such as choosing shortest pathway, avoiding pleural recesses and intervening organs and important structures or utilising the gravity to advantage may be extremely useful. Transrectal and transvaginal routes have also been successfully tried to drain deep pelvic abscesses by catheter._Procedures can be performed by either a "Single step trocar technique" or a "Classical Seldinger technique". Successful PCD is defined as complete resolution of infection requiring no further operative intervention. Percutaneous catheter drainage of abscesses adheres to the basic principles of surgical management by providing decompression, evacuation and continuous drainage without dissemination of sepsis. Its safety, simplicity and excellent cure rates in drainage of abdominal abscesses and fluid collections have established it as preferred first line treatment.*
Key Words : Percutaneous catheter drainage (PCD): Collection: Single step trocar technique: Classical Seldinger technique

INTRODUCTION

Percutaneous catheter drainage (PCD) of abdominal abscesses and fluid collections represents a dramatic advance in patient care. Over last two decades, the procedure has evolved from one of the alternative modes of treatment to the routine first line treatment of choice for abscesses in nearly every organ system except for the most difficult or inaccessible cases[1-4]. Initially it was believed that only patients with simple fluid collections or large unilocular abscesses were ideal for PCD but recently studies have shown that even patients having septated and viscous fluid collections can also be successfully treated particularly with the adjunctive use of fibrinolytic agents[5]. However the simpler the abscess the more likely PCD will be shorter and successful. The procedure is one of the easiest and safest interventional procedures with very high success rate and few complications. PCD has resulted in reduced mortality and morbidity and has helped to reduce length of hospital stay and hospital costs.

INDICATIONS

Because of variability in the presentation of abscesses and fluid collections, the indications for PCD must be stated in general terms. The pre-requisite for PCD is an abnormal fluid or pus collection and/or suspicion that the collection is producing symptoms sufficient to warrant drainage[6]. Our personal experience is that a catheter drainage should be performed if any abscess or fluid collection is larger than 4 to 6 cm. Smaller collections are first given a trial by needle aspiration and only if they enlarge or recur is catheter drainage resorted to.

The abscesses or fluid collections are generally discovered by imaging such as US or CT scan. Whereas commonly fever, leucocytosis, malaise, anorexia or other systemic symptoms point to an infection, these signs and symptoms may be absent in elderly, very ill or immuno-compromised patients. In such cases diagnostic aspiration may be the only

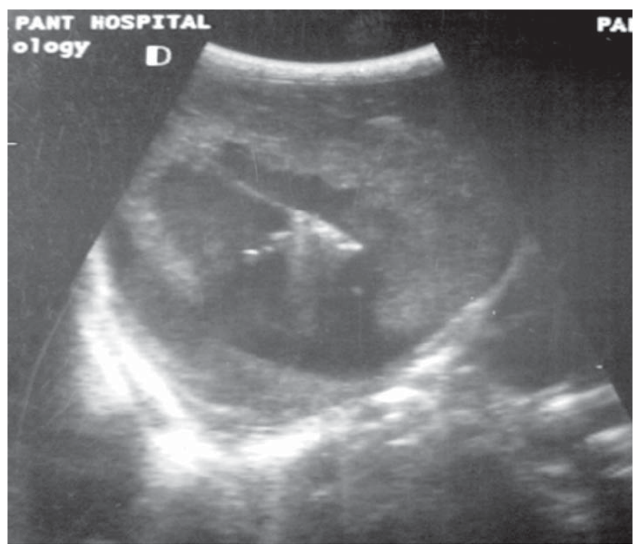


Fig 1: PCD in a right lobe liver abscess with rupture in subdiaphragmatic space.

Correspondence : Dr Sunil Kumar Puri, Professor & Head
E-mail: skpurigbph@yahoo.co.in

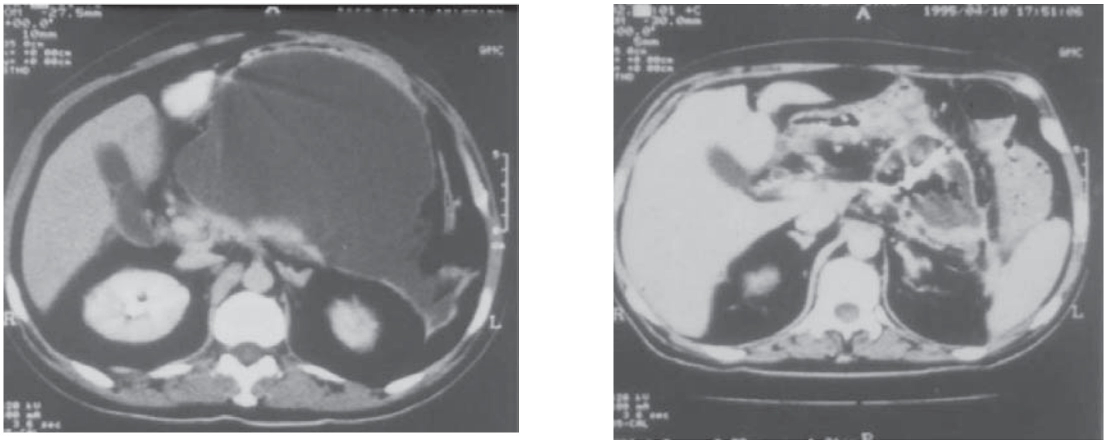


Fig. 2a and 2b: PCD in a post-necrotic pancreatic pseudocyst

means of determining that a fluid collection is infected.

PCD can be performed in almost any organ system. Contraindications are relative and depend on the suitability of surgical alternative. Common relative contraindications are coagulopathy and thick necrotic tissue requiring surgical debridement e.g. pancreatic abscess. Besides straight forward cases which have unilocular collections of pus or fluid where the success rate of PCD is very high (> 80%) there are difficult situations where PCD can be technically difficult, duration of drainage can be very long and therefore the success rate would be less with higher rates of complication and recurrence. Examples of such conditions are multiple abscesses, multiloculated abscesses, pancreatic abscess, drainage routes that traverse bowel or pleura, infected clot and infected tumor[7,8]. In such situations decisions regarding PCD should always be taken in concert with the treating physician or surgeon.

PRE-PROCEDURE WORK-UP

Baseline blood counts are always obtained as these help in monitoring the infection later on by documenting falling WBC counts. Prothrombin time, platelet count and INR are routinely done to assess the coagulation profile so as to minimize the risk of bleeding during or after the procedure. The abscesses and fluid collections can be easily detected by US. However if time permits and cost is not a constraint, a pre-procedure CT scan is always desirable. CT scan is best for localization of the abscess or fluid collection and is of immense help in planning the route of catheter insertion particularly in situations where intervening bowel can not be avoided to gain assess to the abscess. CT scan with oral contrast may also be useful in demonstrating the fistulous communication of the abscess with bowel or any other viscus.

Fig. 3: Cavitogram through the drainage catheter showing communication of the abscess cavity with colon. CBD stent seen in-situ

MATERIAL AND TECHNIQUE:

PCD is performed in vast majority of cases under real-time US guidance preferably taking help of a pre-procedure CT. In difficult assess routes the procedure is done under CT guidance.

All aseptic precautions are taken and only local anesthesia is employed except in pediatric patients where a short general anesthesia (Ketamine) is used.

Prior to catheter insertion, a needle aspiration is always done to know the exact nature of the contents of the cavity as it subsequently determines the selection of the catheter size. For thick pus larger bore catheters are selected. During the initial puncture or catheter insertion the following points are always kept in mind:

a) Shortest pathway with easiest angulation is chosen.
b) Intervening organs or structures are always avoided e.g. bowel, spleen, pleura etc.
c) For right and left hypochondrium, pleural recess is avoided by making the puncture in expiration and entering below tenth intercostal space.
d) For a solid organ abscess, like liver and spleen, access path should traverse a small amount of normal tissue to reduce the risk of peritoneal spillage and bleeding.
e) In specific situations depending upon the gravity of situation one can traverse a solid organ like liver or bowel to enter an abscess.
f) Transrectal and transvaginal routes have also been successfully tried to drain deep pelvic abscesses by catheter[9].

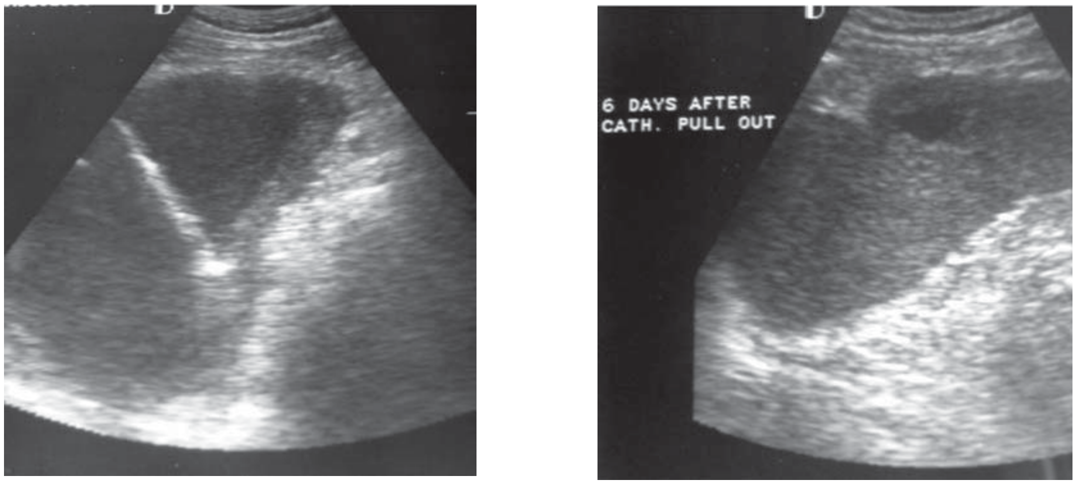


Fig. 4a and 4b: Successful PCD in a large splenic abscess showing almost complete resolution of abscess at 6th day after catheter pull-out.

For catheter insertion, one can use either a “Single step trocar technique” or a “Classical Seldinger technique”. Trochar technique is employed for abscesses or fluid collections which are large and are very easily accessible as the entire assembly of needle, cannula and catheter is inserted in one go. Commonly pigtail catheters are used ranging in size from 8F to 14F depending on the viscosity of fluid or pus aspirated. Care must always be taken to ensure that the drainage holes of the catheter are large enough. Pigtail catheters with locking device are always better as these are less likely to get dislodged. The catheter can be secured to the skin either by a silk suture or adhesive plaster or it can be fixed using specific devices. Lastly the catheter is either connected to a urine bag or a suction device like Romovac.

While using Seldinger technique for PCD the most important material is a suitable guidewire over which the tract is dilated and finally the catheter is introduced. The guidewire should be stiff enough to guide the dilators and catheters into the abscess but should not be too stiff to prevent easy coiling of wire shaft within the abscess. It must have a floppy tip so as to encourage the wire to coil within the abscess and not perforate the wall. Generally a 0.038-inch, 145 cm heavy-duty stainless steel wire is good enough[10]. For multiple abscesses two or even three separate catheters can be inserted in a single sitting.

PATIENT MANAGEMENT

Once the catheter has been inserted, it is only the Radiologist who should be actually involved in day-to-day management of the catheter as well as the patient. Frequently one has to change the dressing and reposition the catheter under US or fluoroscopic guidance. If the flow of pus or fluid is free and US scan does not reveal any significant residual collection, irrigation of the cavity is avoided, particularly in sterile collections. Only if the catheter is blocked and there is thick debris or fluid in the cavity, should it be irrigated with small volume of normal saline. Fibrinolytic agents like streptokinase and urokinase which liquefy the contents and facilitate drainage, have also been tried with good results.

Most of simple abscesses or fluid collections are successfully drained in 1 to 2 weeks time by PCD. Commonly when drainage diminishes to less than 10 ml per day and the patient also has shown good clinical recovery the catheter can be pulled out. Some prefer to keep the catheter inside for a couple of extra days after clamping the catheter and if there is no reaccumulation of fluid or pus, the catheter is finally pulled out.

In situations when the daily drainage of pus is copious and is not diminishing and also the patient does not show any clinical improvement, a fistulous communication with bowel or any other viscus like biliary system should be suspected. A contrast study through the catheter should always be performed in such cases to demonstrate the fistulous communication. In such cases drainage would generally be prolonged to 4 - 6 weeks or even longer when the fistula finally closes. Catheter care is important in such cases and frequently these need to be changed or upsized. Success rate is also lower in such cases.

SUCCESS RATE

Successful PCD is defined as complete resolution of infection requiring no further operative intervention. Commonly a small cavity would remain when the catheter is pulled out but it resolves gradually over a period variable from few weeks to months. Curative drainage has been achieved in greater than 80% of patients[2,3]. Partial success is defined as either adequate drainage of the abscess with surgery subsequently performed to repair an underlying

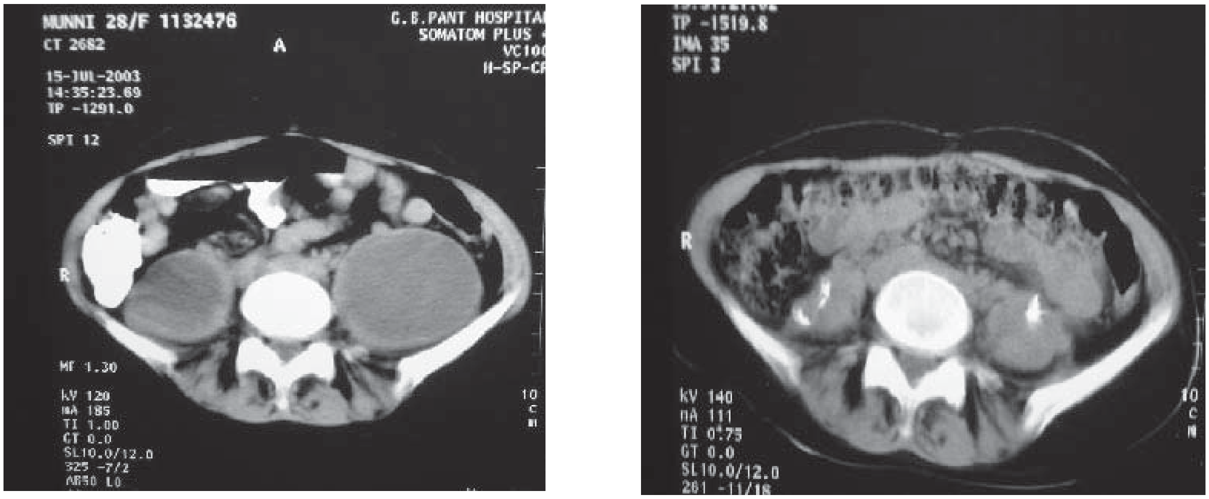


Fig. 5a and 5b: Successful PCD in bilateral psoas abscesses. Complete resolution of both the abscesses just before catheter pull-out.

problem or as temporizing drainage performed to stabilize the patient prior to surgery. Partial success occurs in 5 to 10% of patients. Failure occurs in 5 to 10% and recurrence in another 5 to 10% patients[11,12]. However the success rates will depend on the proportion of abscesses or fluid collections drained in patients with relative contraindications, on the complexity of the collections and on the severity of the underlying medical or surgical problem.

COMPLICATIONS

PCD is a very safe procedure and complications are rare. Complication rates are highly dependent on the expertise and selection of patients. Most of centers agree that there is significant drop in the complication rate once the required expertise is gained and when proper selection criterion is laid down by the department. Complication rates would obviously vary depending on the percentage of difficult and complicated cases drained. Table shows various complications and their occurrence rates.

Complications	Rate (%)
Septic shock	1-2
Bacteremia requiring new intervention	2-5
Hemorrhage requiring transfusion	1
Superinfection (includes infection of sterile fluid collections)	1
Bowel transgression requiring intervention	1
Pleural transgression requiring additional interventional chest procedures	2-10

Catheter dislodgement, by far the commonest problem encountered during PCD is an acceptable complication. Even in spite of best of efforts and usage of fixation devices, catheter dislodgement is not infrequent. However if the patient, nursing staff and attending physician are properly trained the incidence reduces significantly [7]. For all the major complications resulting from percutaneous abscess drainage, the accepted threshold is maximum 10%[6].

CONCLUSION

Percutaneous catheter drainage of abscesses adheres to the basic principles of surgical management by providing decompression, evacuation and continuous drainage without dissemination of sepsis. Its safety, simplicity and excellent cure rates in drainage of abdominal abscesses and fluid collections have established it as preferred first line treatment.

REFERENCES

1. Haaga JR, Weinstein AJ. CT guided percutaneous aspiration and drainage of abscesses. American Journal of Roentgenology. 1980; 135: 1187-94.
2. VanSonnenberg E,Mueller PR, Ferruci JT. Percutaneous drainage of 250 abdominal abscesses and fluid collections. Part I. Results and complications. Radiology 1984; 151: 337-41.
3. Mueller PR, VanSonnenberg E, Ferruci JT. Percutaneous drainage of 250 abdominal abscesses and fluid collections: Part II: Current procedural concepts. Radiology 1984; 151: 343-47.
4. Johnson WC, Gerzof SG, Robbins AH, Nabseth DC. Treatment of abdominal abscesses.Comparative evaluation of operative drainage versus percutaneous catheter drainage guided by computed tomography or ultrasound.Ann Surg 1981; 194: 510-20.
5. Haaga JR, Nakamoto D, Stellato T, Novak RD, Gavant ML, Silverman SG, Bellmore M. Intravavitary urokinase for enhancement of percutaneous abscess drainage: phase II trial. AJR 2000; 174:1681-168
6. Bakal CW ,Sachs David, Burke DR et al. Quality improvement guidelines for adult percutaneous abscess and fluid drainage. J Vasc Interv Radiol 2003;14:S223-S225.
7. Deveney CW, Lurie K, Deveney KE. Improved treatment of intra-abdominal abscesses: a result of improved localization, drainage, and patient care, not technique.Arch Surg 1988; 123:1126-1130.
8. Sones PJ. Percutaneous drainage of abdominal collections.AJR 1984;142:35-59.
9. Chung T, Hoffer FA, Lund DP. Transrectal drainage of deep pelvic abscesses in children using a combined transrectal sonographic and fluoroscopic guidance. Pediatr Radiol 1996;26:874-878.
10. Schroder J. The mechanical properties of guidewires, Part 1: Stiffness and torsional strength. Cardiovasc Intervent Radiol 1993; 16: 43-46.
11. Gerzof SG, Robbins AH, Johnson WC et al.Percutaneous catheter drainage of abdominal abscesses: a five year experience. N Engl J Med 1981; 305: 653-657.
12. Lambiase RE, Deyoe L, Cronan JJ, Dorfman GS. Percutaneous drainage of 335 consecutive abscesses; results of primary drainage with 1-year follow-up. Radiology 1992;184:167-179.

