

# Heavy Particle Beams and Their Clinical Application

YODHVIR SINGH NAGAR, TEJINDER KATARIA

*Department of Radiation Oncology, Rajiv Gandhi Cancer Institute and Research Centre, Rohini, New Delhi, (India)*

**Abstract:** The heavy particle beam therapies deployed in radiotherapy have physical and radiobiological characteristics which differ from those of conventional photon beams and which offer a number of theoretical advantages over photon beams. This review briefly describes the properties and indications for heavy particle beam therapy and analyses various clinical studies conducted in this field. The analysis indicates that for select tumours (uveal melanomas and base skull/spinal chordomas and chondrosarcomas) heavy particle beam produces greater loco-regional control and disease free survival. The clinical gains in other tumours in terms of probability of higher tumour control, survivals and/or the reduced probability of normal tissue complications are however, not completely known. There is a considerable way to go yet, before any definite conclusions on the scope of heavy particle beam therapy can be arrived at.

**Key words :** *Neutrons, Protons, Heavy Particles, Bragg-Peak.*

## Introduction

Radiation oncology has been driven till now by technological innovations for scientific disciplines more than any other medical specialty. The innovation of particle beam radiotherapy is a good example of this rule with work initially performed using particle accelerators built for physics research purposes. The first clinical use of particle radiotherapy with neutrons was by R. Stone and J. Lawrence in late 1930s<sup>1</sup>. Studies of fractionated particle therapy in cancer were initiated using cyclotron produced fast neutrons at the Lawrence Berkeley Laboratory (LBL) in 1970s. Later synchrotrons were developed to generate higher energy charged particles. The particle beams of main interest are neutrons, protons, negative pi mesons and ions (helium, neon, carbon, silicon).

Two main factors motivated the work in particle radiotherapy. One is better depth dose distribution and lateral localization of the radiation dose, which allows a better expression of conformal radiotherapy, the second is presumably more favorable radiobiological properties of high linear energy transfer (LET) radiation. Linear energy transfer is the energy transferred per unit length of track of radiation. High-LET radiation offers the following advantages: (1) it is better able to kill hypoxic cells because it is less dependent on "indirect" (free radical mediated) form of cell killing; (2) cells are less able to repair damage induced by high-linear energy transfer radiation; (3) there is less variation in radiosensitivity across the cell cycle, and thus the therapeutic effect of high-LET radiation is not dependent on cells redistributing themselves in more sensitive phases of cell cycle during the course of therapy<sup>2</sup>. The majority of studies done with high-LET radiation have been performed with fast neutrons, which test the potential radiobiological advantages. Heavy charged particles like silicon, argon or neon nuclei offer both the radiobiological properties of high-LET radiation and the conformal, dose localization characteristics of proton and  $\alpha$ -particle beams. However, owing to the expenses and complexities involved in producing the heavy charged particles therapy beams, clinical studies have been fairly limited. Pi-Meson beams are "hybrid" in that during their entry into tissues they behave as low-LET type radiation, while at the end of their track they are captured by a

nucleus, causing a fragmentation event that consists of mainly high-LET particles.

All charged particles have the physical dose planning advantage and unique properties of minimal scatter as the particulate beams pass through the tissue, and deposition of the ionizing energy at a precise depth (i.e., the Bragg Peak) depending on their energy and mass. Tissues deeper to the tumour can be spared in contrast to the x-ray/telecobalt (photons) beams which are gradually attenuated and always deliver some radiation dose to the tissues beyond the tumour. The theoretical *advantages* provided by particle beams can be exploited for clinical gains when the following conditions apply:

1. Conventional treatment modalities do not provide adequate local tumour control.
2. The likelihood of metastasis prior to radiotherapy is small to nonexistent.
3. There is evidence that local tumour response depends on the dose of radiation delivered.
4. Delivery of an adequate radiation dose to the tumor is limited by the proximity of vital radiosensitive tissues or structures.

An effort has been made here to briefly summarize the various particle beams and their application in treatment of cancer.

