Vascular Imaging:Past, Present & Future.

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***Abstract**: Birth of vascular imaging took place soon after the discovery of X-ray. It was mostly through invasive tools and luminography was possible. In ninteen sixtees and seventees due to introduction of ultrasound, CT and MRI vascular imaging became noninvasive and comprehensive information of vessel content, wall and perivascular information was possible. Invasive techniques are mostly confined to therapeutic interventions. Future belongs to molecular and fusion imaging wherein early lesions will be diagnosed before morphologically and haemodynamically significant abnormalities set in.*

Vascular diseases are responsible for more morbidity and mortality than any other type of disease. This morbidity and mortality may be due to vessel disease itself like rupture of aneurysm or end organ damage like coronary artery occlusion leading to myocardial infarction or an organ disease secondarily involving blood vessels like meningoencephalitis causing endarteritis or Hepatocellular carcinoma infiltrating into portal or hepatic veins. Role of imaging includes (A) diagnosis of vascular disease, end organ damage (B) to provide road map for treatment, whether medical, surgical or endovascular treatment (C) to follow up after the treatment (D) for prognostication.

VASCULAR IMAGING – THE PAST

The past of vascular imaging has been through invasive methods and provided luminal imaging. This period ranges from 1896 to nineteen sixties. Interestingly the birth of vascular imaging took place within three months of discovery of x-rays by Roentgen, when Haschek & Lindenthal injected Teichman mixture in to the blood vessels of an amputated cadaveric hand[1]. In 1920, an x-ray atlas of arterial tree of human body was published wherein Bismuth substrate was used and blood vessels were shown with exceptional details[2]. In 1923, the first arteriogram and venogram were done in live human being with Strontium Bromide[3]. In 1924 iodine was used as intravascular contrast media for the first time and blood vessels seen with excellent details and vascular pathologies were detected[4]. Inorganic iodide was used with many side effects. In 1928 Moniz pioneered the direct puncture technique of Carotid angiography to study cerebral lesions[5]. In 1929 organic iodide was used which was reasonably well tolerated[6]. In 1948 a catheter was used to opacify the aorta through Radial arterial route by Radner[7]. The era of modern angiography technique started when Seldinger introduced percutaneous transfemoral catheterization in 1953[8]. Jonsson performed the first selective coronary angiography in 1948[9]. During this period, several technical developments took place such as dark room fluoroscopy in 1923, image intensifier in 1953 and several other developments like rapid film changer, biplane film changer, cineangiography etc. The birth of interventional radiology took place in 1964 when Dotter & Judkins used catheter application in recanalizing the occluded atherosclerotic arteries[10].

VASCULAR IMAGING – PRESENT

Present era in vascular imaging starts in nineteen seventies. This is the golden period for vascular imaging due to extraordinary innovations like Ultrasound and Doppler, Computed tomography, Magnetic resonance imaging, nuclear medicine and the introduction of computers. This is an era of non-invasive methods that provide information of not only the lumen of the vessel but also of the wall and outside the vessel thereby allowing a comprehensive evaluation of vascular diseases. Due to their non-invasive nature these modalities are used for pre and post surgical or endovascular treatment follow up. This provides greater insight in to the natural history of disease and efficacy of treatment procedures. During this period there has been introduction of physiologic and functional imaging in the form of Positron emission tomography (PET) scanning.

Simultaneous improvements in catheter technology like micro catheter, newer embolic materials, endovascular devices like stent grafts, innovations in equipments like digital subtraction angiography, 3-D rotational angiography and also innovations in surgical techniques like complex aortic grafts etc have revolutionized vascular imaging and management.

ULTRASOUND & DOPPLER

Ultrasound and Doppler are excellent screening tools for major and peripheral vessels. They provide information about the vessel lumen (stenosis or occlusion or aneurysm), about the vessel wall in terms of calcification, intima-media thickness, atherosclerotic plaques and wall edema. They also provide hemodynamic information like blood flow, volume and velocity, thereby differentiating hemodynamically significant from non-significant stenosis. Duplex scanning is an excellent modality for evaluation of deep vein thrombosis and varicose veins. It is also a good modality for initial evaluation of vascular malformations, vascular trauma and vascular emergencies like acute embolism. Major strengths of ultrasound are its non-invasiveness, economy, portability and excellent temporal and spatial resolution. These make it a good tool for screening and follow up. Major limitations are window problems, operator dependency and certain blind areas such as junction of ascending aorta and arch.

POWER DOPPLER

Power Doppler (PD) is also known as energy Doppler or amplitude Doppler. In this magnitude of color, flow output is displayed rather than Doppler frequency signals and it does not display the direction or velocity (Fig. 1). It complements the other two modes, provides excellent details of vessels even with slow flow and enables volume measurements

***Figure 1:** Power Doppler showing vascular tree in normal kidney.*

INTRA VASCULAR ULTRASOUND (IVUS)

Tiny catheter based probes emitting sound waves at 20-40 MHz inside the vessel lumen provide segmental topographic images of the vessel. As sound waves penetrate the vessel wall, the intima, media and adventitia, whether normal or abnormal are well depicted. Lumen narrowing and plaques can be visualized and its area can be measured, thereby making it a useful tool to assess and follow up the treatment efficacy. IVUS though excellent modality is inherently invasive and is mostly confined to research centers. It has found clinical application in accurate localization of renal arteries during endovascular aneurysm repair (EVAR) and in the assessment of iliac venous

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