PROSTATIC INTERVENTIONS

Rajanee Shankar, Sanjay Sharma, Sanjay Thulkar
Department of Radiodiagnosis, All India Institute of Medical Sciences, New Delhi 110 029, India

Abstract: *Prostate interventions are mostly focused on the diagnosis and treatment of the malignancy of the gland. Image guided interventions of the prostate are almost exclusively done under transrectal USG (TRUS) guidance, while CT is being used to plan external beam radiation therapy and brachytherapy. MR guided procedures are now gradually becoming popular. Prostatic Interventions include TRUS or MR Image guided biopsy as well as Image guided therapeutic procedures, such as radiofrequency ablation in malignancy of the prostate. Its role in non malignant conditions of prostate includes abscess drainage and aspiration of prostatic cysts. Majority of the procedures performed on prostate are as good as surgical procedure for the treatment of localized prostatic malignancy.*
Key Words: Prostate interventions: Image guided biopsy: Brachytherapy, Cryo-ablation and Radiofrequency ablation

INTRODUCTION

The prostate is an organ that is located deep within the male pelvis. Prostate interventions are mostly focused on the diagnosis and treatment of the malignancy of the gland[1,2]. Endoscopic methods (cystourethroscopic) are widely practiced for the treatment of prostatic hyperplasia and some benign pathologies. Imaging of the gland is best achieved by Ultrasonography (USG) and/ or Magnetic Resonance Imaging (MRI). Computed Tomography (CT) can only used to stage the cancer of the prostate as the contrast resolution of this modality is relatively inferior. Image guided interventions of the prostate are almost exclusively done under transrectal USG (TRUS) guidance, while CT is being used to plan external beam radiation therapy and brachytherapy. MR guided procedures are now gradually becoming popular[3,4].

PROSTATE - ANATOMY

The prostate is a variable-sized gland located in the male pelvis, measuring 3-4 centimeters long by 3-5 centimeters in width. On average the adult gland weighs approximately 20 grams. It is found behind the pubic bone, in front of the rectum, and below the bladder, surrounded by the pelvic muscles. The prostate has various concentric zones. These zones are termed: anterior fibromuscular stroma, peripheral zone, central zone, and transition zone. Almost all prostate cancers start in the peripheral zone. The transition zone generally accounts for less than 5% of the total prostate volume. Nonetheless, it is the exclusive site for the development of benign prostatic hyperplasia (BPH) and may become massive. The central zone is not commonly associated with any disease process. The anterior fibromuscular stroma is the anchoring point of the urethral sphincter that controls urination. It does not have any glands and therefore cancer or benign enlargement does not develop here[5].

Correspondence : Dr. Sanjay Sharma, Associate Professor, fax: 25688663, **e-mail** : drsharma@hotmail.com

PROSTATIC INTERVENTIONS

The various procedures done (or assisted) by a radiologist under image guidance are given in Table 1.

Table 1 : *Overview of Prostatic interventions*

Prostatic interventions
1 Malignancy of the prostate
a) Image guided biopsy- (i) TRUS guided- (ii) MR guided.
b) Image guided therapeutic procedures- TRUS guided - MR guided.
I. Brachytherapy; II. Cryoablation
III. Radiofrequency ablation (RFA)
2 Nonmalignant conditions of prostate
a) Abscess drainage
b) Aspiration of prostatic cysts

MODALITY OF CHOICE FOR GUIDANCE – USG OR MRI?

In our institute TRUS is almost exclusively used to guide procedures. But recent literature points that MR can also be used for the purpose with good results[3,4,6]. CT is used only for planning the procedure and guidance during the procedure is usually provided by TRUS. The role of USG, especially TRUS will be emphasized upon in this article.

IMAGE GUIDED PROSTATE BIOPSY

Although not a prostate ‘intervention’ in the true sense, this procedure is the commonest to be performed in routine urologic practice. In contemporary practice, most prostate cancers are either invisible on ultrasound or indistinguishable from concurrent benign prostatic hyperplasia. Diagnosis therefore rests on prostate biopsy. Biopsies are not simply directed at ultrasonically visible lesions, as these would miss many cancers; rather representative areas in the whole gland are sampled. The sampling itself is systematic, using patterns based on prostate zonal anatomy and the geographical distribution and frequency of cancer. Thus the whole gland is sampled under image guidance with sample(s) taken from any visible lesion as well[1]. For cancer diagnosis, TRUS on its own has a positive predictive value of 6% if prostate specific antigen (PSA) and digital rectal examination (DRE) are normal[7].

The identification of a high-risk group is an area of a continuing debate and shifting consensus, but currently an abnormal DRE and/or elevated PSA (greater than 4 ng/ml or the age-corrected level) is taken to signify an increased risk of prostate cancer[1,8]. There has been many modifications of the prostate biopsy technique, from the classical sextant biopsy method consisting of 6 cores to the more recent extended biopsy protocols that may include 8, 10, 12, >12 and saturation biopsy protocols. Extended protocols are increasingly being used to improve diagnostic accuracy, especially in those patients who require repeat biopsy[1].

Prostate biopsy can be performed through transrectal as well as transperineal approaches. The former is generally preferred. The first step for TRUS guided biopsy is patient preparation. This consists of performing cleansing enema (proctoglycs) 2-6 hours before biopsy. This could be self administered. Prophylactic antibiotics are also administered. We give Ciprofloxacin-Tinidazole (500 mg) combination twice a day for 3 days beginning a day before biopsy. Differences may be found locally in the type, dosage and the duration of this pre-procedure medication. For local anesthesia, lidocaine has been proposed, which may be used as a gel applied in the rectum or in the form of a prostate infiltrate.

The patient is placed in prone or left lateral position and the biopsy needle is introduced in tandem with the probe through either an externally mounted guide or an in-built channel within the probe. Then under image guidance several samples are obtained at each target site. The number of target sites varies with different protocols with the underlying notion that an increase in number of samples leads to an increase in the diagnostic yield. We normally take six samples- two samples each from apex, base and the lateral aspect of the mid portion of the gland. The sample(s) from the additional suspicious areas could also be taken. The prostatic tissue so obtained is subjected to histological grading (Gleason's score). Higher the grade, more malignant is the cancer. This grading has important bearing in the patient management and influences the choice of therapy. Sample(s) may be obtained from the seminal vesicle when involvement is suspected. Nowadays MR guided biopsy is also becoming popular as MR spectroscopy reveals additional foci suspicious for cancer[3,4].

Bleeding, pain/discomfort (including dysuria), infectious complications, vasovagal episodes, urinary retention, epididymitis, periprostatic hematoma, disseminated intravascular coagulopathy (DIC) are the complications that can potentially occur following the procedure[9]. Of these mild self-limiting bleeding (haematuria, rectal bleeding or hematospermia) lasting a few days (average 5 days for hematuria) is the commonest complication, but severe hemorrhage requiring hospitalization is rare. When it occurs, this severe bleeding is nearly always from a rectal vein or artery. It may occur some hours post-biopsy although usually on the day of the procedure. Because of its infrequency, management has not been clearly defined.

IMAGE GUIDED THERAPEUTIC PROCEDURES FOR PROSTATIC MALIGNANCY

Organ-confined prostate cancer can be effectively treated with surgery, 3-dimensional conformal radiation therapy, prostate brachytherapy, cryoablation, radiofrequency ablation[10,11,12]. Apart from these accepted methods there are numerous other non-surgical methods that focus on in situ parenchymal ablation viz., laser, chemicals, photosensitive agents, high intensity focused ultrasound (HIFU) etc[13,14]. Each treatment must be individualized.

BRACHYTHERAPY

Brachy (near) therapy involves the direct implantation of radioactive isotopes into the prostatic parenchyma. The use of radioactive seed implants for prostate cancer is not new. This technique has long held promise as a method of delivering a very high dose of radiation to the prostate while simultaneously reducing the amount of radiation to the adjacent organs such as the bladder or the rectum. Along with advances in medical imaging technology, efficient and effective means of planning and monitoring the placement of seeds have been developed[15]. The most widely used have been CT planning and TRUS guidance. The advantage of modern implant techniques is the avoidance of surgery.

The initial step is the determination of the prostate volume and a rendering of its spatial geometry which is done either using TRUS or CT studies. Then the method of seed (radioactive implant) loading is determined. These methods give either a uniform distribution (Quimby method) or a peripherally weighted distribution (Patterson-Parker system) sparing the prostatic urethra. Finally computerized preplanning is performed that determines the exact location and the strength of the seeds to provide optimal irradiation. The seeds are placed in the prostate by needles through the perineal skin under anesthesia in an operating room environment. This is done with the patient in lithotomy position and takes about an hour. The template, a multichannel needle-steering device corresponding to the electronic grid matrix superimposed on the prostate images, is attached to the rectal probe. The probe is adjusted until the sequential images on the monitor correlate with similar images from the conformal planning studies and then the support brackets are locked in position. The implant takes place using either preloaded needles or with a Mick applicator, where the seeds are contained in a carrier. After needle insertions, cystoscopy is performed to look for any stray seeds in the bladder or urethra which are removed and reinserted. CT scans with three-dimensional reconstruction can be performed afterward to confirm appropriate dosimetric geometry (Fig.1).

Post procedure morbidity includes moderate proctitis, urethral complications, and impotence each occurring in about 10%. The rate increases in older patients with a history of TURP or radiation therapy [(16)]. In patients with low-grade, small to nonpalpable lesions with a PSA value of less than 10 ng/ml, brachytherapy is associated with a 90% success rate. Patients with more advanced tumors or tumors with aggressive histology show a poor response with clinical failure occurring in 18% to 32%[17].

CRYOABLATION

Cryoablation is a form of cryotherapy for prostatic malignancy that involves the controlled freezing of the prostate gland in order to destroy cancerous cells. The damage caused by freezing occurs at several levels: molecular, cellular and whole tissue structure. Important factors influencing freezing injury are the rate of temperature reduction after the initiation of freezing, the time cells remain frozen and the subsequent heating rate during thawing. During cryoablation of the prostate, the surrounding connective tissue and the smallest blood vessels are also damaged and subsequently have an inadequate blood supply that is believed to slow the growth of cancer[18].

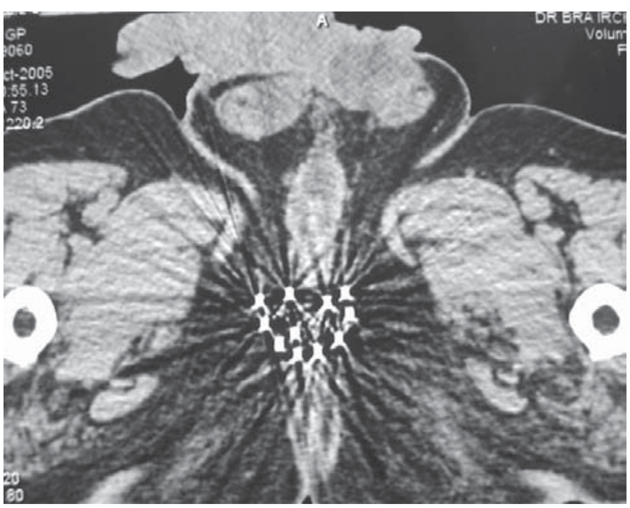


Fig. 1 Axial CT image at the level of prostate showing the final placement of the needles for interstitial brachytherapy. Each needles were individually guided using TRUS.

Suitable candidates for this procedure are patients who have organ-confined prostate cancer or those who have minimal spreading beyond the prostate. This form of therapy is not performed in our institute. First the staging workup is done to assess the disease extent. Cryoablation is performed in localized cancer. Under anesthesia and in lithotomy position, an ultrasound probe is guided into the rectum. The prostate is imaged and its dimensions measured. An aiming grid software program is then activated and images of the prostate are projected on a screen. Under continuous monitoring with ultrasound imaging, cryoablation probes are placed at predetermined sites within the prostate by using a transperineal approach. The freezing starts at the front part of the prostate by activating the front probes, followed by the middle and finally the back probes. This sequence allows continuous monitoring (by visualizing the freezing process through TRUS). Two freezing cycles are usually done. Between them, the prostate is allowed to thaw either passively or actively by using helium gas. If the prostate is more than 26 to 27 mm. long, an apical pullback maneuver is usually done to freeze the lower part of the prostate. Double freezing is performed again[11].

Each of the commercially available cryosurgical systems has a different type of probe and placement strategy, but aim to freeze the prostate, tumor(s) and surrounding tissue — except the urethral area. By keeping the urethra warm during prostate freezing, the urethral wall remains viable, minimizing the risk of urethral damage, obstruction and urinary incontinence. Oral antibiotics are usually given for 10 to 14 days. Other symptoms and signs the patient may experience are generalized fatigue that usually persists for seven to 10 days, urethral discharge, scrotal swelling, numbness at the tip of the penis, passage of flecks of tissue, pain or burning sensation during urination and increased urinary frequency and/or urgency. Urethral injury might cause significant complications. Impotence occurs in about 50% of the patients. Recto-urethral fistula formation is another potential complication.

A PSA test is usually done at three months. Also, a prostatic biopsy may be done at three to six months to assess for prostate destruction and absence of viable cancer cells especially if PSA level is detectable. If the biopsy proves negative, PSA measurements are obtained monthly for one to two years, then every six months for the next one to three years and every year thereafter. Initial success defined as negative biopsy at 3 months occurs in over 89% to 95% [19, 20]. The overall negative biopsy rate at 1 to 2 years for patients with localized disease is 82% to 87% [19, 20].

OTHER IMAGE GUIDED THERAPEUTIC PROCEDURES FOR LOCALIZED PROSTATIC MALIGNANCY

All these procedures aim at localized prostatic parenchymal destruction to kill the malignant cells. A staging workup is done in all patients to assess the disease extent. The tumor volume and its spatial geometry are assessed in the preplanning workup[6]. The physical or chemical agent is then introduced under imaging guidance to destroy the parenchyma.

HIFU for prostate cancer is based on the ability of a highly focused beam of US to deposit a high amount of energy into the tissue thus causing parenchymal destruction. It is carried out under a spinal or general anesthetic[14]. With the patient lying on his left side, an endorectal probe incorporating an ultrasound scanner and a HIFU treatment applicator is inserted. This allows the target area to be monitored and defined before being treated. The probe emits a beam of ultrasound, which is focused to reach a high intensity in the target area. Absorption of the ultrasound energy creates an increase in temperature (between 70ºC and 100ºC), which destroys the tissue within the focal area. A cooling balloon surrounding the probe protects the rectal mucosa from the high temperature. A urethral or suprapubic catheter is used after the procedure. Transurethral resection of the prostate may be carried out immediately before the HIFU treatment, to reduce the volume of the prostate and minimize the amount of necrotic debris left after the HIFU procedure[21].

Radio-frequency ablation for prostatic cancer is performed with the patient being positioned in lithotomy position under anesthesia. The electrodes are introduced via the perineum under TRUS guidance (MRI guidance can also be used) and then the tumor is ablated[22]. As with other methods adjacent tissue, like the rectum or urethra might get involved and lead to rectal wall necrosis, urethral strictures etc.

IMAGE GUIDED ABSCESS DRAINAGE

Prostatic abscess is a relatively uncommon infection found in diabetes, chronic renal failure, conditions of immunosuppression and in those undergoing urethral instrumentation or chronic catheterization. The prostate is usually enlarged, but tenderness and fluctuation are unreliable signs and are seen in less than one-third of cases. Consequently, imaging plays a large part in diagnosis of prostatic abscess. Although treatment includes antibiotics, most cases require drainage. Transurethral incision or resection is currently regarded the best method of draining a prostatic abscess, especially if the abscess is in the peri urethral region[23].

Abscesses may be treated with TRUS guided aspiration and drainage[24] (Fig. 2). With the patient in the lithotomy position, the collection is assessed and needle is introduced under guidance. Because of difficulty removing the probe and needle guide over a guide wire, if a biopsy guide is to be used, a detachable one is preferred. After insertion, the drainage catheter should be taped to the inner aspect of thigh, left to gravity drainage, and flushed every 6 to 8 hours. The patient is put on antibiotics. Removal is appropriate when the patient has defervesced, tube out put is less than 20 ml/day and the residual potential space has been obliterated on an abscessogram.

IMAGE GUIDED ASPIRATION OF PROSTATIC CYSTS

Prostatic cysts may be of different types- mullerian duct cysts, prostatic utricle, cysts of the prostate, ejaculatory duct cysts- but they cannot be always differentiated on TRUS[24]. Midline periurethral cysts, also known as utricle cysts, are thought to be derived from an incompletely regressed mullerian duct. Ejaculatory duct cysts, derived from Wolffian ducts, typically contain sperm and can be confused with utricle cysts when they appear midline by ultrasound. Prostatic cysts, also known as retention or degenerative cysts are more lateral in location and rarely reach sufficient size to compress the adjacent ejaculatory ducts and cause infertility. These cysts may develop complications- hemorrhage, infection etc. Obstructing cysts are most commonly seen in a periurethral location but can affect the seminal vesicles or the vas deferens. These cysts can cause obstruction of the genital tract leading to infertility.

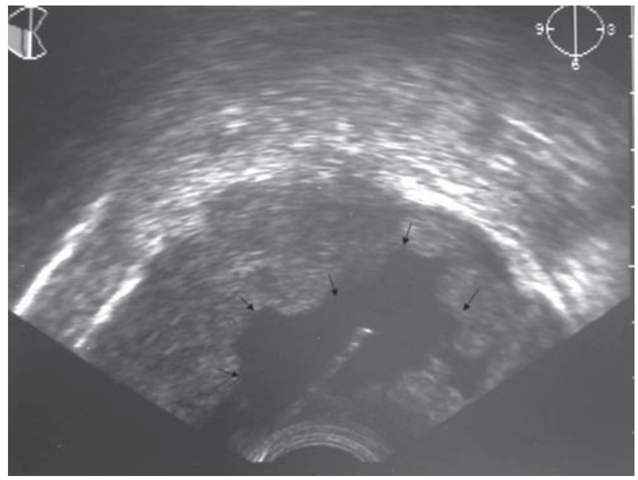


Fig. 2 Prostatic abscess (black arrows) being aspirated by an 18 gauge needle under TRUS guidance.

In some cases, fertility can be restored to patients with cysts that are occluding part of the ductal system by decompression, provided that the ductal system itself is intact [25]. In these cases, ultrasound guided aspiration of the cystic contents is used to relieve the pressure, which can allow the ducts to open and to function normally. TRUS can also be performed to guide aspiration for the relief of discomfort resulting from pressure of these cysts on adjacent structures or for diagnostic purposes if complications occur[24].