## Neutron Beam Radiotherapy

There are two kinds of neutron beams, slow and fast neutrons. Neutrons are neutral and do not carry any charge on them. Fast neutron beams are generated by cyclotrons, usually of 40-70million electron volts energy so as to give at least as good tissue penetration as cobalt or 4-6million volts photon beams. Protons are accelerated to a beryllium target, resulting in a forward-transmitted neutron beam, (Fig-1) which is attenuated exponentially in tissues like the x-rays because neutrons like photons are uncharged. The use of neutrons following World War II was based squarely on the premise that the presence of hypoxic cells limits the curability of human tumours by x-ray therapy. A lower oxygen enhancement ratio of neutrons was thought to be beneficial for tumour control. However, at a later date, it was theorized that the potential advantages of neutrons are purely radiobiological: Cells which are radioresistant due to very slow proliferation (long G1 phase) are

less radioresistant to neutrons than to photons, to the fact that neutrons are high-LET radiation and thus have high relative biological effectiveness (RBE) of 2-3. An RBE of 2 means that a given dose of high-LET radiation is twice as damaging as the same physical dose of photons. The disadvantage of neutrons causing a relatively high proportion of late complications for given tumour effect can be overcome by restriction of the total dose or by giving total dose in shorter overall treatment times, such as in 4 weeks instead of 6-7 weeks.

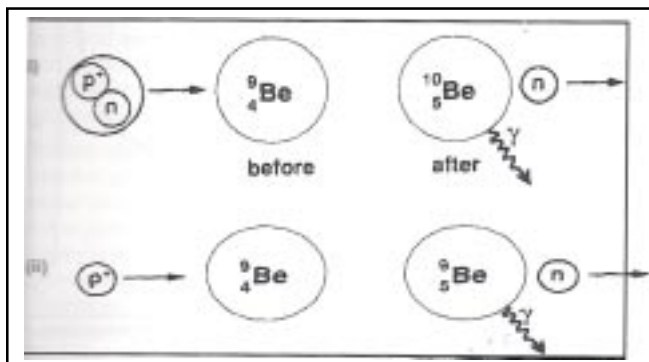


Fig.1: (i) The  $d^+$  - Be stripping process. Deuterons are accelerated to high energy in the cyclotron and are then made to impinge on a beryllium target. When incident on the target, the proton is "stripped" from the deuteron, leaving a neutron that retains part of the energy, on atom of beryllium is converted to boron. (ii) The  $p^+$  - Be process. Protons are accelerated to high energy in a cyclotron and made to impinge on a target of beryllium where they "knock out" neutrons.

**Early Trials :** Stone and co-workers<sup>1</sup> first tested fast neutron therapy clinically between 1938 and 1941 at Lawrence Berkeley Laboratory, California. About 240 patients, mostly with locally advanced tumours were selected for treatment. They reported that many advanced cancers had been successfully treated; especially cancers of salivary gland, prostate and secondary neck nodes, but late normal tissue complications were severe and common.

A re-evaluation of fast neutron therapy began in 1965 at Hammersmith Hospital, London where the first Medical Research Council (MRC) cyclotron unit was built. A prospective randomized clinical trial to compare neutrons with x-rays was started in 1971. Advanced head and neck cancers were treated because the available neutron beam could penetrate relatively superficial depths. The trial involved patients with tumours of the salivary glands, buccal mucosa, hypopharynx and larynx. The neutron treatments were delivered in only 12 fractions and were clearly superior to photons as judged by local control although there were higher complication rates<sup>3</sup>. In the following 30 years, about 30,000 patients have been treated with fast neutrons and only about 1000 of these have been recruited to randomized clinical trials.

The assessment of neutron beam therapy has also been difficult due to physical and technical limitations of the neutron generators used in early clinical trials. These limitations have included the unreliable performance or irregular availability of machines, poor penetrating power of neutron beams, low dose rates, fixed treatment heads and inadequate range of available field sizes. Another difficulty in evaluation of neutron therapy has been the different fractionation regimes used in the randomized treatment groups.

## Clinical evaluation

**Head and neck cancers :** The study of neutron beam therapy has been mostly in head and neck cancers. There have been eight randomized

trials of head and neck cancers. Five trials have compared neutrons alone with standard photon irradiation<sup>3,6,7,8</sup> while three have compared a combination of photon and neutron regimen with photons alone<sup>4,5,9</sup>. In none of the eight randomized trials have neutrons been demonstrated to be superior to photons when the balance of local tumour control rates and incidence of late complications are taken into account. Megavoltage therapy is more efficacious than neutrons in the management of squamous cell carcinomas of head and neck.