CONCLUSION

Majority of the procedures performed on the gland are concerned with the detection and treatment of prostatic malignancy, and are as good as surgical procedure for the treatment of localized malignancy. However these procedures have their own set of complications as described. MR guidance for these therapeutic interventions is gradually becoming more widespread. Newer techniques are being evaluated in comparison with the existing ones. Compared with these procedures for diagnosis/treatment of malignancy, abscess drainage or cyst aspirations are performed relatively infrequently. With further advances with imaging and newer procedures for tissue ablation, the choice of treatment for prostatic malignancy might change.

REFERENCES

1. Raja J, Ramachandran N, Munneke G, Patel U. Current status of transrectal ultrasound-guided prostate biopsy in the diagnosis of prostate cancer. Clinical Radiology 2006; 61: 142-153.
2. Onik GM, Cohen JK, Reyes GD et al. Transrectal ultrasound-guided percutaneous radical cryosurgical ablation of the prostate. Cancer 1993;72:1292-1299.
3. Robert CS, Kevin C, Peter C et al. System for prostate brachytherapy and biopsy in a standard 1.5 T MRI scanner. Magnetic Resonance in Medicine 2004;52:683-687.
4. Atalar E, Menard C. MR-guided interventions for prostate cancer. Magn Reson Imaging Clin N Am 2005 Aug;13(3):491-504.
5. McNeal JE, Redwine EA, Freiha FS, Stamey TA. Zonal distribution of prostatic adenocarcinoma. Correlation with histologic pattern and direction of spread. Am J Surg Pathol 1988;12:897-906.
6. Roy C, Servois V, Sauer B. Treatment of prostate carcinoma and imaging follow up. J Radiol 2006 Feb;87(2 Pt 2):244-256.
7. Coley CM, Barry MJ, Fleming C, Mulley AG. Early detection of prostate cancer. Ann Intern Med 1997;126:394-406.
8. Thompson IM, Pauler DK, Goodman PJ, et al. Prevalence of prostate cancer among men with a prostate-specific antigen level % 4.0 ng per milliliter. N Engl J Med 2004;350:2239-2246.
9. Naughton CK, Ornstein DK, Smith DS, Catalona WJ. Pain and morbidity of transrectal ultrasound guided prostate biopsy: a prospective randomized trial of 6 versus 12 cores. J Urol 2000;163:168-171.
10. Barnes AS, Haker SJ, Mulkern RV, So M, D'Amico AV, Tempany CM. Magnetic resonance spectroscopy-guided transperineal prostate biopsy and brachytherapy for recurrent prostate cancer. Urology 2005 Dec;66(6):1319-1326.
11. Mouraviev V, Polascik TJ. Update on cryotherapy for prostate cancer in 2006. Curr Opin Urol 2006 May;16(3):152-156.
12. Jindal G, Friedman M, Locklin J, Wood BJ. Palliative radiofrequency ablation for recurrent prostate cancer. Cardiovasc Intervent Radiol 2006;29(3):482-485.
13. Te AE, Malloy TR, Stein BS, Ulchaker JC, Nseyo UO, Hai MA. Impact of prostate-specific antigen level and prostate volume as predictors of efficacy in photoselective vaporization prostatectomy: analysis and results of an ongoing prospective multicentre study at 3 years. BJU Int 2006 Jun;97(6):1229-1233.
14. Uchida T, Ohkusa H, Yamashita H, Shoji S, Nagata Y, Hyodo T, Satoh T. Five years experience of transrectal high-intensity focused ultrasound using the Sonablate device in the treatment of localized prostate cancer. Int J Urol 2006 Mar;13(3):228-233.
15. Urbanic JJ, Lee WR. Update on brachytherapy in localized prostate cancer: the importance of dosimetry. Curr Opin Urol 2006 May;16(3):157-161.
16. Nag S, Beyer D, Friedland J et al. American brachytherapy society recommendations for transperineal permanent brachytherapy of prostate cancer. Int J Radiat Oncol Biol Phys 1999;44:789-799.
17. Stock RG, Stone NN, DeWyngaert JK, et al .Prostate specific antigen findings and biopsy results following interactive ultrasound guided transperineal brachytherapy for early stage prostate carcinoma. Cancer 1996;77:2386-2392.
18. Long JP. Cryosurgical ablation of the prostate: current technique and clinical outcomes. Surg Technol Int 2003;11:213-219.
19. Bahn DK, Lee F, Solomon MH et al. Prostate cancer: US guided percutaneous cryoablation. Work in progress. Radiology 1995;194:551-556.
20. Coogan CL, McKiel CF. Percutaneous cryoablation of the prostate: Preliminary results after 95 procedures. J Urol 1996;156:115-121.
21. Gardner TA, Koch MO. Prostate cancer therapy with high-intensity focused ultrasound. Clin Genitourin Cancer 2005;4(3):187-192.
22. Zlotta AR, Djavan B, Matos C et al. Percutaneous transperineal radiofrequency ablation of prostate tumor: safety, feasibility and pathological effects on human prostate cancer. BJU 1998;81:265-275.
23. Granados E, Riley G, Salvador J et al. Prostatic abscess: diagnosis and treatment. J Urol 1992;148:80-82.
24. Rifkin MD: Ultrasound of the prostate,1997, 2nd ed. Philadelphia, Lippincott-Raven.
25. Kuligowska E, Fenlon HM. Transrectal US in male infertility: spectrum of findings and role in patient care. Radiology 1998;207: 173-181.

INTERVENTIONS IN OBSTETRICS AND GYNECOLOGY : A CONCISE REVIEW

J D Souza*, R Pant, IK Indrajit*****

**Professor, Dept of Radiodiagnosis, INHS Asvini, Mumbai 400 005, India*

***Consultant, Dept of Radiodiagnosis, Armed Forces Medical College, Pune 411 040, India*

****Consultant, Dept of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India*

Abstract: *Clinico-imaging interventions are indispensable for a multitude of invasive procedures in the female pelvis. The common imaging modalities used for Interventions in Obstetrics & Gynecology, comprise Ultrasonography (USG), DSA, CT Scan and MRI. Amongst them ultrasonographic (USG) guidance, either by transabdominal, endovaginal, or endorectal is a powerful tool, whose advantageous features are safety, avoids ionizing radiation, convenient, easy portability and facilitates bed side utility. Interventions in female pelvis can be categorised into Non-Vascular or Vascular. Common non-vascular techniques include Tuboovarian abscess drainage, Ovarian cyst/ abscess drainage, Uterine fluid collections drainage, Fallopian tube recanalisation and Antegrade stenting for obstructive uropathy. Common Vascular Interventions comprise of Uterine fibroid embolization, Post partum haemorrhage embolization, Tumor embolization, and Ovarian vein embolization. It must be remembered that timely intervention rather than masterly inactivity in dealing with female pelvic intervention cases forms the key to clinical success.*

***Key Words**: Interventions in female pelvis; ultrasonographic (USG) guidance; Uterine fibroid embolization*

INTRODUCTION

Clinico-imaging interventions are increasingly useful in a variety of Obstetrics and Gynecology entities, including few life-threatening conditions. Amongst them ultrasonographic (USG) guidance, either by transabdominal, endovaginal, or endorectal is a powerful tool. USG guided procedures can be performed quickly, safely and avoids ionizing radiation, a concern in the young fertile patients[1]. Ultrasonography additionally offers unique advantages like convenience, portability, bed side availability, and flexibility. Besides, USG enables quick applications at varied locations like Radiology Department, operating room, patient examination room, ICU or labour room.

Interventions in female pelvis can be categorised for convenience into Non-Vascular or Vascular. Common non-vascular techniques include Tuboovarian abscess drainage, Ovarian cyst/ abscess drainage, Uterine fluid collections drainage, Fallopian tube recanalisation and Antegrade stenting for obstructive uropathy. Common Vascular Interventions comprise of Uterine fibroid embolization, Post partum haemorrhage embolization, Tumor embolization, and Ovarian vein embolization. Most non-vascular interventions are performed using Ultrasonography or DSA systems, while vascular interventions largely are preformed under a setting of DSA.

Correspondence : J D SOUZA, Professor, Department of Radiodiagnosis, INHS Asvini, Mumbai 400 005 India

NON-VASCULAR INTERVENTIONAL TECHNIQUES

Drainage of abscesses

Pelvic abscesses can be due to a variety of causes like tubo-ovarian, uterine fluid collections, appendiceal, diverticular, inflammatory bowel abscesses, and peritonitis related collections. Two endovaginally guided techniques have been advocated, namely: a) Seldinger technique with sequential placement of a needle and a J-wire, followed by dilation and placement of a self-retaining drain and b) Trocar technique with a single-step placement of a drainage catheter with a stiffened stylet[1].

Besides abscesses, other collections amenable to drainage include loculated ascites, pseudocysts surrounding ventriculoperitoneal shunt tips, urinomas, resolving hematomas, lymphoceles, peritoneal inclusion cysts, and pancreatic pseudocysts or effusions[1,2]. Access point is perhaps the most important issue to be considered in a given case of drainage, prior to the actual procedure. Alternative drainage routes such as "anterior abdominal, posterior transgluteal, and transrectal approaches are possible but may be more painful or require CT guidance". It is for these reasons, transvaginal guided drainage procedures have become increasingly useful in pelvic interventions[3].

Transvaginal Aspiration and Biopsy has been used for a) therapy of recurrent endometriotic cysts in the ovary or adnexa; b) therapy of recurrent hemorrhagic ovarian cysts; c) therapy of postoperative cystic adnexal collections; and d) diagnosis of ovarian cysts in selected patients[3].

In transvaginal guided drainage procedures, most collections can be reached with a 20–25-cm-long (20 or 22 gauge) needle, often without local anesthetics. A typical procedure

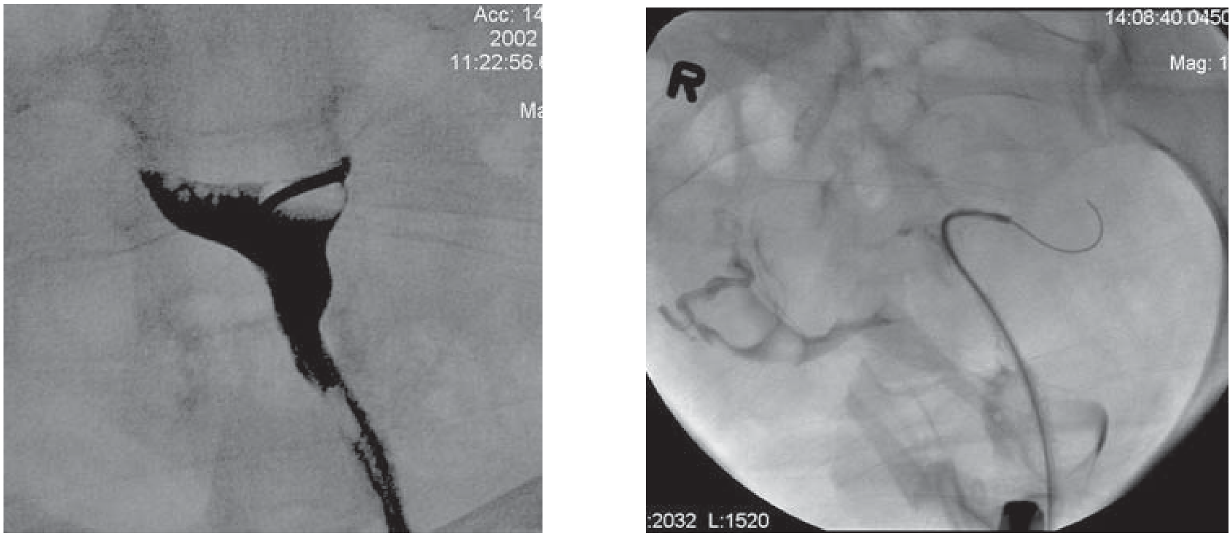


Figure 1A) : Fallopian Tube Recanalisation : *A preprocedure HSG determines the site of the block*

involves simple aspiration or when returning aspirate is purulent / serous or serosanguineous in an afebrile patient, placement of a drainage catheter. Furthermore, aspirates should be sent for Gram stain, culture and sensitivity and cytologic examination.

ASPIRATION OF OVARIAN CYST

USG guided aspiration of ovarian cysts must be preceded by a diagnostic endovaginal study to evaluate the features of the cyst and determine the shortest, safest needle route, avoiding intestine, bladder and vascular structures[4]. Color Doppler examination augments planning.

This procedure is ideal for aspiration of simple ovarian cysts in pre-and perimenopausal women in whom the risk of malignancy is low. Aspiration of symptomatic ovarian cysts that has benign morphological features at USG with an endovaginally or transabdominally guided small-gauge needle is simple and effective. Currently, this form of therapy is slowly replacing the classic therapy for persistent symptomatic cysts i.e. surgical extirpation by laparoscopy or open laparotomy, procedures that have risks associated with anesthesia and bleeding, bowel perforation, infection, and adhesion formation. It is advisable to avoid aspiration of cysts with features of mature cystic teratoma (hyperechoic mural plug, fat-fluid level, hair matrix), and complex cysts. these require surgical excision.

FALLOPIAN TUBE RECANALISATION

This is a simple and effective procedure used to treat primary and secondary infertility[5]. Use of selective salpingography and fallopian tube recanalization has revolutionized the diagnosis and treatment of infertility[6]. In fallopian tube recanalization, a catheter and guide wire system is used to clear proximal tubal obstructions. The recanalization procedure is simple for interventional radiologists to perform and is successfully completed in most patients (71%-92%). Pregnancy rates after the procedure have been variable, with an average rate of 30%[5].

A preprocedure HSG determines the site of the block (Figure 1A). The disposals for the procedure include a canula, a guiding catheter, selective Cobra catheters, hydrophilic guide wires and contrast. With the help of canula, guiding catheter, the selective Cobra catheters is manipulated under fluoroscopy to the site of the block. The block is opened out with the help of hydrophilic guide wire[6]. A check injection of contrast is made to confirm the opening of the Fallopian tubes. The end point is a patent tube with peritoneal spill. The patients are followed up for confirmation of conception (Figure 1B).

OBSTRUCTIVE UROPATHY

This morbid entity occurs in women presenting with carcinoma cervix, due to local spread with infiltration at the bladder base, causing obstruction to the lower ureter. They can be unilateral or bilateral. After an initial percutaneous nephrostomy the obstruction is crossed with a hydrophilic wire. Then by serially dilating the strictured segment of the lower ureter, a D-J stent is inserted that negotiates the strictured segment and allows urine to pass freely into the urinary bladder, thereby relieving the symptoms and signs of obstructive uropathy. (Figure 2A and 2B).

INTERVENTIONS IN EARLY PREGNANCY

USG guided procedures in pregnancy are safe and help in diagnosis and treatment of compromised fetus. A variety of procedures can be utilized in early pregnancy, to solve special issues Ectopic pregnancy can be treated by injecting Methotrexate into the gestation sac by transvaginally guided needle. Amniocentesis is a specialized intervention procedure

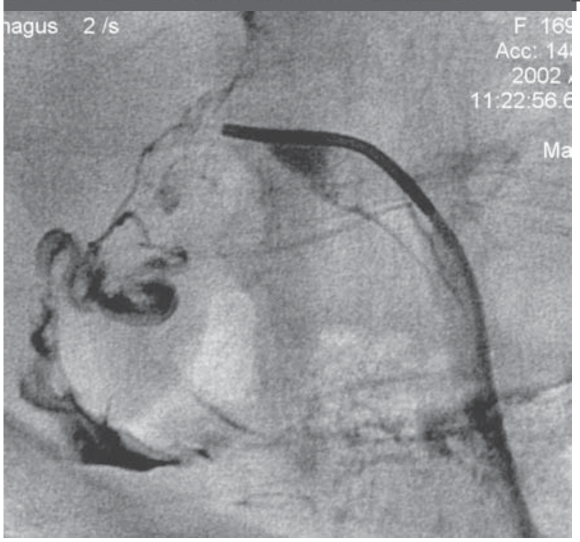


Figure 1B) : Fallopian Tube Recanalisation : *The end point is a patent tube with peritoneal spill. The patients are followed up for confirmation of conception*

used to derive samples of amniotic material. Indications of amniocentesis include a) diagnosis of genetic disorders and b) fetal maturity.

Chorionic Villous Biopsy is indicated in early diagnosis of genetic disorders. It is less traumatic under USG guidance. However chances of fetal limb deformity is present if done less than 10 weeks. Coelocentesis is performed between 6-12 weeks for prenatal diagnosis of chromosomal and genetic disorders. There is a 95% success rate, in this period, because of low rate of contamination by maternal cells. Amniopatch is used to patch up defect in amniotic membranes in cases of premature rupture membranes (PROM).

The procedure for Amniopatch entails use of one unit of maternal blood, platelets and cryoprecipitate. USG guided injection of these into amniotic cavity takes only a few minutes. The mechanism of action is that platelets activate the clotting mechanism and the cryoprecipitate acts like a cement to hold the platelets in place. It can take 2 weeks for the membrane to reattach. Cordocentesis is useful in umbilical cord catheterization and fetal blood exchange transfusions. It is also useful in nutrient supplementation, in Gene therapy and in treatment of infection. The catheter is in vein for 30 - 210 minutes.

VASCULAR INTERVENTIONAL TECHNIQUES

Uterine Artery Embolisation for Uterine Fibroids

Uterine Fibroids are benign neoplasms of smooth muscle origin that affect 25-40% of women over 35 years. Common presentation of symptomatic uterine fibroids is menorrhagia, which often leads to iron deficiency, dyspareunia, low back pain, frequency of urination, constipation and infertility. Uterine-sparing treatment options for patients with symptomatic uterine fibroids include medical management with Gn Rh analogue, Danazol, or surgical procedures like Abdominal myomectomy, Laparoscopic myomectomy, Laparoscopic myolysis, and Hysteroscopic resection. Of late, Uterine Fibroid Embolization (UFE) is a promising

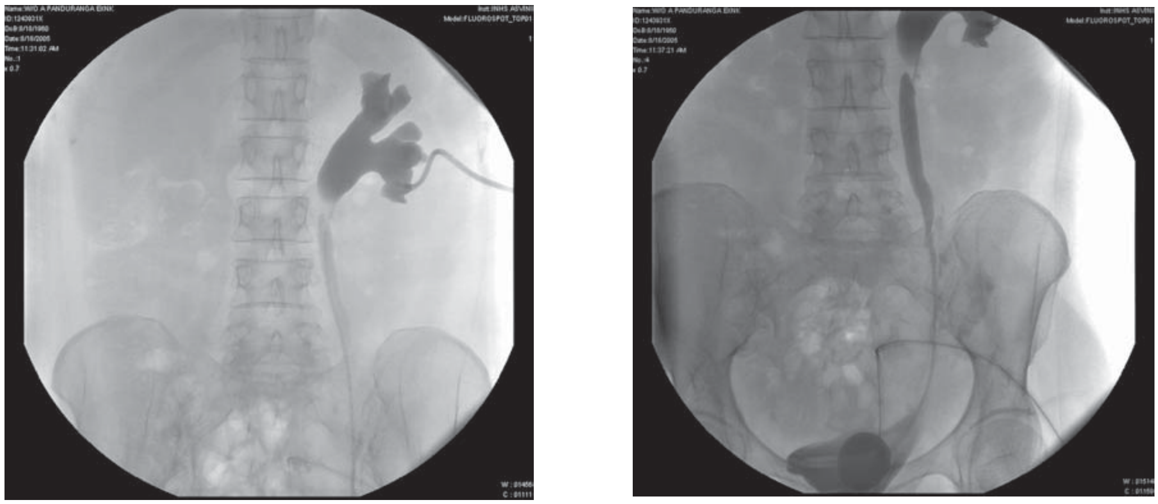


Figure 2 A) : Obstructive Uropathy: *By serially dilating the strictured segment of lower ureter, a D-J stent is inserted*

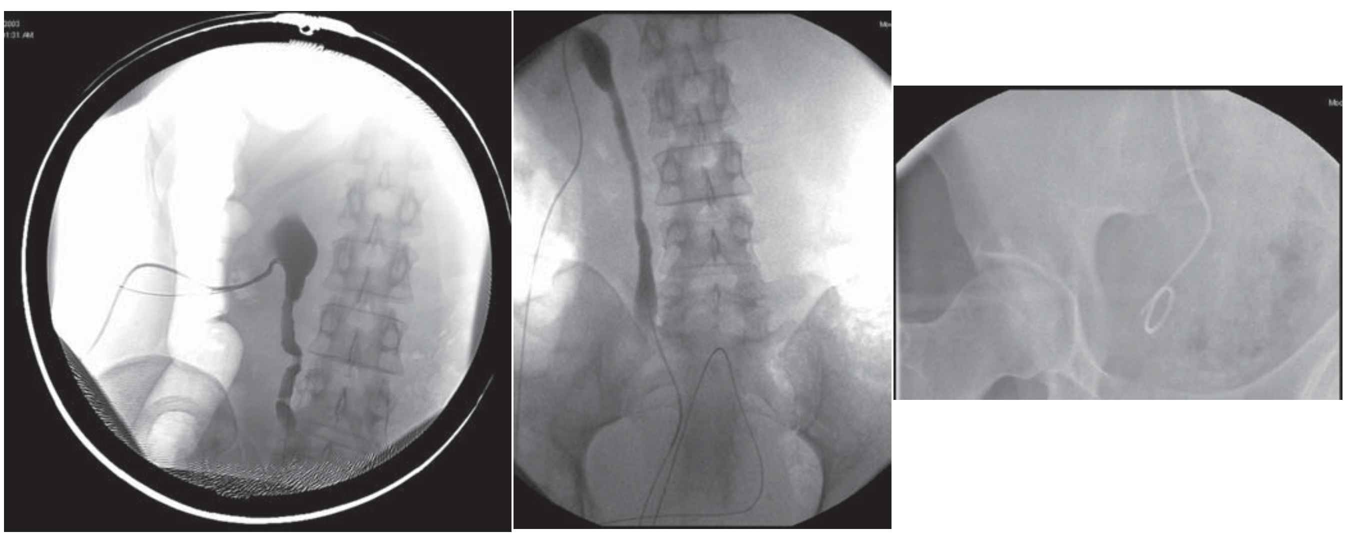


Figure 2B) Obstructive Uropathy: *DJ Stent negotiates the strictured segment and allows urine to pass freely into the urinary bladder, thereby relieving the symptoms and signs of obstructive uropathy*

interventional technique found effective in selected cases of fibroid[7].

The advantages of UFE includes a) no blood loss ; b) no general anesthesia or surgical incisions; c) recovery and hospitalisation are significantly shorter ; d) all fibroids are treated at once, which is not the case with myomectomy; e) recurrence rates appear to be lower than those of myomectomy; and f) early menopause-like syndrome is rare as compared with gonadotropin-releasing therapy.

A standard percutaneous transfemoral approach, invariably via the right side, is usual. Some radiologists find it easier to catheterise both arteries using a bilateral approach and selectively catheterising the contralateral as opposed to the ipsilateral uterine artery. A guide wire is then manipulated until it engages in the uterine artery. Limited arteriography at this stage additionally allows assessment of the vascularity and size of the fibroid uterus. (Figure 3A). When the correct position of the catheter has been confirmed, embolisation particles if Polyvinyl Alcohol and/or Gelfoam (Table 1) are slowly injected into the uterine artery, where they wedge in the smaller vessels blocking the flow of blood. The absence of distal flow in the uterine artery will be clearly seen on X-ray fluoroscopy. (Figure 3B).

Disadvantages include a) effect on fertility is still uncertain [8] ; b) late infection occurs in a small percentage of patients and c) long-term follow up data is not available[9].

Table 1: *Characteristics of Polyvinyl Alcohol and Gelfoam (35). Adapted from reference [10]*

Characteristic	Polyvinyl Alcohol	Gelfoam
Physical properties	Nonbiodegradable Synthetic	Biodegradable Prepared from purified skin gelatin
Mechanism of action	Acute inflammation mural angionecrosis, fibrosis, and thrombosis	Acute panarteritis with disruption of elastic tissue and thrombosis
Duration of occlusion	Several months with the potential for recanalization	30–45 days
Advantages	Easy to administer after selection of particle size Variable sizes available	Ideal for temporary occlusion
Disadvantages	Possibility for different size particles in preparation Potential for proximal occlusion caused by particle aggregation Nonradiopaque	Tedious to prepare Variable sizes of pledgets Nonradiopaque
Indications	Permanent embolisation	Temporary embolisation

Post Partum Haemorrhage

Obstetric haemorrhage is a potentially cause for maternal morbidity and death. Its causes include uterine atony, retained products of conception, placental abnormalities, uterine rupture, lower genital tract laceration, cervical ectopic pregnancy and coagulopathies. In general, "patients with postpartum haemorrhage (PPH) are primarily managed by vaginal packing, uterine massage and intravenous administration of oxytocin or methylergonovine for uterine atony, curretage for retained placenta, and suturing of lacerations"[11].

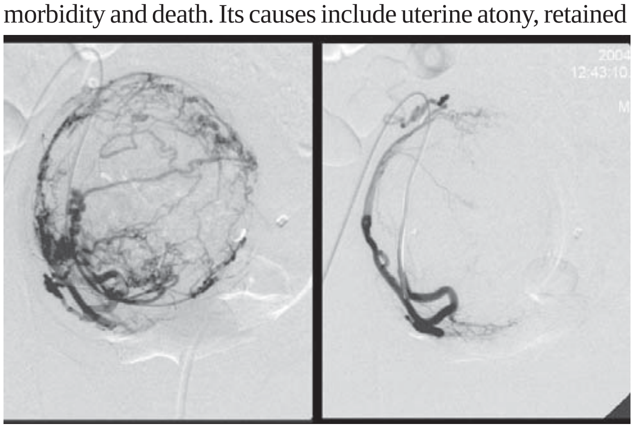


Figure 3A) : Uterine Artery Embolisation for Uterine Fibroids: *Preliminary arteriography allows assessment of the vascularity and size of the fibroid uterus. Following embolisation with particles (Polyvinyl Alcohol and/or Gelfoam) into the uterine artery, an absence of distal flow in the uterine artery is the endpoint.*

Conventional management in cases of persistent vaginal bleeding is by way of bilateral internal iliac artery ligation and occasionally hysterectomy[12]. Transcatheter arterial embolization is now considered to be a superior technique replacing bilateral internal iliac artery ligation in major centres, more so with available facilities for interventional radiology[13]. (Figure 4A&B).

In management of post-operative, post-abortion and postpartum intractable bleeding, with normal coagulation, its overall success rate of is over 90%. The advantages of UAE include: "preservation of the fertility[14]; decreased incidence of rebleeding from collaterals due to more distal occlusion obtained with embolization than with surgical

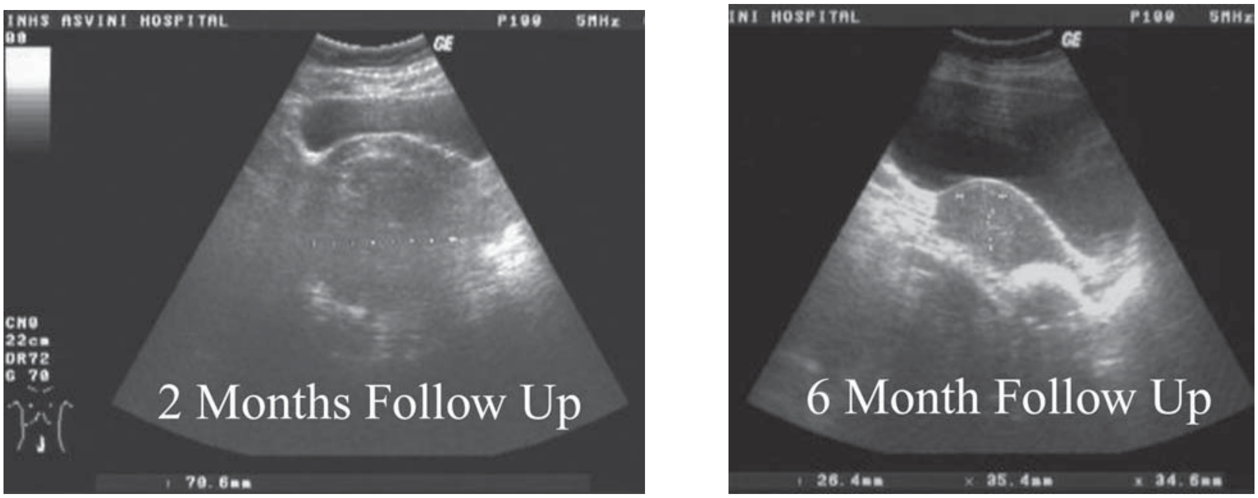


Figure 3B) : Uterine Artery Embolisation for Uterine Fibroids : *long-term follow up ultrasonography showing regression of fibroid lesion*

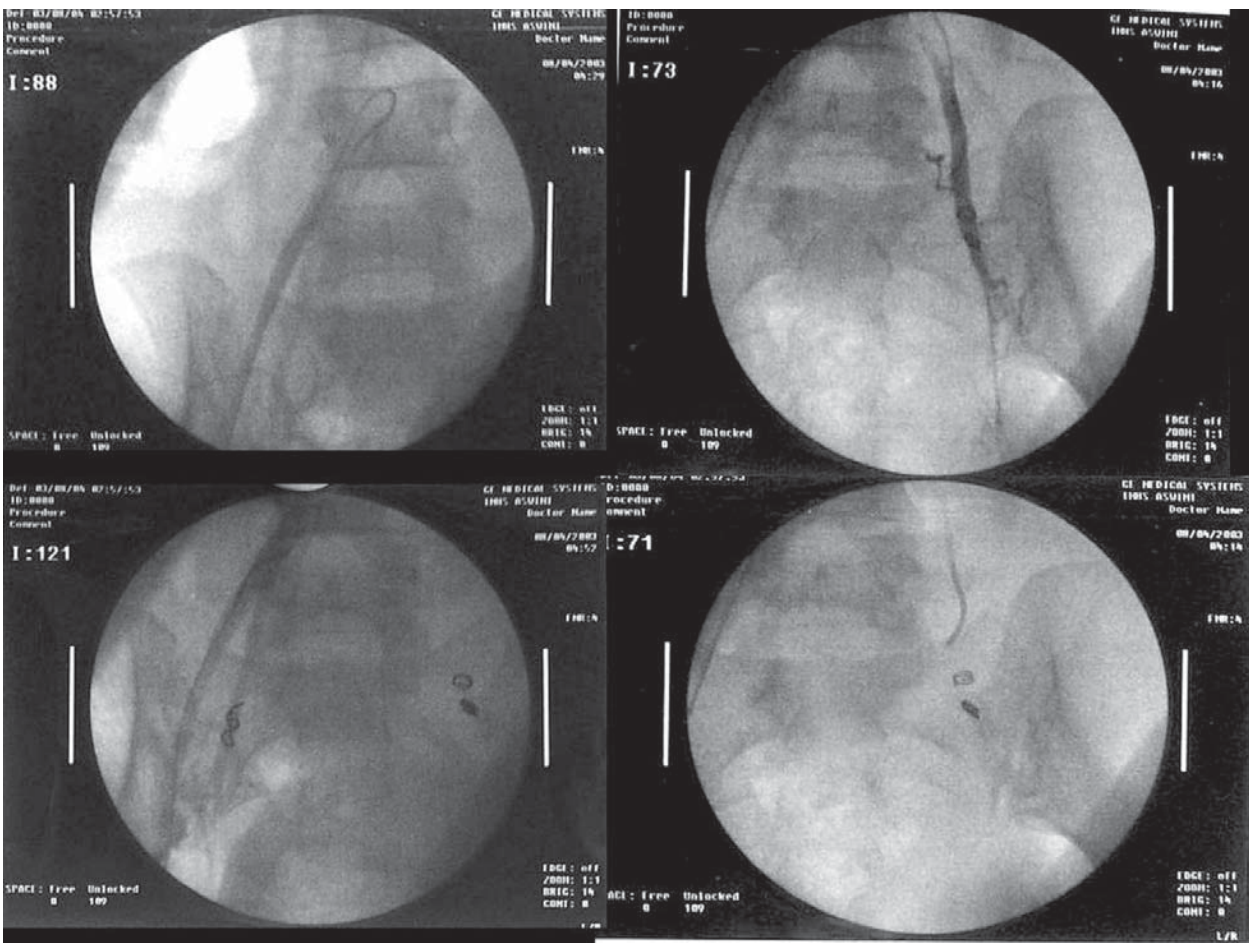


Figure 4 A) Post Partum Haemorrhage : *Transcatheter arterial embolization was chosen over bilateral internal iliac artery ligation in a middle aged lady with intractable life threatening Post Partum Haemorrhage. Selective Diagnostive angiography in this case was non- contributory. Angiography shows successful and complete blockage of both internal iliac arteries*

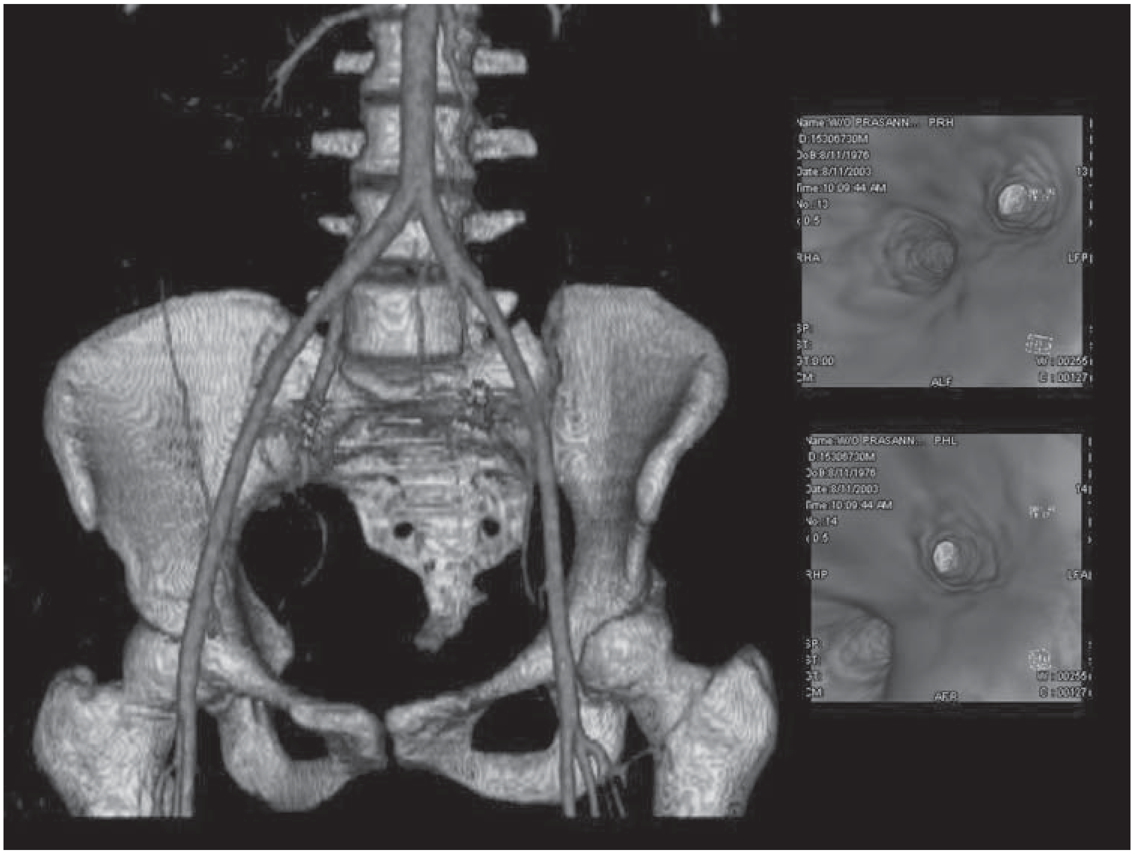


Figure 4 B) Post Partum Haemorrhage : *3D Volume Rendered Multidetector CT Angiography shows successful and complete blockage of both internal iliac arteries. Virtual Scopy images shows intraluminal perspective of the the blockage*

ligation; and the ability of radiologist to visualize, catheterize and occlude collateral vessels contributing to bleeding”[11].

CONCLUSION

A variety of interventional techniques in Obstetrics and Gynecology have been established, addressing few common entities, encountered in clinical practice. Interventional procedures in the female pelvis range from subtle to life threatening. These can be categorized into vascular and non vascular indications. It must be remembered that timely intervention rather than masterly inactivity forms the key to success.