**Non-small cell lung cancer (NSCLC) :** The results of first randomized trial of neutrons in patients of non-small cell lung cancer (NSCLC) were reported from Berlin-Buch in 1982<sup>10</sup>. In this study a total of 201 patients were randomized to receive either photons alone or a combination of photons and neutrons. The local control was significantly higher in the combined group (39%) than in the photon alone group (20%). No data were reported on the radiation morbidity rate. However, the mortality was significantly higher in the neutron treated group than in the photon treated group. Subsequently, two randomized trials compared neutron beam therapy alone with photon therapy alone in inoperable NSCLC. None of these two trials reported any advantage of neutrons in terms of local tumour control rate and survival rate over photons. Another randomized trial by radiation therapy oncology group on inoperable NSCLC cancer compared neutron therapy alone, combined neutrons and photons, and standard photon irradiation alone. In the final analysis of 102/113 patients the local tumour control rates were higher in patients treated with photons alone (44%) than in groups treated with neutrons (27%). The serious radiation related morbidity was significantly higher in the groups treated with neutrons (24%) than in the group treated with photons (5%). There was no difference in the survival rates in the three treatment groups.

The evidence from all these trials indicates that neutrons offer no significant advantage compared with photons in treating advanced inoperable lung cancers.

**Prostate cancer :** Two randomized trials of neutron therapy have been reported for inoperable prostate cancer. The first trial of radiation therapy oncology group 77-04<sup>11</sup> compared a combined schedule of neutrons plus photons (2 fractions neutrons and 3 fractions photons per week) with photons alone. Both regimens were given in 35 fractions over 7 weeks. Fifty-five patients were allocated in the combined group and 36 in the photon alone group. The overall survival (46% versus 29%) and cause specific survival rates (55% versus 43%) were significantly higher in the neutron treated group. The serious late radiation morbidity was similar in both the groups (13%).

The second trial by Russell et al<sup>12</sup> compared neutron therapy alone with standard photon therapy in 178 patients of inoperable prostate cancer. Neutron therapy was delivered in 12 fractions over 4 weeks (20.4 Gy) and photons in 35 fractions over 7 weeks (70Gy). The actuarial loco-regional control rates were 89% in neutron group and 68% in the photon group ( $p=0.01$ ). The serious late radiation complications were significantly higher in the neutron treated group (24%) than in the photon group (8%). However, the overall and cause-specific mortality rates and distant failure rates were similar in the two groups. Improved loco-regional control and lack of serious treatment morbidity with use of multileaf collimator argues that fast neutron beam therapy is an acceptable form of treatment for prostate cancers. However, the superiority of fast neutrons alone in treating

inoperable prostate cancer still remains to be proven.

**Bone and soft tissue sarcomas, malignant melanomas :** No randomized clinical trials comparing neutrons and photons have been conducted so far for these tumours. However, these tumours are generally thought to be radioresistant and have many characteristics as being favorable for response to neutron radiotherapy. The comparative local control rates with neutron irradiation versus photon irradiation in patients with inoperable gross disease were 53% versus 38% for soft tissue sarcomas, 55% versus 21% for osteogenic sarcomas and 49% versus 33% for chondrosarcomas. Complication rates ranged between 7% and 29%<sup>13</sup>. At present it appears that a surgically based treatment regimen using adjuvant photon irradiation is the best approach to management of sarcomas, but neutron radiotherapy appears to be more effective than photon irradiation alone for those tumours in which a surgical resection is not an option.

### Proton or Helium Ion Radiotherapy

Protons are of increasing interest in radiotherapy because of their advantage of good physical dose distribution and because the machines to accelerate them are smaller and cheaper than for the heavier nuclear particles. In the entrance plateau the average LET is about 0.5 KeV/mm rising to a theoretical maximum of 100 KeV/mm over a track. The dose deposited by a beam of monoenergetic protons increases slowly with depth but reaches a sharp maximum near the end of the particle's range in the Bragg peak (Fig.2). The beam has sharp edges, with little side scatter and the dose falls to zero after the Bragg peak, at the end of the particles range. The possibility of precisely confining the high-dose region to the tumour volume while minimizing the dose to surrounding normal tissues is the biggest advantage and attraction to the radiation oncologist.

The way in which the narrow Bragg peak can be spread out to encompass a tumour of realistic size is illustrated in fig. 3. In this figure curve-A shows the narrow Bragg peak of the primary beam of 160-MeV proton beam at Harvard cyclotron. Beams of lower intensity and shorter range, shown in curves B,C,D and E are obtained by passing through a rotating wheel with plastic sectors of varying thickness (filter). The composite curve S, which is the scan of individual peaks, results in a uniform dose over 2.8 cm. This figure shows the depth-dose curve for the 187-MeV proton beam from the synchrocyclotron from Uppsala, Sweden. The dose falls off laterally from 90 percent to 20 percent within a few millimeters.

The first clinical trials began in 1954 at Lawrence Berkeley Laboratory (LBL) where 30 patients were treated through 1957. In 1957 the LBL cyclotron was modified to produce a beam of helium ions, and 2054 patients were treated through 1991. The number of patients treated with proton beams exceeds 8500 in Boston (United States), 3000 in Moscow, and 5000 in Loma Linda, California (United States). Presently there are about 25 proton facilities operating throughout the world.

The use of proton or helium ion radiation therapy has been investigated in the following general categories of tumors/abnormalities :

1. Tumors located next to vital structures, such as *intracranial lesions* or lesions along the axial skeleton such that complete surgical excision or adequate doses of conventional radiation therapy are impossible. These tumors/lesions include uveal melanomas, chordomas, and chondrosarcomas at the base of the skull and along the

axial skeleton.

2. Primary therapy for *melanoma of the uveal tract* (iris, choroid, or ciliary body), with no evidence of metastasis or extrascleral extension, and with tumors up to 24mm in largest diameter and 14mm in height.

3. Tumors that are associated with a *high rate of local recurrence* despite maximal doses of conventional radiation therapy. The most common tumor in this group is advanced prostate cancer (i.e., T3 or

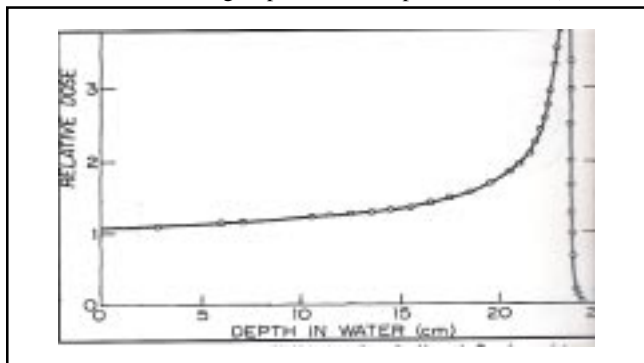


Fig.2: Depth-dose curve for 187-MeV protons from the Uppsala Synchrocyclotron. The dose reaches a sharp peak at a depth of about 23cm.

T4) without distant metastases. These patients are generally not candidates for surgical resection, however the 5- and 10 year local recurrence rate associated with conventional radiation are estimated at 24%-28% and 39%-42%, respectively.

### Clinical evaluation

*Uveal melanoma :* The treatment of this tumour by protons or helium is now routinely used around the world, and is considered as treatment

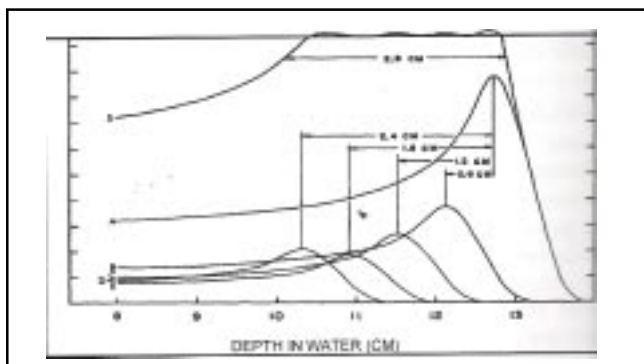


Fig.3: The way in which the Bragg peak for a proton beam can be spread out. Curve A is the depth-dose distribution for the primary beam of 160-MeV protons at the Harvard cyclotron, which has a half-width of only 0.6cm. Beams of lower intensity and shorter range, as illustrated by curves B,C,D, and E, can be added to give a composite curve S, which results in a uniform dose over 2.8 cm. The broadening of the peak is achieved by passing the beam through a rotating wheel with sectors of varying thickness.