REFERENCES

1. *Scanlan KA, Propeck PA, Lee FT, Jr. Invasive Procedures in the Female Pelvis: Value of Transabdominal, Endovaginal, and Endorectal US Guidance. RadioGraphics 2001; 21:491–506*
2. *Reuter KL. Critical uses of intraoperative gynecologic sonography. Am J Roentgenol 1997; 169:541–546.*
3. *O’Neill MJ, Rafferty EA,Lee SI,Arellano RS,Gervais DA, Hahn PF,Yoder IC, Mueller PR. Transvaginal Interventional Procedures: Aspiration, Biopsy, and Catheter Drainage. RadioGraphics 2001; 21:657–672*
4. *Troiano RN, Taylor KJW. Sonographically guided therapeutic aspiration of benign-appearing ovarian cysts and endometriomas. Am J Roentgenol 1998; 171:1601–1605.*
5. *Thurmond AS, Machan LS, Maubon AJ, Rouanet JP, Hovsepian DM, Van Moore A, Zagoria RJ, Dickey KW, Bass JC. A review of selective salpingography and fallopian tube catheterization. Radiographics 2000 Nov-Dec;20(6):1759-68*
6. *Thurmond AS, Novy M, Uchida BT, Rosch J. Fallopian tube obstruction: selective salpingography and recanalization. Work in progress. Radiology 1987 May;163(2):511-4 7. Ravina J, Herbreteau D, Ciraru-Vigneron N, et al. Arterial embolisation to treat uterine myomata. Lancet 1995; 346:671–672.*
8. *Spies JB. Uterine Artery Embolization for Fibroids: Understanding the Technical Causes of Failure J Vasc Interv Radiol 2003; 14:11–14*
9. *Andersen PE, Lund N, Justesen P, et al. Uterine artery embolization for symptomatic uterine fibroids: initial success and short-term results. Acta Radiol 2001; 42:234–238.*
10. *Siskin GP, Englander M, Stainken BF, Ahn J, Dowling K, Dolen EG. Embolic Agents Used for Uterine Fibroid Embolization. AJR 2000;175:767–773*
11. *Hong TM, Tseng HS, Lee RC, Wang JH, Chang CY. Uterine artery embolization: an effective treatment for intractable obstetric haemorrhage Clinical Radiology 2004;59, 96–101*
12. *Collins CD, Jackson JE. Pelvic arterial embolization following hysterectomy and bilateral internal iliac artery ligation for intractable primary post partum haemorrhage. Clin Radiol 1995;50:710—4.*
13. *Pelage JP, Le Dref O, Mateo J, et al. Life-threatening primary postpartum hemorrhage: treatment with emergency selective arterial embolization. Radiology 1998;208: 359—62.*
14. *Goldberg J, Pereira L, Berghella V. Pregnancy after uterine artery embolization. Obstet Gynecol 2002;100:869—72.*

ULTRASOUND GUIDED ENDOCAVITORY INTERVENTIONAL PROCEDURES IN GYNAECOLOGY

Bhupendra Ahuja
Vice Dean, Indian College of Medical Ultrasound, Dr. Ahuja Ultrasound Scan Centre, Sarkar Market, Delhi Gate, Agra-282 002 (U.P.) India

Abstract: *Ultrasound guided procedures have been used with endocavitory probes, more so on female genital organs and related structures that are situated deep in pelvis which often cannot be approached directly. The proximity of the transducer to the pelvic organs makes possible the use of high frequency probes, thereby enhancing the resolution and clinical efficiency. The advantage of these procedure over surgery are easy to do, precise needle placement, rare chance of injury to adjacent organs, shorter time of stay in hospital and low cost. The complications are rare which can be bleeding, infection and unintentional puncture of organs. In practice, the interventional procedures most commonly performed by endocavitory ultrasound include oocyte retrieval, ovarian cyst aspiration, fine needle aspiration for cytology, drainage of pelvic abscesses, culdocentesis, management of ectopic pregnancy, multiple embryo reduction. besides the other procedures, that can be done by the help of transvaginal ultrasound include embryo transfer, transcervical fallopian canulation, fetal reduction in multiple pregnancy, chorionic villus sampling and early amniocentesis.*
The extreme accuracy, least invasiveness and fewer complications are making endocavitory ultrasound guided procedures widely acceptable.

INTRODUCTION

Ultrasound guided abdominal aspirations were started way back in 1974 when Smith & Bartrum performed percutaneous aspiration of intraabdominal abscess. Female genital organs and related structures are deeply situated in the pelvis and cannot be approached directly because of presence of urinary bladder and bowel loops anterior to these organs. Percutaneous abdominal approach of these structures is difficult and more traumatic. With the advancement in sonographic equipments and techniques, now endocavitory procedures are preferred over abdominal approach wherever it is possible.

The proximity of the transducer to the pelvic organs makes possible the use of high frequency probes, thereby enhancing the resolution and clinical efficiency. The elastic vault of vagina allows approximation of the ovaries by increased pressure of the tip of the probe. Since there is no need for full urinary bladder, pelvic anatomy is undistorted and ovaries are kept beyond the focal zone of the transducer. Obesity or adhesions do not significantly inhibit the visualization of pelvic structures and pathologies.

The advantage of these procedure over surgery are easy to do, precise needle placement, rare chance of injury to adjacent organs, shorter time of stay in hospital and low cost. The complications are rare which can be bleeding, infection and unintentional puncture of organs.

Correspondence : Dr. Bhupendra Ahuja, Vice Dean, Indian College of Medical Ultrasound Dr. Ahuja Ultrasound Scan Centre, Sarkar Market, Delhi Gate, Agra-282 002 (U.P.), India

The punctures are usually performed with the guidance of 5.0 to 7.5 MHz vaginal transducer probes through a needle guide that is attached to the shaft of the probe. A software-generated fixed "biopsy guide" line is displayed on the ultrasound monitor screen, which marks the path of the entering needle. Needle ranging from 16G to 2G is employed, depending on the nature of the procedure itself; the narrowest possible needle able to perform the desired task should be used. For better imaging, the "zoom" feature of the equipment should be used as frequently as possible. After the initial withdrawal the needle, the pelvic structures and cul-de-sac must be observed sonographically for approximately 10 minutes and rescanned after a 2 to 3 hours observation period to check for internal bleeding or previously undetected complications.

ENDOCAVITORY INTERVENTIONAL PROCEDURES

Following interventional procedures are most commonly performed by endocavitory ultrasound :
1.Oocyte retrieval; 2.Ovarian cyst aspiration; 3.Fine needle aspiration for cytological ex.; 4. Drainage of pelvic abscesses; 5.Culdocentesis; 6.Management of ectopic pregnancy ; 7.Multiple embryo reduction

OOCYTE RETRIEVAL

Initially in IVF the ovum pick-up or oocyte retrieval was done by the laproscopic route. In 1981, Lenz was first to demonstrate transabdominal transvesical route for pick-up.

Gliecher made a major breakthrough by using vaginal ultrasound for ovum pick-up. Now this is most widely used method as it is less traumatic, no injury to urinary bladder and most important is of all, the follicle can be accurately located due to their close approximity to the transducer. Vagina is cleaned by normal saline. No antiseptic is used. Mild sedation or general anaesthesia is given if multiple pricks are to be made. Otherwise local anaesthesia with 10 ml of 1% Lignocaine is sufficient to do the procedure comfortably.

Before inserting the probe into the cover, operator should apply the ultrasonic coupling gel. The cover (sterile condom, surgical rubber glove or specially produced rubber cover) is stretched over the gel to expel the air from the tip of the probe. This can prevent the artefacts during the procedure. The gel or lubricant should not be used while inserting the probe because of spermicidal action and reported embryotoxicity. Instead, one can use a physiologic saline or culture medium. Sterile needle guides are used for transvaginal puncture of the follicles. The keyboard of the ultrasound machine is covered with a sterile cover, which enables the operator to make any readjustment under sterile conditions. The patient's legs and perigenital area are then covered using the sterile drapes. After cleaning the vagina with isotonic saline or cultured medium the vaginal probe in inserted into the vagina.

TECHNIQUE

(i) Place the transducer alongwith its biopsy guide in the vagina.
(ii) Scan ovaries, uterus and iliac vessels.
(iii) Face the biopsy line marker on the USG screen.
(iv) Move the transducer till the biopsy marker crosses the maximum diameter of the follicle.
(v) Introduce needle through the vaginal mucosa and parametrium into the follicle, with a sharp jabbing movement.
(vi) Normally try to aspirate the middle, larger follicle first.
(vii) This is important because it can give access to both lateral and medial follicles without having to withdraw the needle completely.
(viii) It is essential to gently rotate the needle in its axis while aspirating the follicle.
(ix) Majority of the gynaecologists do not flush the follicle at the time of aspiration. This is done only in case of natural cycle IVF where there is only one egg to be retrieved. In this case, the follicle may be flushed multiple times to recover the egg.
(x) When aspirating the opposite ovary, the needle should be withdrawn, transducer repositioned and needle reintroduced.
(xi) The needle should be occasionally flushed with media to prevent clotting and blockage.
(xii) In highly mobile ovaries, it may be difficult to puncture the ovary. This is overcome by fixing the ovary between the transducer and the lateral pelvic wall prior to puncture. In ovaries, which are high up, one may have to go transuterine.
(xiii) Iliac vessel identification is essential in preventing inadvertent vessel puncture.

This is done by looking for the following.

(a) Constant relation of the iliac artery and vein.
(b) Pulsation's of vessels.
(c) In case of vessel mimicking of follicle, a rotation of transducer by 90 degree will result in cylindrical appearance of the vessel. In addition, a side-to-side movement of the transducer will result in varying diameter in case of follicle and constant diameter in case of vessel.
(d) Ovarian capsule demarcation between ovarian tissues and vessels.

COMPLICATIONS

(i) Vaginal bleeding : Normally, this can be controlled by pressure, vaginal packing, occasional vault stitch.
(ii) Inadvertent puncture of : iliac vessels, ovarian vessels, hydrosalpinges, endometrioses and ureter.
(iii) Acute pelvic inflammation.

OVARIAN CYST ASPIRATION

Transvaginal guidance permits direct visualization and aspiration of persistent follicular cyst. Such cysts may impair folliculogenesis due to elaboration of hormones, or as a result of decreased perfusion by parenchymal compression. In the puncture of an ovarian or paraovarian cyst the center of the cyst is targeted and the needle is inserted. Such a procedure is highly debated in the literature. The concern of cell spillage from potentially malignant ovarian cyst into the abdominal cavity prevents many from using it more frequently. Although the aspirated fluid is necessarily submitted for cytologic evaluation, a negative cytologic examination may sometimes represent a false-negative result. High sensitivity and specificity of transvaginal color Doppler in differentiation between benign and malignant adnexal lesions seems to increase the reliability in decision making which cysts should be aspirated.

Bret et al published two papers describing their experience using transvaginal sonography in the aspiration of the ovarian cysts. They reported a 48% recurrence rate after cyst aspiration in premenopausal patients, and an 80% recurrence rate in postmenopausal women. This group attempted to prevent cyst recurrence by injecting alcohol immediately after cyst aspiration, but this procedure was successful in only 4 of 7 patients.

The aspiration of endometriomata is considered to be relatively contraindicated. Aboulghar et al studied 21 patients in which transvaginal ultrasonically guided aspiration of pelvic and endometriotic cysts was performed. Reaccumulation occurred in only 6 cases during a 12-month follow-up. Certainly, the aspiration of endometriotic cysts is technically simple; however, its overall benefit and safety are still inconclusive due to the lack of experience obtained by evaluating larger series.

In infertility program waegemaekers et al aspirated 32 unilocular anechoic cysts with an average diameter of 45 mm transvaginally. The authors concluded that ovarian cysts puncture in the early follicular phase could diminish the cancellation rate of *in vitro* fertilization cycles.

DRAINAGE OF PELVIC ABSCESSES

Infertility is attributed to tubal obstruction or dysfunction in 30-40% of patients. It is well known that tubal occlusion is common sequelae of pelvic inflammatory disease (PID). Since recurrent episodes of PID are frequent, one should expect high incidence of this entity in infertile population. In patients with a tubo-ovarian abscess, abscess drainage with sonographic guidance can hasten the recovery process and improve the efficacy of antibiotic therapy. Once the needle is placed into the abscess cavity, the fluid can be aspirated as completely as possible and the needle withdrawn, or an indwelling drainage catheter can be placed. Teisala et al used transvaginal ultrasound guided aspiration to drain 10 tubo-ovarian abscesses receiving antimicrobial treatment. Only light sedation was required, and the procedure was well tolerated by the patients. This technique is accepted as an alternative to open laparoscopy for treating the tubo-ovarian abscess.

DIAGNOSTIC CULDOCENTESIS

The introduction of transvaginal sonography has limited the need for diagnostic culdocentesis. The presence or absence of fluid in the pelvic cavity is easily established by the vaginal approach, but it may be necessary to differentiate between different biological fluids (clear fluid, blood or pus). The wide availability of transvaginal color Doppler sonography to distinguish the dominant pelvic pathology in the presence of pelvic fluid on the basis of different vascularity patterns is very helpful in routine investigations. Sometimes, in conjunction with clinical signs, subjective symptoms, transvaginal color Doppler findings and the rapid β-human chorionic gonadotropin (β-hCG) test, the clinician still requires the information provided by culdocentesis. Inserting a needle in the cul-de-sac is a simple technique that can be performed safely and accurately with transvaginal ultrasound guidance. High quality B-mode transvaginal sonography with superimposed color Doppler flow allows accurate simultaneous identification of the main pelvic vessels, physiological angiogenesis (corpus luteum) and ectopic peritrophoblastic blood flow. Color will help in accurate needle placement and in diminishing the risk of injury to adjacent vessels, especially in women who have had previous inflammatory disease of the pelvis with an obliterated cul-de-sac.

FINE NEEDLE ASPIRATION FOR CYTOLOGICAL EXAMINATION

FNA of solid as cystic lesion is done by 22 G or 23 G needle. Thus this procedure is quick safe and there are least chances of cell spillage from potentially malignant ovarian masses into the abdominal cavity.

Zanetta et al reported on transvaginal ultrasound guided fine needle sampling of deep cancer recurrences in the pelvis. For aspirates and biopsies, sensitivity was respectively 76 and 91, while accuracy was 83 and 91. This technique is a safe procedure with limited invasiveness and extremely high specificity even when performed on small targets (median diameter in the study was 30 mm). Whenever possible, biopsies should be preferred. A negative fine needle biopsies obtained from a clinically suspicious lesion requires a repeat sampling.

CONSERVATIVE MANAGEMENT OF ECTOPIC PREGNANCY

In past most of the cases of ectopic pregnancy used to present with ruptured ectopic or unstable haemodynamic state. Gynaecologists were left with no other choice than salpingectomy or salpingoophrectomy.

Now with the advancement of more sensitive serological tests and transvaginal color Doppler ultrasound, it has become possible to diagnose ectopic pregnancy at an early stage. Thus, making the medical treatment possible. Patient with enraptured ectopic pregnancy and adnexal mass less than 3 cm are treated with local administration of Inj Methotrexate. It is injected at the site of maximum trophoblastic flow. The total dose is calculated by 1 mg/kg body weight. Estimation of serum ?-hCG levels and TVS color Doppler ex. in done every second day until ?-hCG levels reached non gravid levels. In case of live foetus in an ectopic gestational sac, first Inj Kcl is injected in foetal heart and then Inj Methotrexate in the sac. For cervical and cornual ectopic pregnancies also similar procedure is adopted.

OTHER PROCEDURES

There are many more interventional procedures, which can be done by the help of transvaginal ultrasound. These are :

- Embryo transfer
- Transcervical fallopian cannulation

- Fetal reduction in multiple pregnancy
- Chorionic villus sampling
- Early amniocentesis

CONCLUSION

With the time endocavitory interventions are being used more and more often. Newer applications are being introduced. Although their major role is in Assisted Reproductive Techniques (ART), these procedures can be performed for diagnostic as well as therapeutic purposes. Its therapeutic role is tubo ovarian abscess and ectopic pregnancy is becoming treatment of choice. The extreme accuracy, least invasiveness and fewer complications are making these procedures widely acceptable.

REFERENCES

1. *Aboulghar MA, Mansour RT, Serour GI, Rizk B. Ultrasound transvaginal aspiration of endometriotic cysts : an optional line of treatment in selected cases of endometriosis. Hum Reprod 1991; 6 : 1408-10.*
2. *Bret PM, Guibaud L, Atri M. Transvaginal US-guided aspiration of ovarian cysts and solid pelvic masses. Radiology 1992; 185 : 377.*
3. *Brown DL, Felker RE, Stowall TG, Emerson DS, Ling FV. Serial endovaginal sonography of ectopic pregnancies treated by methotrexate. Obstet 1991; 77 : 406-08.*
4. *Feichtinger W, Kemeter P. Conservative treatment of ectopic pregnancy by transvaginal aspiration under sonographic control and methotrexate injection. Lancet 1987; 14, 1 (8529) : 381-82.*
5. *Fleischer AC, Pennel RG, McKee MS, Worell JA, Keefe B, Herbert CM, Hill GA. Ectopic pregnancy : features and transvaginal sonography. Radiology 1990; 174 : 375-79.*
6. *Hill ML, Nyberg DA. Transvaginal sonography guided procedures. In : Nyberg DA, Hill LM, Bohm-Velez M, Mendelson EB (Eds). Transvaginal Ultrasound 1992; 319-29 (St. Louis : Mosby Yeark Book).*
7. *Kurjak A, Zalud I, Schulman H. Ectopic pregnancy transvaginal color Doppler of trophoblastic flow in questionable adnexa. J Ultrasound Med 1991; 10 : 685-87.*
8. *Lerner JP, Monteagudo A. Vaginal sonographic puncture procedures. In : Goldstein SR, Timor-Tritsch IE (Eds.) Ultrasound in Gynaecology 1995; 223-38 (New York : Churchill Livingstone).*
9. *Menard A, Crequat J, Mandelbroat L, Hanny JP, Mandelanat P. Treatment of unruptured tubal pregnancy by local injection of methotrexate under transvaginal sonographic control. Fertil Steril 1990; 54 : 47-48.*
10. *Smith EH, Bartrum RJ Jr. Ultrasonically guided percutaneous aspiration of abscesses. AJR 1974; 122 : 308-12.*
11. *Teisala K, Heinonen PK, Punnonen R. Transvaginal ultrasound in the diagnosis and treatment of tuboovarian abscess. Br J Obstet Gynaecol 1990; 97 : 178-80.*
12. *Waegemaekers CT, Berg-Helder A, Blankhart A, Naaktgeboren N. Transvaginal ovarian cyst puncture in the early follicular phase of an IVF cycle, indications and results. Hum Reprod 1988; 3 (suppl 1) : 80.*
13. *Zanetta G, Brenna A, Pittelli M, Lissoni A, Trio D, Riotta S. Transvaginal ultrasound-guided fine needle sampling of deep cancer recurrences in the pelvis : usefulness and limitations. Gynaecol Oncol 1994 54(1) : 59-63.*
14. *Gleicher N,* et al *: Retrieval for IVF by sonographically controlled vaginal culdocentesis* Lancet *2 : 508, 1983.*
15. *Lenz Z, Lavritsen JG, Kjellow M : Collection of human oocyte for IVF by ultrasonically guided follicular puncture,* Lancet *1163, 1981.*
16. *Sanja Kupesic, Asim Kurjak, guided procedures using transvaginal sonography. Textbook of ultrasound in Obs. & Gyn.*