of choice for many patients as an alternative to brachytherapy for small tumours located close to the optic disc or the macula and as an alternative to enucleation for large tumours. The rationale for preferring proton therapy to brachytherapy is that normal ocular structures receive the same dose as the tumour apex due to a homogenous dose distribution. With brachytherapy, however the structures located at the tumour base receive several times the dose delivered to the tumour apex. Also in proton therapy there is no exposure to the surgeon's hands as happens during fixation of episcleral plaques especially gamma rays emitting <sup>60</sup>Co applications. Patients are treated by focusing a pencil beam of radiation on to the precisely localized tumours by means of stereotactic beam direction techniques providing adequate local control while still preserving vision. Treatment is usually given in a smaller number of fractions (about 5) over 8 to 10 days. In a recent review<sup>14</sup> 5 years

tumour control rate was 99% and a strong correlation was seen between local control rate and survival. Tumour related mortality was 27% for patients with locally controlled tumours and 53% for those with recurrent tumours.

**Chordomas and chondrosarcoms** : The available evidence suggests that proton or helium ion beams irradiation is superior to, conventional radiation or resection, as treatment for chordomas or chondrosarcomas of the skull base or cervical spine. High local control rates (70%) have been observed<sup>15</sup>. These excellent results have been obtained in treating carefully selected tumours, which have allowed complete sparing of the critical normal tissues. They therefore should be compared directly with historical series of photon therapy which often will have included large lesions for which the dose prescribed may have been greatly compromised by radiation tolerance of the central nervous system.

**Prostate cancer** : It is suggested, with some confidence, that the local control of prostate cancer may be greatly increased, without increasing normal tissue morbidity, by delivering higher doses of charged particles such as protons and helium ions to a well-circumscribed tumour volume. Shipley et al.<sup>16</sup> have reported the results of one randomized trial of high dose radiotherapy using a proton therapy boost compared with conventional dose irradiation with mega-voltage photons. Two hundred two patients with locally advanced prostate cancer were recruited to this study. Patients first received 50.4 Gy photon therapy to the whole pelvis. They were then randomized to have either additional standard photon treatment of 16.8Gy or conformal proton therapy to a dose of 25.2 Gy (an increase of 12.5%). The local tumour control rates at 5 years were similar (about 86%) in the two treatment groups. However, the serious, late radiation-related complications were significantly higher in the group of patients who were given the high dose conformal proton therapy. In this study no significant differences were observed in overall or cause specific survival rates.

In 2000 Schulte and colleagues published 39 month outcomes in 911 patients with limited stage prostate cancer treated at Loma Linda University Medical Center<sup>17</sup>. Patients were treated with either protons alone or proton boost following standard external beam radiation therapy. The estimated 5-year outcomes of no biochemical evidence of disease were 82%. Actual long-term outcomes and survival are not included in the published report. In addition, new sophisticated treatment planning techniques referred to as conformal therapy and intensity modulated radiation therapy (IMRT), have permitted dose escalation of conventional radiation therapy to 80Gy, a dose higher than that achieved with proton therapy in the above study. There are currently no controlled clinical trials that have compared the outcomes of conformal photon beam therapy with that of proton beam radiotherapy.

## Heavy Ion Beams

Heavy ions (heavier than protons) include helium, carbon, silicon, neon and argon beams. In comparison to photons, heavy charged particles such as protons or carbon ions provide a higher physical selectivity because of a finite range in tissue and in the case of carbon ions, biologic advantages such as an increased relative biologic effectiveness (RBE) in the Bragg peak region. These advantages lead to improved dose distributions, permitting a dose escalation within the tumour region and an optimal sparing of neighboring normal tissues. therefore, therapy with charged particles suggests a clinical gain in the treatment of non-radioresponsive tumours in critical locations that are rarely radiocurable with routine photon therapy. The experience in the treatment of chordomas and chondrosarcomas with heavily charged particles other than protons is limited. the results of RT with neon and helium ions at Lawrence Berkeley Laboratory (LBL), in Berkeley, California between 1977 and 1992 demonstrate the superiority of charged particles compared with photons in the management of these tumours. However, the advantages of particle therapy could not fully

be exploited because of passive beam delivery and the inability to achieve individual biologic plan optimization. Since August 1998, the irradiation of patients with chordomas and low-grade chondrosarcomas has been available within a clinical Phase I/II study at the heavy ion synchrotron schwerionensynchrotron (SIS) at Gesellschaft fur Schwerionenforschung mbH (GSI) in Darmstadt, Germany. Treatments are carried out within three beam time blocks of one month each year using carbon ions<sup>18</sup>.

**Negative Pi-Mesons** : In the 1960s, negative pi mesons appeared to be promising in radiotherapy. They have a mass equal to 230 electrons, which is about 1/8 of that of a proton. They traverse tissues depositing ionization at low linear energy transfer but at the end of their range they are captured into a nucleus, which then disintegrates ejecting several alpha particles, neutrons, or protons and a beryllium nucleus in the form of a 'star' of partly high-linear energy transfer radiation locally in the tumour. Pion therapy requires extremely large, complex and expensive beam generation and delivery systems. They are produced in a low yield by very high-energy proton beams, 600-800 MeV, and are therefore very expensive to produce. Three pion facilities were developed in 1970s, in Los Alamos, United States, in Vancouver, Canada, and in Villigen, Switzerland but none of them is now being used to produce pions.

About 1200 patients were recruited to clinical studies of pion therapy between 1974 and 1996, of whom only about 160 have been included in randomized trials. Two randomized studies at Vancouver comparing pions with photons in supratentorial astrocytomas and inoperable prostate cancers did not show any enhanced therapeutic benefit in terms of survival and morbidity with pions compared to photons<sup>19,20</sup>.

## Conclusions

Amongst the range of the charged particles, protons, helium and heavy ions that have been evaluated only protons appear to show continuing promise in radiotherapy. Their physical advantages are clear, and have shown important advantages in treating a number of selected, rather uncommon tumours. There is good evidence, although not conclusive, that protons are more effective than photons in treating chordomas and other tumours of the base of skull and upper cervical spine. Protons have an established role in treating choroidal melanomas and are considered to be the treatment of choice for many of these lesions. The clinical indications for proton therapy and highly sophisticated techniques employed must continue to be developed and evaluated. There is need for much more evidence from phase III randomized trials about the possible advantages of protons compared with the best conformal photon radiotherapy.

## References

1. Stone RS. Neutron therapy and specific ionization: Janeway Memorial Lecture. *Am J roentgenol*, 1948;59:771-85.
2. Hall EJ: *Alternative radiation modalities*. pp 432-445; *Radiobiology for the Radiologist for the Radiologist*, 5th ed. Philadelphia, JB Lippincott, 2000.
3. MRC Neutron Therapy Working Group. A comparative review of the Hammersmith (1971-75) and Edinburgh (1977-82) neutron therapy trials of certain cancers of the oral cavity, oropharynx, larynx and hypopharynx. *British J Radiol*, 1986;59:429-40.
4. Griffin TW, David R, Laramore GE, Hussey DH, Hendrickson FR, Rodriguez-Antunez A. Mixed beam radiation therapy for unresectable squamous cell carcinoma of head and neck: the result of a randomized RTOG study. *Int J Radiat Oncol Biol Phys*, 1984;19:2211-15.
5. Maor MH, Hussey DH, Barkley HT, Peters LJ. Neutron therapy for head and neck cancers: II. Further followup on the MD Anderson TAMVEC randomized trial. *Int J Radiat Oncol Biol Phys*, 1983;9:1261-5.
6. Griffin TW, David R, Hendrickson FR, Maor MH, Laramore GE. Fast neutron radiation therapy for unresectable squamous cell carcinomas of the head and neck: the result of a randomized RTOG study. *Int J Radiat Oncol Biol Phys*, 1984;19:2217-23.