IMSA NEWS

IMSA Chapter Activities

CME Hyderabad

13-10-2006	: Dr. W.H.Allum, "***Challenges in Cancer Surgery Marsden experience***"
	: Dr. C. Subramanyeswar Rao, "***Management of Oesophageal Cancer Indian Experience***"
29-12-2006	: Dr. Guidubaldo Querci della Rovere, "***Management of Axilla in Breast Cancer***"
	: Dr. P. Raghu Ram, "***Retro areolar Breast Cancer – Extending the boundaries of Breast Conserving Surgery***"

CME Bihar Chapter

17-12-2006	: Dr. H.K.Singh, "Diabetes & Eye - Update"
	: Dr. Ajay Sinha "Diabetes & Eye – Update"

CME Delhi Chapter

11-02-2007	: General Discussion "***Rheumatology Update 2007***"
23-02-2007	: Dr. Madhur Yadav, "***Hypertension and its Management***"

Rural CME Delhi Chapter

16-03-2007	:Dr. Ranjan Sachdev, USA, "***Arthritis – Pain Management update***"
	: Dr. Goswami, "***Yogic Exercises in all types of Arthritis***" & *Practical Demonstration of Yogic exercise*
	: Dr. Y.D. Sharma, "***Aurvedic Management of pain in Arthritis***"

Tamil Nadu Chapter

14-01-2007	: Dr. O.P.Kapoor, "***My Concept of Sensitivity and Specificity of*** **the Results of Investigations as applied to a family physician**"
11-02-2007	: Dr. Michiel Arul Doss, "***The Mechanism Underlying the gender bias in thyroid cancer***"
11-03-2007	: Prof. Dr. B. Krishnaswamy, "***Frail Elderly***"

Election of Fellows/Members

Dr. Ammar Ibrahim Elshafie Hassan *Khartoum, (Sudan)*
Dr. Anju Aggarwal *Delhi*
Dr. Pawan Kumar Goyal *Rewari (Haryana)*
Dr. Ashok Kumar Dhar *J & K*
Dr. Gonakoti Srinivas Armon Rao *Hyderabad (A.P)*
Dr. Rajender Prashad Tripathi *Delhi*
Dr. Amarjit Singh *Pune (Maha)*
Dr. Prabhat Kumar Verma *Saharanpur (UP)*
Dr. Jaswir Singh *Patiala (Punjab)*
Dr. Subrahmanya Kameswara Rao Annangi *Kakindada (A.P.)*
Dr. Ashok Gupta *New Delhi*
Dr. Yashpal Sharma *Jammu (J&K)*
Dr Gurmeet S. Bhagowalia *Patiala (Punjab)*

HONOURS

- **Dr. Tarun Gupta** has been elected as President of **IMA NDB** for the year 2007.
- **Dr. S.N.A.Rizvi** received the prestigious "**Netaji Oration**" of Association of Physicians of India at the 62nd Annual Conference of API, held at Goa on 16th Feb,2007 for his outstanding work on "**Metabolic Bone Disease**".
- **Prof. N.S.Neki** has been awarded fellowship of **American College of Physicians;** he will receive the Scroll at the annual conference to be held at San-Diego, California, USA on April 19, 2007. He has alsobeen awarded "**J NagMemorial Award**" for year 2006 in recognition of his work on growth of clinical nutrition.

REVISED IMSA FELLOWSHIP / MEMBERSHIP FEE

It has been decided to revise the Fellowship and Membership fee of IMSA with effect from 1/7/2007 as under:

	Revised	Existing
Fellowship	**Rs. 5,500/-**	**4,500/-**
Membership	**Rs. 3,500/-**	**3000/-**

There will no change in the fee in respect of applications received up to 30/6/2007. For Fellows elected from abroad, there will be no change in the fee structure.

Secretary General

PERCUTANEOUS VERTEBROPLASTY

Dandu Ravi Varma
Interventional Radiology Services, Department of Radiology, Krishna Institute of Medical Sciences,
1-8-31/1, Minister Road, Secunderabad, 500003, India.

Abstract: *The potential of interventional radiology in providing simple and effective minimally invasive solutions for debilitating disorders; is best demonstrated by percutaneous vertebroplasty. Since its introduction in the late 1980's, it has gained popularity as an alternative to spinal surgery in the treatment of selected cases of vertebral compression fractures. It has proved to be effective in stabilizing the collapsed vertebra, as well as providing pain relief. This review describes the procedure and its role in vertebral compression fractures of various etiologies.*
Key Words: Vertebral compression fractures ; Percutaneous vertebroplasty

INTRODUCTION

Percutaneous vertebroplasty (PVP) is an interventional radiological procedure that involves the injection of acrylic polymer into a partially collapsed vertebral body under imaging guidance. The procedure attempts to provide stability to the collapsed vertebra and relief of pain. Though initially, this procedure was used in management of vertebral hemangiomas, it has proved to be an effective technique in the management of vertebral compression fractures (VCFs) due to a wide range of etiologies such as osteoporosis, osteolytic metastases, multiple myeloma, lymphoma and other benign vertebral lesions[1].

VERTEBRAL COMPRESSION FRACTURES

Vertebral fractures are common in elderly individuals who have osteoporosis. It is estimated that up to half of women and up to one quarter of men will have vertebral fractures at some point in their lives. Multiple vertebral fractures are seen in half of these cases[2]. These fractures are usually located in the thoraco-lumbar region, which represents a transition between the relatively stiff thoracic vertebrae and the more mobile lumbar segments. In the bones weakened by osteoporosis or tumors, even a simple fall or even daily activities such as picking up a bag of groceries may result in a VCF.

Advanced age is also associated with an increase in risk of pathological VCF due to malignancy. Involvement of the vertebral body is a common mode of presentation in osteolytic metastases, multiple myeloma and lymphoma. Primary modes of treatment in these patients include radiotherapy, chemotherapy or surgical resection and internal fixation. Though radiotherapy and chemotherapy may reduce the tumor burden, pain relief is usually delayed by weeks or months.

Correspondence : Dr. Dandu Ravi Varma, 1-8-31/1, Minister Road, Secunderabad, 500003, India. Mob:(+91) 9849666240 Fax: +91- (0) 40 - 27840980, **Email**: varmaji@rediffmail.com

Clinical examination of patients with vertebral compression fractures usually reveals deep tenderness over the affected vertebra. Associated neural compression may result in myelopathy or radiculopathy. In addition, the kyphotic deformity that results, may compromise the gastrointestinal and pulmonary function. Patients with VCFs have lower levels of functional performance and need more assistance, as compared to age matched controls.

Vertebral hemangiomas are the most common tumors of the spine, with a reported incidence of 12% based on autopsy series. Most lesions are asymptomatic and are often seen on MR imaging studies of the spine. These lesions require treatment when they present with neural compromise and pain. Though surgery is the treatment of choice for aggressive lesions, there is a potential for large blood losses during surgery. Over the years, PVP has proved to be an effective therapeutic modality in the management of all the above conditions(figure1&2).The indications and contraindications of PVP in each of these pathological conditions are summarized in Table 1.[3]

THERAPEUTIC BENEFITS OF PERCUTANEOUS VERTEBROPLASTY

PVP aims at stabilizing the vertebral body by filling the inter-trabecular spaces with an acrylic polymer (Polymethyl methacrylate (PMMA); bone cement). The injected bone cement slowly diffuses into the inter-trabecular marrow spaces and forms a firm internal cast that anchors the fracture fragments. Injection of cement volumes as low as 2ml have shown to restore the strength of the vertebra in thoracic and lumbar regions. It is this restoration of stiffness that prevents micro-motion at the fracture site, promotes repair and thus relieves the pain. Similarly, the flexion-extension and lateral compliance parameters are restored, similar to the biomechanics of the normal spine.[4] Polymerization of bone cement is an exothermic reaction. The destruction of nerve endings within the vertebra by the thermal effects of polymerization, as well as the cyto-toxic, mechanical and

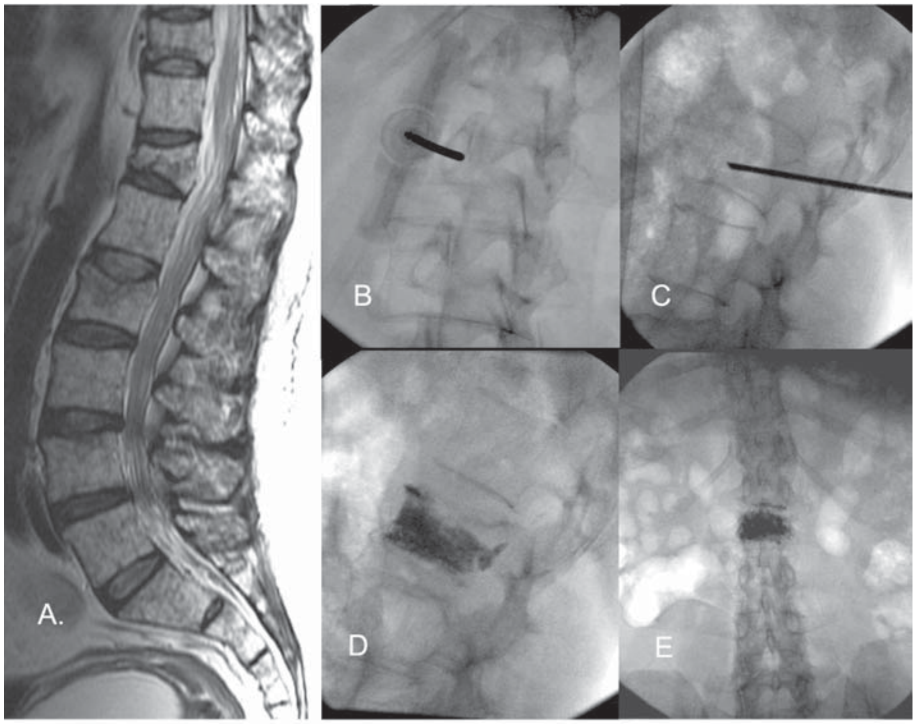


Figure 1: *Multiple vertebral compression fractures in a patient with multiple myeloma. Sagittal T2 weighted MR scan (A) reveals collapse of D10, D12 and L2 vertebral bodies. Note the buckling of posterior cortex and absence of epidural soft tissue component. Introduction of the needle through the pedicle into the vertebral body (B &C) are demonstrated. Post vertebroplasty radiographs revealing an internal cement cast.*

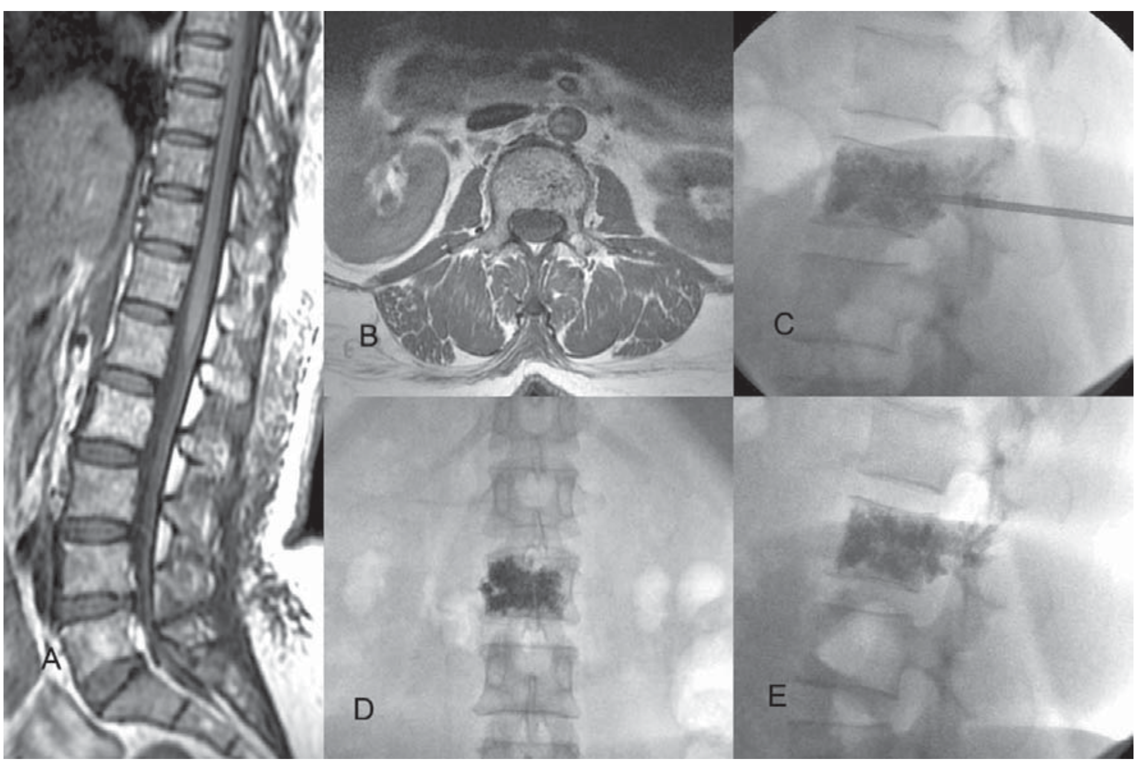


Figure 2: *Vertebral hemangioma. Sagittal and Axial T1 weighted images (A&B) reveal a large hemangioma involving the L2 vertebral body. Injection of bone cement was performed through pedicular access (C). Post vertebroplasty radiographs reveal good cement cast within the lesion (D&E)*

vascular effects of PMMA are thought to play a role in the pain relief provided by PVP.[5]

PROCEDURE

If PVP is considered as a therapeutic option in a patient with VCF, plain radiographs of the affected region are performed to localize the collapsed vertebrae. These radiographs also play the role of baseline studies for comparison of follow up radiographs. Further, cross sectional imaging (CT scan or MRI) is performed to assess the integrity of the posterior cortex of the vertebral body, to evaluate for epidural soft tissue components and to exclude other causes of back pain. Most patients with osteoporosis and other destructive lesions of the vertebral bodies have multiple chronic fractures, most of which would be asymptomatic. The most severely compressed vertebra may not be the source of the patient's symptoms. Thus, it is essential to confirm a strong correlation between the clinical signs and symptoms and imaging studies, to ensure best procedural results.

The procedure requires guidance of high-quality fluoroscopy, and is usually performed in an interventional radiology suite. Some operators prefer to perform the procedure under CT scan guidance. Most patients tolerate the procedure well with a combination of neuroleptic analgesia and generous infiltration of local anesthetic agent along the path of the needle, down to the periosteum. Patients who are in severe pain may require administration of general anesthesia to ensure proper positioning and absolute immobility that are required during the procedure.

For PVP of dorsal and lumbar vertebra, the patient is postioned prone and the vertebral body is most commonly accessed from the posterolateral aspect, through a trans-pedicular access. Under fluoroscopic guidance, the pedicle is projected end-on over the target vertebral body and an 11-gauge or 13-gauge needle is advanced through the skin and muscular planes so as to enter the vertebra through the pedicle. The tip of the needle is advanced to lie in the anterior third of the collapsed vertebral body. A slight medial angulation of the needle during entry enables positioning of the needle tip near the midline, so that more uniform filling of the vertebra can be achieved from unilateral pedicular access.

Once the needle is in optimal position, the acrylic bone cement is prepared to achieve a "tooth-paste" like consistency. The bone cement is injected slowly using 1cc syringes, under careful fluoroscopic monitoring to track its progress. If early progression of the cement into the posterior part of the body or into the peri-vertebral veins is noted, the injection is halted for a few seconds and then resumed to

Table 1: *Indications and Contraindications of Percutaneous Vertebroplasty*

Percutaneous Vertebroplasty
Indications:
• Painful vertebral compression fractures in a weakened bone (osteoporosis / benign or malignant neoplastic lesions / osteonecrosis) refractory to medical therapy or causing limitation of daily living activities
• Unstable compression fracture with movement at the site of wedge deformity
• Old traumatic fractures in a normal vertebra with non union of fracture fragments
• Impending fracture in a vertebra destroyed by benign or malignant tumors
• Impending fracture in patients with multiple osteoporotic compression fractures, where further collapse would compromise pulmonary or gastrointestinal function or increase risk of falls
Absolute Contraindications:
• Stable fracture with good response to medical therapy
• Uncorrectable bleeding diathesis
• Active infection
• Acute traumatic fracture in a nonosteoporotic vertebra
• Allergy to any component used in the procedure.
Relative Contraindications:
• Radicular pain caused by compressive syndrome unrelated to vertebral collapse
• Retropulsion of fracture fragments with neural compromise
• Epidural extension of tumor with significant canal compromise
• Vertebra plana
• Stable fracture of more than 2 years duration

achieve optimal vertebral filling. Cement injection is terminated when the bone cement reaches the posterior cortex of the vertebral body or if significant leakage of the cement into the peri-vertebral venous plexus and foraminal veins occurs.

It is usually not necessary to achieve complete radiographic filling of the vertebral body. Injection of even small quantities of bone cement (~14% of the vertebral volume) results in restoration of bone strength to pre-collapse values. However, uniform distribution of the cement within the body permits more effective transmission of compressive loads.[6] Depending on the distribution of the cement within the vertebral body, a decision may be made whether injection through the contralateral pedicle would be required.

Following the procedure, the patient is encouraged to lie in a supine position for at least one hour to allow the cement to harden. The patient can be discharged after a few hours of observation after performing a neurological assessment and providing optimum analgesia. Pain relief is usually immediate and the patient can rapidly assume normal activities of daily living.

RESULTS

There have been no randomized controlled studies comparing PVP with conservative therapy. However, several large series have demonstrated the benefit of this procedure. The reported rates of positive outcome after PVP range from 73 to over 90%, based on the predominant indication[7,8,9,10]. Experience reported from various centers in India has shown similar benefit with this procedure[11,12].

Alleviating the pain and improving functional performance status, goes a long way in improving the quality of life in this group of individuals[13]. Careful selection of patients for therapy with attention to ensure concordance of clinical symptoms and radiological findings and exclusion of other causes of back pain are essential to ensure optimal procedural results.