7. Duncan W, Orr JA, Arnott SJ, Jack WJL, Kerr GR, Williams JR. Fast neutron therapy for squamous cell carcinomas in the head and neck region: results of a randomized trial. *Int J Radiat Oncol Biol Phys*, 1987;13:171-8.
8. Maor MH, et al. Evaluation of a neutron boost in head and neck cancers. Results of a randomized RTOG trial 78-08. *Am J Clin Oncol*, 1986;9:61-6.
9. Maor MH, et al. fast neutron therapy in advanced head and neck cancer: a collaborative international randomized trial. *Int J Radiat Oncol Biol Phys*, 1995;32:599-604.
10. Eichhorn HJ. Results of a pilot study on neutron therapy with 600 patients. *Int J Radiat Oncol Biol Phys*, 1982;8:1561-5.
11. Laramore GE, Krall JM, Thomas FJ, Griffin TW, Maor MH, Hendrickson FR. Fast neutron radiotherapy for locally advanced prostate cancer: results of an RTOG randomized study. *Int J Radiat Oncol Biol Phys*, 1985;11:1621-6.
12. Russell KJ, et al. Photon versus fast neutron external beam radiotherapy in the treatment of locally advanced prostate cancer: results of a randomized prospective trial. *Int J Radiat Oncol Biol Phys*, 1994;28:47-54.
13. Laramore GE, Griffith JT, Boespflug M, et al: Fast neutron radiotherapy for sarcomas of soft tissues, bone and cartilage. *Am J Clin Oncol*, 1989;12:320.
14. Egger E, Zografos L, Schalenbourg A. Eye retention after proton beam radiotherapy for uveal melanoma. *Int J Radiat Oncol Biol Phys*, 2003;55:876-880.
15. Hug EB, Fitzek MM, Liebsch NJ, Munzenrider JE. Locally Challenging osteo-and chondrogenic tumours of the axial skeleton: results of combined proton and photon radiation therapy using three dimensional treatment planning. *Int J Radiat Oncol Biol Phys*, 1995;31:467-76.
16. Shipley WU, Verhey LJ, Munzenrider JE. Advance prostate cancer: The results of a randomized comparative trial of high dose irradiation boosting with conformal photons compared with conventional dose irradiation using protons alone. *Int J Radiation Oncol Biol Phys* 1995;32:3-12.
17. Schulte RW, Slater JD, Rossi CJ, Slater JM. Value and perspectives of proton radiation therapy for limited stage prostate cancer. *Strahltherapie und Onkologie* 2000;176(1):3-8.
18. Schulz-Ertner D, Heberer T, Jakel O, et al. Radiotherapy for chordomas and low grade chondrosarcomas of the skull base with carbon ion. *Int J Radiation Oncol Biol Phys* 2002;53:36-42.
19. Pickles T, et al. Pion radiation for high-grade astrocytoma: results of a randomized study. *Int J Radiation Oncol Biol Phys* 1997;37:491-7.
20. Pickles T, et al. Pion conformal radiation of prostate cancer: results of a randomized study. *Int J Radiation Oncol Biol Phys* 1999;43:47-55.

### IMSA News

#### IMSA Chapter Activities Jan.-March 2005

##### Tamil Nadu Chapter

- 9.1.2005 : Prof. G. Krishnamoorthy, "Consciousness"  
 13.2.2005 : Dr. P. Venugopal, S. Menon, "Novel Thiazole Compound with Antioxidant Property and its role in Diabetes"  
 13.3.2005 : Dr. A.r. Chandrasekaran, "Emerging Trends in Primary Health Care".

##### Delhi Chapter

- 8.1.2005 : Dr. A.P. Arora, Dr. V.K. Gujaral, "Acute Coronary Syndrome in Diabetics. Pitfalls & Precautions in Diabetics Management in cardiac patient." Venue: Seminar Hall, National Heart Institute.  
 20.1.2005 : Dr. G. Kapur, "An Overview of Paediatric malignancies & their chemotherapy".  
 : Dr. A. Saharia, "Organ preservations in paediatric tumours: surgical aspect".