Complications are commoner during management of tumor associated VCFs (5 - 10%) as compared to osteoporotic VCFs (1%). The most common complications are related to the leakage of bone cement into the spinal epidural space or into the foraminal veins. Clinically significant complications that require surgical decompression to remove the extruded cement or repair of a fractured pedicle occur in less than 1% of the procedures[14]. Careful preoperative evaluation of integrity of the posterior cortex of the vertebra and extreme care while injecting the bone cement, ensure that symptomatic leakage of cement into the epidural space does not occur. Other reported complications such as local hemorrhage, fracture of posterior elements, rib fractures, transient increase in pain and nerve root irritation are self limiting. Other potentially serious complications such as pulmonary embolism due to PMMA, allergic reactions and hypotension due to the monomer component and infection are fortunately rare.

FUTURE DIRECTIONS

Though most experience with PVP worldwide has come from the use of PMMA as the bone cement, it is not an ideal cementing agent. Newer bone cements that have more radio-opacity and more favorable setting times are under development. The ideal bone cement would stabilize the vertebra in the immediate post-procedure period, would permit the growth of new bone and would be ultimately replaced by the new bone. Better delivery systems that permit more controlled injection of the bone cement into the vertebral body are currently being evaluated. PVP is effective in stabilizing the vertebra and preventing further collapse. However, it does little to restore the height or shape of the collapsed vertebra. Kyphoplasty is a modification of the PVP procedure, where the height of the collapsed vertebra is restored by inflating a high pressure balloon introduced into the vertebral body through trans-pedicular access. The resulting cavity is subsequently filled bone cement to ensure stability. Restoring the height of the collapsed vertebra may improve gastrointestinal and pulmonary functions and may prevent subsequent vertebral compression fractures.

REFERENCES

1. *Ide Ch, Gangi A, Rimmelin A, et al. Vertebral hemangiomas with spinal cord compression: the place of preoperative percutaneous vertebroplasy with methyl methacrylate. Neuroradiology 1996; 38: 585 – 589.*
2. *Ross PD. Clinical consequences of vertebral fractures. Am J Med. 1997; 103(2A): 30S – 43S.*
3. *Practice guideline for the performance of percutaneous vertebroplasty. ACR Practice guidelines: American College of Radiology 2000.*
4. *Belkoff SM, Mathis JM, Jasper LE, et al. The biomechanics of vertebroplasty. The effect of cement volume on mechanical behavior. Spine 26; 2001. 1537 – 1541.*
5. *Deramond H, Depriester C, Galibert P et al. Vertebroplasty with polymethyl methacrylate. Technique, indications, and results. Radiol Clin North Am 36: 533 – 546. 1998.*
6. *Liebschner MAK, Rosenberg WS, Keaveny TM. Effects of Bone Cement Volume and Distribution on Vertebral Stiffness After Vertebroplasty. Spine 2001; 26: 1547 – 1554.*
7. *Gangi A, Dietemann JL. Guth S, et al. Computed tomography and fluoroscopy-guided vertebroplasty. Results in 187 patients. Sem Intervent Radiol 1999; 16: 137 – 142.*
8. *Mc Graw JK, Lippert JA, Minkus KD et al. Prospective evaluation of pain relief in 100 patients undergoing percutaneous vertebroplasty: results and follow-up. J Vasc Interv Radiol. 2002;13: 883 – 886.*
9. *Kobayashi K, Shimoyama K, Nakamura K et al. Percutaneous vertebroplasty immediately relieves pain of osteoporotic vertebral compression fractures and prevents immobilization of patients. Eur Radiol 2005; 15: 360 – 367.*
10. *Alvarez L, Perez-Higueras A, Granizo JJ et al. Predictors of outcomes of percutaneous vertebroplasty for osteoporotic vertebral fractures. Spine 2005; 30: 87 – 92.*
11. *Purkayastha S, Gupta AK, Kapilamoorthy TR, et al. Percutaneous vertebroplasty in the management of vertebral lesions. Neurology India 2005; 53: 167 – 173.*
12. *Nirala AP, Vatsal DK, Husain M, et al. Percutaneous vertebroplasty: An experience of 31 procedures. Neurology India 2003; 51: 490 – 492.*
13. *McKiernan F, Faciszewski T, Jensen R. Quality of life following vertebroplasty. Journal of bone and joint surgery 2004; 86: 2600 – 2606.*
14. *Deramond H, Depriester C, Galibert P, et al. Percutaneous vertebroplasty with polymethylmethacrylate. Technique, indications, and results, .Radiol Clin North Am 1998; 36: 533-46.*

REVIEW AND CURRENT STATUS OF IMAGE GUIDED INTERVENTIONAL TECHNIQUES IN THE MANAGEMENT OF CHRONIC LOW BACK PAIN

S Chaturvedi*, A Chaturvedi and C Mohan*****

**Consultant, Dept. of Anaesthesiology and Pain Medicine, Command Hospital Air Force, Bangalore 560007, India*
***Consultant, Dept. of Radiodiagnosis, Command Hospital Air Force, Bangalore 560007, India*
****Professor, Dept. of Radiodiagnosis, Army Hospital (Research and Referral) Delhi Cantt, New Delhi 110010, India*

Abstract: *Chronic low backache (LBA) is a ubiquitous malady affecting almost 60-80% of the adult population sometime in their lives and leading to considerable loss of working man-hours and productivity. It is a multifactorial disorder with many possible etiologies and due to the complex structure of the spine, it is often difficult to pinpoint the exact structure causing symptoms. Percutaneous injection techniques have been used to treat back pain for many years but with conflicting and controversial results. An increasing number of patients with lumbo-sacral and sacroiliac pain can be evaluated and treated with interventional procedures including injections of local anesthetics or long-acting steroids into facet joints, sacroiliac joints, selective nerve roots, spondylolytic areas, and the epidural space. Most of these techniques are simple, safe, cost effective and useful in the short and medium term. In recent years there has been an increasing realization by surgeons that not all patients with LBA respond to surgery. In cases with failed back surgery syndrome (FBSS) where outcomes with repeat surgeries are poor and response to conservative management disappointing, Interventional techniques offer a viable alternative treatment option.*

Key Words: Chronic back pain, Interventional technique, Facet joint, Epidural steroid, Epidural adhesionolysis

INTRODUCTION

Low back pain is the most frequent cause of activity limitation in people below the age of 45 years, the fifth most frequent cause for hospitalization, and the third ranking for surgical procedures[1]. Lifetime prevalence of spinal pain has been reported as 65% to 80% [2]. Chronic pain may be variously described as - pain which persists a month beyond the usual course of an acute disease; persistent pain that is not amenable to routine pain control methods; pain that exists beyond an expected time frame for healing and pain where healing may never occur[3].

Interventional techniques in the management of chronic spinal pain in-clude neural blockade and minimally in-vasive surgical procedures ranging from epidural injections, facet joint injections, and neuroablation techniques, to intra-discal thermal therapy, disc decompres-sion, morphine pump implantation, and spinal cord stimulation[4]. Anatomical structures incriminated as possible sources of chronic LBA, includes facet joints, discs, nerve roots and the sacro-iliac joints. Contrary to the commonly held belief, disc herniation contributes to only a small fraction of these. In large studies employing precision diagnostic injections to locate the cause of low back pain, the source of pain was facet joint(s) in as many as 24-40%, disc herniation and nerve root irritation in 13-20%, discogenic pain in 26% and sacroiliac joint pain in 4-6%. In 13-19% patients the cause of pain still remained elusive[3]. In cases of Post laminectomy pain syndrome or Failed Back Surgery syndrome (FBSS), the non-surgical causes outnumber the surgical causes with facetal arthropathy noted in as many as 32% and epidural fibrosis in 45% of cases[5].

Correspondence : Dr. S Chaturvedi, Consultant Anaesthesiology **E mail**: docchats@yahoo.com

PATIENT WORK UP AND SELECTION

The patient should be symptomatic with chronic backache and disability of moderate to-severe degree for at least three months duration that was unresponsive to conservative treatment, including the administration of nonsteroidal anti-inflammatory drugs and rest followed by physical therapy and physiotherapy. It is essential to exclude other causes such as disc herniation, spinal stenosis and nerve entrapment. The procedure is explained to the patient in detail and written consent obtained. Contraindications include allergy to local anaesthetics or steroid, bacteri-al infection, possible pregnancy, bleeding diathesis, and anticoagulant therapy. Pre-cautions are warranted in patients with anti-platelet or anticoagulant therapy and dia-betes mellitus[6].

FACET JOINT INTERVENTIONS

Facet joints are true synovial joints, with a joint space, hyaline cartilage surfaces, a synovial membrane, and a fibrous capsule. Two medial branches of the dorsal rami innervate the facet joints. In recent studies, nociceptive substance P immunoreactive nerve fibers and autonomic nerves have been identified in the lumbar facet joint capsule and synovial folds, which may cause pain under increased or abnormal loads. This may be a consequence of segmental instability, inflammatory synovitis, degenerative arthritis or a combination of these[6].

The features most commonly associated with the syndrome are enumerated in Table 1.

Table 1 : *Features of Facet Syndrome*

Clinical Features of Facet Syndrome
1. Backache and tenderness localized over one or more facet joints
2. Diffuse referred pain over the buttock and sometimes posterolateral thigh
3. Exacerbation of pain with any sustained posture
4. Loss of lumbar lordosis, or paraspinous muscle spasm
5. Exacerbation of pain with hyperextension.

A diagnosis of facet syndrome relies exclusively on the results of radiographically confirmed diagnostic anesthetic blocks [6]. Based on responses to controlled diagnostic blocks of these joints, facet joints have been implicated as responsible for spinal pain in as many as 15 % to 45 % of patients with low back pain[3]. Ghormley described facet joint mediated pain as early as in 1933 and also described the facet syndrome [7]. Since facet joint mediated pain is one of the commonest etiologies of chronic LBA, many techniques have been developed to diagnose and treat it. Described below are the most commonly practiced of these-namely, facet joint injections, facet denervations and injections for spondylolysis.

FACET JOINT INJECTIONS

Facet joint injection with local anesthetic and steroid is the simplest and most common procedure for facet joint mediated pain. These infiltrations are diagnostic as well as therapeutic and performed under CT or fluoroscopic guidance. Levels for injection are selected on the basis of local pain or tenderness and imaging evidence of disease, and occasionally upto three levels injected. Once the facet joint appears in profile as two parallel lines on fluoroscopy, with least obliquity, this point is marked on the skin. After cleaning and draping and local anesthesia, a 22 G spinal needle is inserted in line with the X-ray beam till it contacts bone at the lip of the facet joint. With fine movements the needle tip pops into the joint with a distinct 'give' [Fig 1]. Once the needle is in place, 1 – 1.5 ml of a mixture of 20 mg of Depomedrol and 0.25% bupivacaine is injected into each joint. The lumbar facet joint typically has a volume of 0.8 to 1.2 ml and care is taken not to inject a larger volume. CT guidance is useful in patients with large osteophytes that block access to the joint or in whom the fluoroscopic procedure fails particularly at the more oblique L5 – S1 joint (Fig.2). More recent trials have documented encouraging reports of short term and limited evidence of long-term (3–6 months) pain relief [8].

FACET DENERVATION

Denervation of the facet joint for facetal pain is achieved by denervation of the medial branch of the dorsal ramus by 95% ethanol or radio frequency (RF) ablation. Since the facet

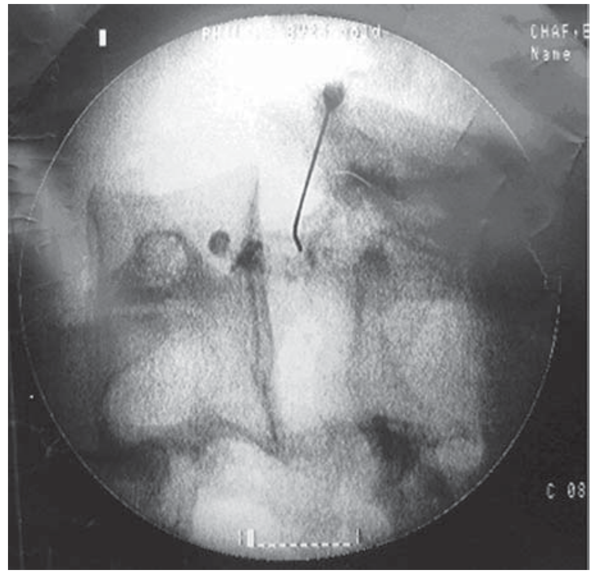


Fig 1: *Fluoroscopic guided facet joint injection with intra articular position of needle*

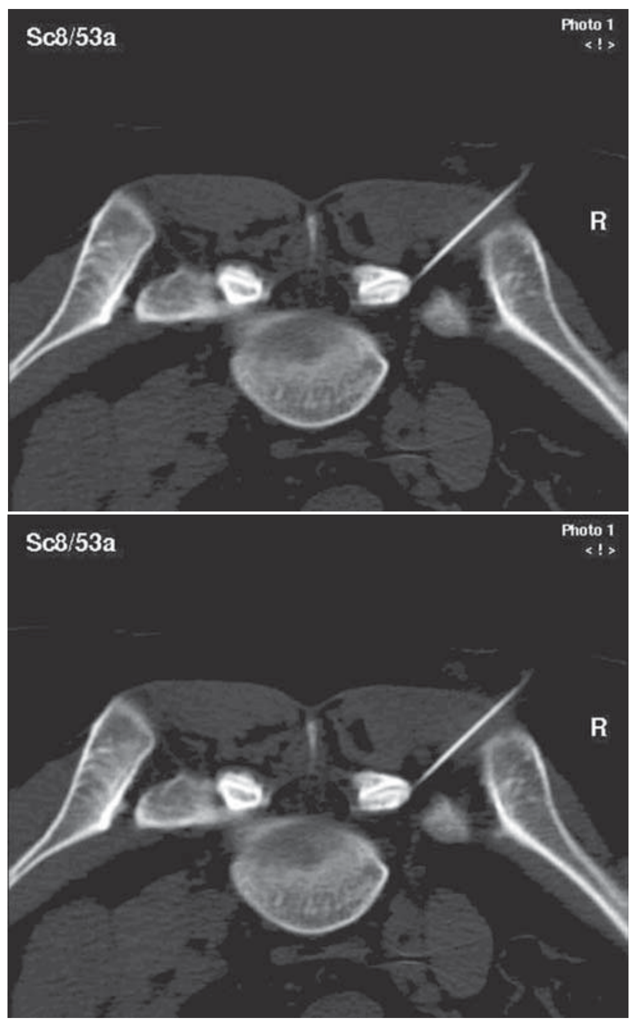


Fig 2: CT guided facet injection demonstrating needle positioned in right L5-S1 facet joint.

joint is supplied by medial branch nerve exiting at the level of the facet joint as well as at the next higher level, denervating a facet joint requires to be done at two levels [8]. The procedure may be performed with CT or fluoroscopic guidance. The patient is prepared and positioned in a similar manner as for facet injections. A 22–gauge spinal needle or RF needle is advanced in a gun barrel fashion towards the transverse processes (eye of the "Scottie dog") above and below the target facet joint(Fig.3). Once the position is confirmed, 1 ml of nonionic contrast material is injected followed by injection of 1.5 ml of 95% ethanol at each level. [9]. The proponents of ethanol and RF ablation have demonstrated similar results – excellent pain relief in the immediate period and moderate (50-60%) relief in the long term[10]. Choice of the modality will largely depend on availability and preference of the operator. According to the current guidelines formulated by Boswell et al, the evidence for facet denervation by medial branch neurotomy is moderate to strong for short-term and long-term relief of lumbar facet joint pain[11].

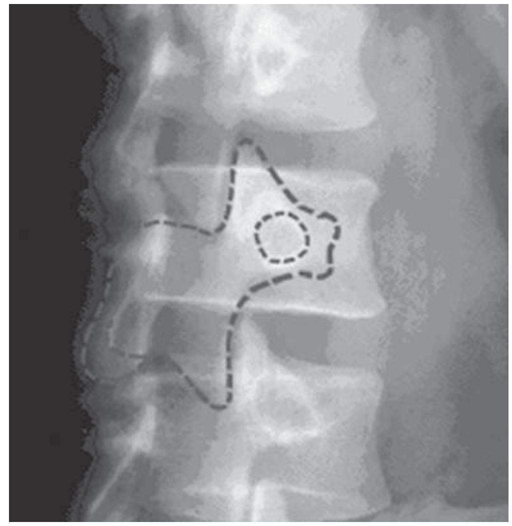


Fig 3: *"Scottie Dog appearance" on Oblique radiograph with the facet joint seen behind the ear and the eye shows the area where the medial branch nerve is targeted.*

INJECTION FOR SPONDYLOLYSIS

Image guided infiltration at the level of spondylolysis is carried out for otherwise unexplained local pain at that level, either at fracture site at pars inter-articularis break or at adjacent facet joint. CT guidance is preferred because the pars defects are easily identified at CT [Fig 4]. The procedure is similar to a CT-guided facet joint injection and using a 22-gauge spinal needle a combination of a local anesthetic and steroid - 1 ml of Bupivacaine 0.25 % and 20 mg of Depomedrol are injected on each side. Complications due to facet joint infiltrations or denervation are related to needle placement and drug administration. These include dural puncture, spinal cord trauma, infection, intravascular in-jection, spinal anesthesia, chemical men-ingitis, neural trauma and hematoma formation. Facet capsule rupture may occur if large volumes of injectate are used for intraarticular in-jections.

Fig 4 : *CT guided infiltration of right L5-S1 spondylolytic site*

EPIDURAL STEROID INJECTIONS

Epidural injection of corticosteroids is one of the most commonly used interven-tions in managing chronic spinal pain and anesthesiologists have for long performed blind epidural injections. Fluoroscopic guidance aids the diagnosis and confirms spread as prior epidurography is performed with non-ionic contrast media. Epidural steroids have been widely used for a number of indications ranging from local pain or radiculopathy in the setting of documented disk herniation, central or foraminal stenosis, and in FBSS with epidural adhesions. Various combinations of saline solution, local anesthetics, and steroids have been injected and relief of pain is variously attributed to lysis of adhesions, change in relationship between the disk and the nerve root and reduction of inflammation and swelling.

CAUDAL EPIDURAL INJECTIONS

Fluoroscopic guided caudal epidural entry is relatively easily achieved with minimal risk of inadvertent dural puncture. Keeping the needle below the S 2-3 disk space minimizes the risk of dural puncture and it is helpful to keep the needle as horizontal as possible. An epidurogram is performed by at this stage by injecting 8 - 10 ml of non-ionic contrast (Onmipaque) diluted to 50 %. Postero-anterior fluoroscopy is performed at this stage to outline epidural anatomy of nerve roots, fat and adhesions [Fig 5]. Disadvantages of the caudal ap-proach include: requirement of substan-tial volume of fluid, dilution of the injec-tate, extra-epidural placement of the nee-dle, and increased risk for intravascular placement of the needle. Large randomized trials have concluded that their effectiveness in managing lumbar radiculopathy is strong for short-term relief and moderate for long term relief. The evidence in post lumbar laminectomy syndrome was however limited[11,5].

INTERLAMINAR EPIDURAL INJECTIONS

This is a refinement of the epidural approach where the entry is more close to the assumed site of pathology. This method requires less volume than the caudal route and therefore can be used in cases where one or two segments are involved (Fig 6). For a dorsal interlaminar approach, the patient is placed in the prone position with a pillow under the abdomen. An antero-posterior view is obtained fluoroscopically and

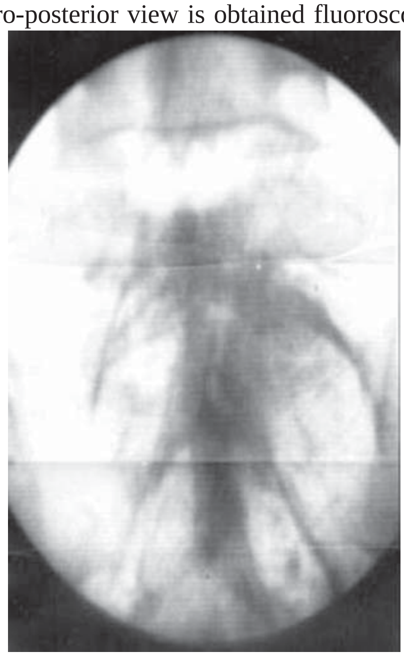


***Fig 5 (a)**: Normal Epidurography showing X-mas tree appearance.*

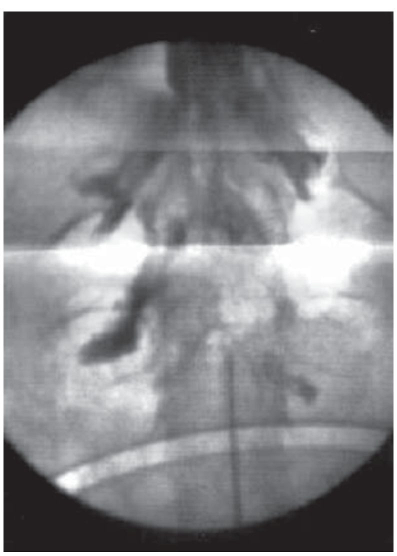


***Fig 5 (b)**: Epidurography showing epidural fibrosis on the left. Note needle through sacral hiatus*

an 18-gauge epidural needle with an air filled syringe attached is advanced to the posterior margin of the spinal canal. Epidurography is performed with 8 - 10 ml of nonionic myelography approved iodinated contrast material followed by 80 mg of Depomedrol and 10 -15 ml of saline. There are various pitfalls with the interlaminar approach and this technique is not as operator friendly as a caudal epidural. Dilution of the injectate, preferential cranial and posterior flow of the solution, extra-epidural and intravascular place-ment of needle, dural puncture and trauma to spinal cord are few of them[13].

TRANSFORAMINAL EPIDURAL INJECTIONS / SELECTIVE NERVE ROOT BLOCKS

Ttrans-foraminal approach is target specific and aims at reaching the primary site of pathology with smallest volume - ventrolateral epidural space around the dorsal nerve roots. The aim of selective nerve root blocks (SNRB) technique is to attempt to anesthetize the desired nerve for diagnostic as well as therapeutic purposes. Selective nerve root blocks are used primarily in the following subsets of patients with radiculopathy:

a) In post discectomy patients with recurrent radiculopathy but no recurrent disk herniation.
b) Patients with disk herniations not willing for surgery.
c) Nerve root blocks can help patients with symptoms related to a nerve root but who have no definite radiologic diagnosis explaining the symptoms.
d) In patients with uncertain pain etiology, SNRB is an effective and accurate means of determining if a certain nerve root is the source of the symptoms.

A 22-gauge spinal needle is advanced under the pedicle with the patient in position. Bending the distal 5 mm of the needle by 10 – 15 ^{0} aids in positioning into the neural foramen (Fig 7). 1 % Lignocaine (for a diagnostic block) or 1 - 2 ml of an appropriate steroid mixed with a small amount (0.5 ml) of

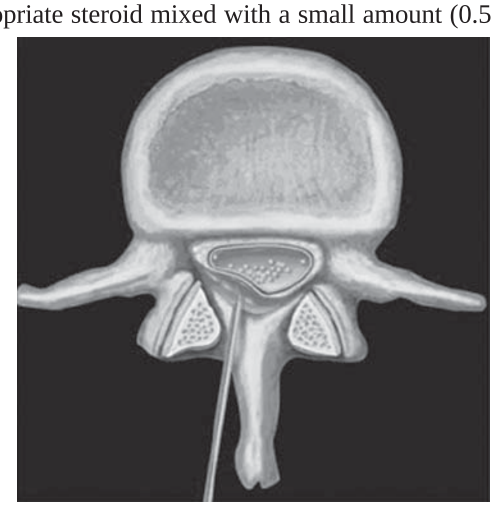


***Fig 6:** Diagrammatic representation of trans-laminar epidural injection. (Image source- www.amirsys.com/tour_pr/PR_Interventional_Sample.pdf accessed on 15/5/06)*

bupivacaine (for a therapeutic block) is then slowly injected. A number of trials have demonstrated the efficacy of selective nerve root blocks with most studies reporting an average time of pain relief as 1-3 months. Maximum benefit was found in patients with foraminal stenosis, as compared with those who had disk herniations. Complications due to epidural injections are rare and include dural puncture, infection, hematoma formation, abscess formation, subdural injection, intracranial air injection, epidural lipomatosis, nerve damage, headache, intravascular injection, cerebral vascular or pulmonary embolus and effects of steroids. Spinal cord trauma and spinal cord or epidural hematoma formation and cord infarction are potentially catastrophic complications [12,13,14].

EPIDURAL ADHESIONOLYSIS

Percutaneous epidural adhesionolysis is a refinement of the epidural technique, which allows a targeted delivery of steroids and hyaluronidase in an attempt to lyse epidural adhesions and fibrosis - which are the commonest cause of FBSS. Because scar formation is often uneven, multiple passes are often required to access the scarred areas. Targeted installation of hyaluronidase and steroids in 20-30 ml of saline are instilled to achieve volumetric adhesionolysis. All the prospective studies done so far to evaluate the effectiveness of spinal endoscopic adhesionolysis in lumbar spinal stenosis have reported good short-term and long-term improvement in low back pain but with limited success with leg pain[4,15]. Complications with adhesionolysis are catheter shearing, dural puncture and hematoma. High volumes of fluid may lead to excessive epidural hydrostatic pressures. This may cause spinal cord compression, excessive intraspinal and intracranial pressures[14].

SACROILIAC JOINT INTERVENTIONS

The sacroiliac joint is a diarthrodial joint with a joint capsule and synovial fluid. The sacral side of the joint is lined with the hyaline cartilage and the iliac side with fibrocartilage and receives innervation from the lumbosacral nerve roots. Common causes of SI joint pain are seronegative spondyloarthopathies and mechanical causes due to prolonged loading or leg asymmetry. On the basis of precision diagnostic blocks, the prevalence of SI joint pain is estimated between 6 – 10 %. Sacroiliac joint pain can be managed by intraarticular injections or neurolysis of the sacroiliac joint under fluoroscopic or CT guidance with good results[16].

SI JOINT INJECTIONS

After confirming needle position, injection of 2 – 3 ml of solution of steroid and local anesthetic is carried out. With CT guidance in the patient prone position, the middle and inferior third of the joint are easily accessible with a dorsal, angulated approach (Fig 8). Evidence for intraarticular sacroiliac joint injections is moderate for short-term relief and limited for long-term relief. Apart from those complications inherent with all these interventions, a potential complication of trauma to the sciatic nerve is to be guarded against.

RADIOFREQUENCY NEUROTOMY OF SI JOINTS

Theoretically RF ablation of the SI joint should have a longer lasting effect than joint injections. Small retrospective studies have reported 50 – 60 % long-term pain relief (6-9 months) but these are small studies and no definite conclusions can be derived through them at this stage[17].

DRUGS, DOSAGE AND FREQUENCY OF INTERVENTIONS

There is little consensus with regards to type, dosage, frequency and total number of injections or other interventions. Most of the commonly used formulations of long-acting steroids including methylprednisolone (Depo Medrol®), triamcinolone diacetate (Aristocort®), triamcinolone acetonide (Kenalog®), and betamethasone acetate and phosphate mixture (Celestone Soluspan ®), appear to be safe and effective. Betamethasone may be the best choice in avoiding side effects if interventions are repeated within two weeks. However; if interventions are carried out at six-week intervals or longer, any one of the

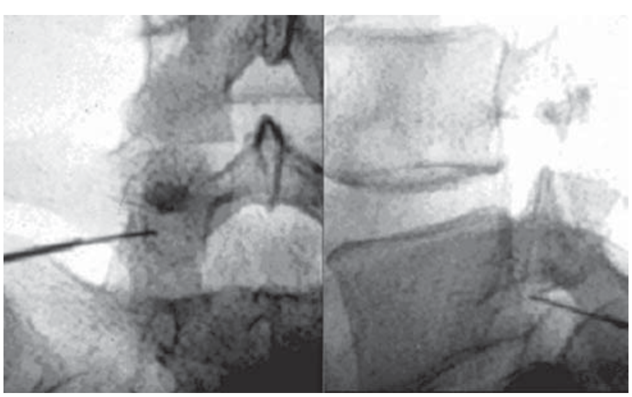


Fig 7: *Selective nerve root block with needle tip just below the pedicle.*

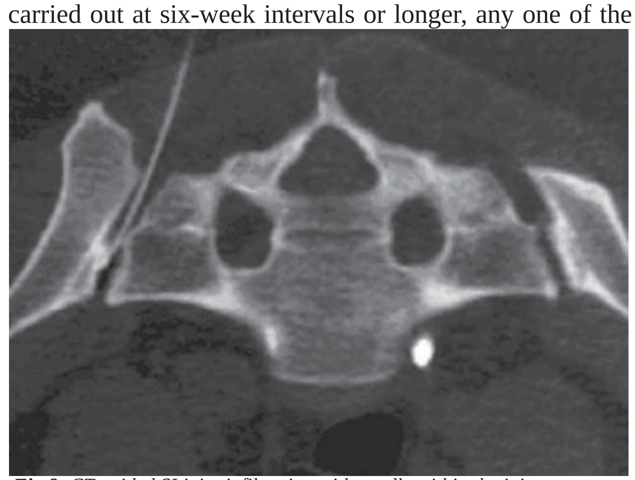


Fig 8: *CT guided SI joint infiltration with needle within the joint space.*

four formulations will be safe and effective[11].

CONCLUSION

Chronic back pain is a leading cause of morbidity in society. With better understanding of the anatomy and pathophysiology of back pain, it is now possible to deliver concentrated, guided boluses of therapeutic agents and neuro ablative procedures while minimizing systemic side effects. Most of these procedures can be performed in an out patient setting. Early interventions can minimize development of neuropathic pain and its chronicity. Many of these interventional procedures are not curative and should not modalities to be used in isolation but form a valuable component in the armamentarium of a pain clinic along with pharmacotherapy, physiotherapy, psychotherapy and rehabilitation.

Based on responses to controlled diagnostic blocks of these joints, facet joints have been implicated as responsible for spinal pain in as many as 15 % to 45 % of patients with low back pain[5]. Ghormley described facet joint mediated pain as early as in 1933 and also described the facet syndrome [7]. Since facet joint mediated pain is one of the commonest etiologies of chronic LBA, many techniques have been developed to diagnose and treat it. Described below are the most commonly practiced of these-namely, facet joint injections, facet denervations and injections for spondylolysis.

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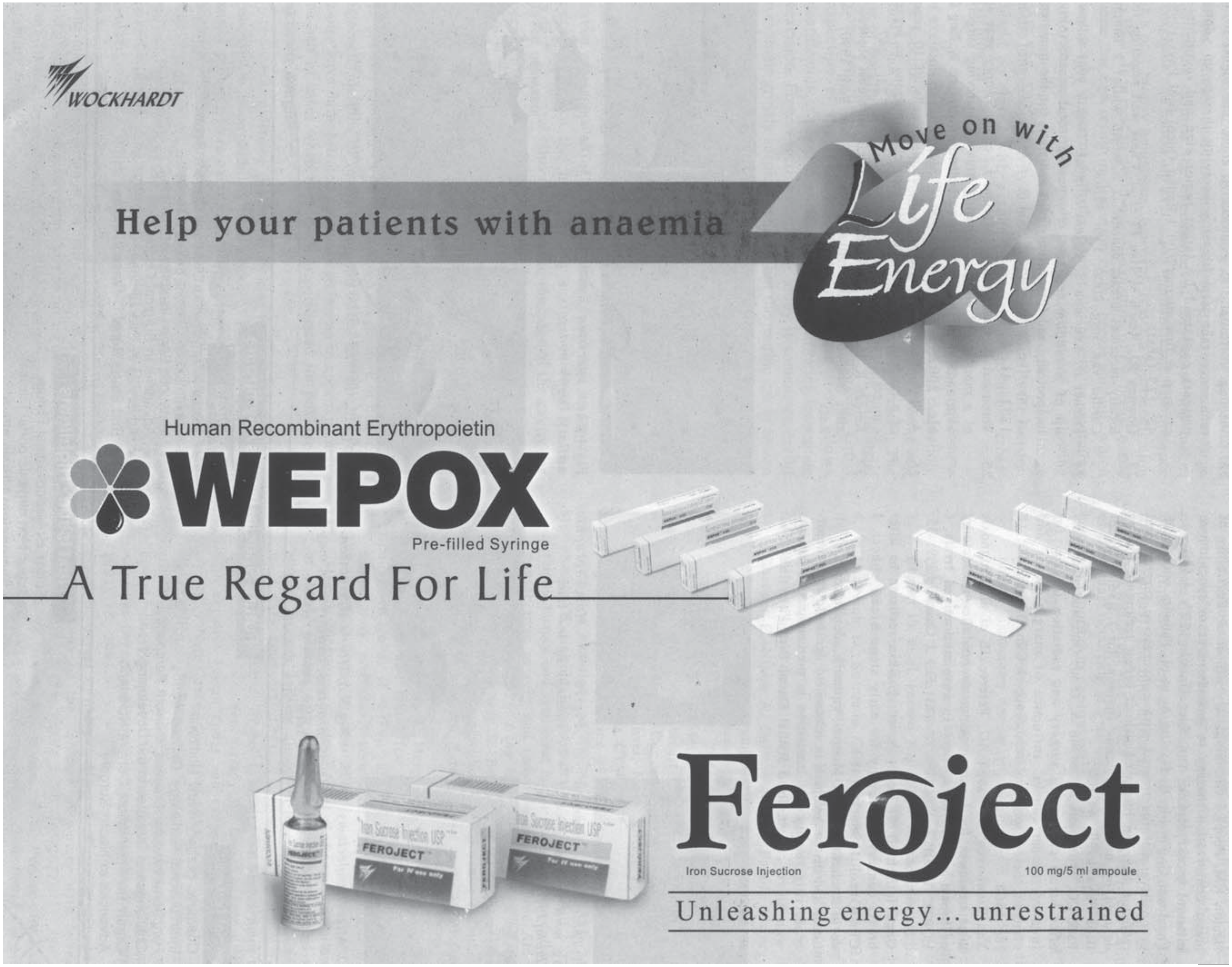
REFERENCES

1. *Wall PD, Melzack R. Textbook of Pain, 3rd ed. Churchill Livingstone, New York. 1994; pp.441- 442.*
2. *Luo X, Pietrobon R, Sun SX, Liu GG, Hey L. Estimates and patterns of direct health care expenditures among individuals with back pain in the United States. Spine 2004; 29:79-86.*
3. *Manchikanti L, Singh V, Saini B. Epidemiology of low back pain. In Manchikanti L, Slipman CW, Fellows B (eds), Interventional Pain Management: Low Back Pain – Diagnosis and Treatment. ASIPP Publishing, Paducah, KY. 2002; pp 3-20.*
4. *Manchikanti L, et al. Evidence-based practice guidelines for interventional techniques in the management of chronic spinal pain. Pain Physician 2003; 6:3- 4.*
5. *Manchikanti L, Rivera JJ, Pampati V, Damron KS, Beyer CD, Brandon DE, Wilson SR. Spinal endoscopic adhesionolysis in the management of chronic low back pain: A preliminary report of a randomized, double- blind trial. Pain Physician 2003; 6: 259-268.*
6. *Boswell MV, Shah RV, Everett CR, Sehgal N, Mckenzie-Brown AM, et al. Interventional Techniques in The Management of Chronic Spinal Pain: Evidence-Based Practice Guidelines Pain Physician. 2005; 8: 1- 47.*
7. *Ghormley RK. Low back pain with special reference to the articular facets, with presentation of an operative procedure. JAMA. 1933; 101:1773-7.*
8. *Gilula LA, Lander P. Management of Spinal Pain with Imaging-guided Injection. Radiographics 2003; 23:189-191.*
9. *Prithviraj P et al. Radiographic Imaging for Regional Anesthesia and Pain Management. Churchill-Livingstone, Philadelphia. 2003. pp 189-191.*
10. *Niemisto L, Kalso E, Malmivaara A, Seitsalo S, Hurri H; Cochrane Collaboration Back Review Group.. Radiofrequency denervation for neck and back pain: a systematic review within the framework of the Cochrane collaboration back review group. Spine 2003, 28:1877-1888.*
11. *Boswell M, Hansen H, Trescot A, Hirsch, J. Epidural steroids in the management of chronic spinal pain and radiculopathy. Pain Physician 2003; 6:319-334.*
12. *Windsor RE, Storm S, Sugar R. Prevention and management of complications resulting from common spinal injections. Pain Physician 2003; 6:473-484.*
13. *Schultz D. Risk of transforaminal epidural injections. Pain Physician 2004; 7:289 – 290.*
14. *Helm S, Jasper J, Racz G. Complications of transforaminal epidural injections. Pain Physician 2003; 6: 389 – 390.*
15. *Geurts JW, Kallewaard JW, Richardson J, Groen. Targeted methylprednisolone acetate/hyaluronidase/clonidine injection after diagnostic epiduroscopy for chronic sciatica: a prospective, 1-year follow- up study. Reg Anesth Pain Med 2002; 27:343-352.*
16. *McKenzie-Brown A, Shah RV, Sehgal N, Everett CR. A systematic review of sacro-iliac joint interventions. Pain Physician 2005; 8:115-125.*
17. *Gevargez A, Groenemeyer D, Schirp S, Braun M. CT-guided percutaneous radiofrequency denervation of the sacroiliac joint. Eur Radiol 2002; 12:1260-1365.*



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