- : Dr. A.K. Anand, "Targeted radiotherapy - reducing late radiation morbidity in paediatric solid tumours".  
 12.2.2005 : Dr. A.K. Jhingan, "The diabetes is a vascular disease".  
 : Dr. (Prof.) S.K. Agarwal, "Diabetic Dyslipidemia".  
 22.2.2005 : Dr. Lt. Col. S.K. Malaui, "Acute Myocardial Infarction".  
 : Dr. Col. K.K. Singh, "Seizures".  
 24.2.2005 : Dr. L.M. Prasher, "ENT today; What all possibilities are".  
 : Dr. Kapil Kochhar, "Incisional Hernia - Revisited".  
 12-3-2005 : Dr. Vinod Sharma, "Percutaneous Interventions in 21st century: controversies, the challenges and follow-up guidelines".  
 : Dr. O.P. Yadav, "CABG in diabetics; challenges & follow-up guideline".  
 15-3-2005 : Dr. Raghugaind (UK), "Care of Elders".  
 30-3-2005 : Dr. Col. D.P. Vats, "Cataract".  
 : Dr. Col. Rajal Kumar, "Approach to Care of Anaemia".

#### Election of Fellows/Members 25.2.2005

Dr. Waseem Qureshi  
 Dr. D.K. Mehtra  
 Dr. Sreeramadasu Ramaiah  
 Dr. (Mrs.) Chrusheela Satishchandra Gaikwad  
 Dr. Deepak Singhal  
 Dr. C.R. Sundararajan  
 Dr. Jayaraj Govindaraj  
 Dr. S.M. Rajendran  
 Dr. (Lt. Genl.)S.P. Kalra  
 Dr. P.C. Rajaram  
 Dr. Tulsi Dass Chugh

Srinagar  
 New Delhi  
 Mumbai  
 Mumbai  
 Delhi  
 Chennai  
 Chennai  
 Chidambaram  
 New Delhi  
 Chennai  
 New Delhi

Dr. Karri Prasada Reddy  
 Dr. Desai Jagruti Yogesh Kumar  
 Dr. Desai Yogesh Kumar Chhanganlal  
 Dr. Mehtra Naresh Chandran  
 Dr. Dudhwala Bharatkumar Gamanlal  
 Dr. M.M. Karia  
 Dr. Sadhna M. Desai  
 Dr. Anita Jayant Shah  
 Dr. Atam Prakash Arora  
 Member :  
 Dr. Amit Bhatia  
 Dr. Lal Bahadur  
 Dr. Mohd. Minhajul Haq

Visakhapatnam  
 Surat (Gujarat)  
 Surat (Gujarat)  
 Surat (Gujarat)  
 Surat (Gujarat)  
 Surat (Gujarat)  
 Surat (Gujarat)  
 New Delhi  
 New Delhi  
 Jaunpur (U.P.)  
 Surat (Gujarat)

**HONOUR** Dr. Mohsin Wali, Fellow of International Medical Sciences Academy has been elected as a Fellow of the American College of Cardiology on 1.2.2005. IMSA is proud to have him on its roll and congratulates him on this achievement. *President, BOT and CEC members and all the fellows and Members of IMSA.*

#### Announcement

**IMSACON 2005** International Medical Sciences Academy is holding its annual meeting 'IMSACON 2005' at Jaipur (Rajasthan) on 22,23,24 Oct. 2005 at Rajputana Palace Sheraton Hotel, Jaipur. *Theme of the Conference is 'Emerging Health Challenges'.* Dr. S. Panickker is the **organising secretary**; his address is *Sanjevani Hospital & Diabetes Centre, F-58, Kalidas Marg, Bani Park, Jaipur-302016.*

All fellows and members are welcome to attend the conference with their spouses and accompanying persons. In case they intend to present paper in the scientific sessions of the conference, they may send abstract of their papers to the organising secretary (Jaipur) at the address given above with a copy to the secretary general IMSA at Headquarter.

**IMSACON 2006** International Medical Sciences Academy will be holding its annual conference 'IMSACON 2006' at Lahore (Pakistan) on 3,4,5 November 2006 at 'Lahore Medical and Dental College'. *Theme of the conference is 'Update in Medical and Dental Sciences.'*