

New Advances in MRI.

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Abstract: MR technology was looked upon as an imaging advancement that provided high-resolution images without exposing patients to radiation in its early days. Now a new set of improvements is impacting not only image quality but also the patient comfort and work efficiency. One of the biggest change is the migration from the 1.5T machine to the 3T ones. The combination of MRI systems with larger gradients, improved surface coils, and parallel imaging techniques have produced substantial improvements in MRI quality and speed of image acquisition. Newer advances in MR neuroimaging include MR spectroscopy, diffusion and diffusion tensor imaging with tractography, perfusion imaging and functional imaging. With recent technical advances in hardware, software, and intravenous contrast agents, MRI has evolved into a clinically useful procedure to detect and characterise liver pathologies. MRE is an emerging diagnostic imaging technique for quantitatively assessing the mechanical properties of tissue. MR imaging has the potential to change how we assess the small bowel, because of the functional information and soft-tissue contrast it can provide, the direct multiplanar imaging capabilities, and the lack of ionizing radiation. Magnetic resonance (MR) urography comprises an evolving group of techniques with the potential for allowing optimal noninvasive evaluation of many abnormalities of the urinary tract. A combination of MR imaging and its advanced features provides superb anatomic, metabolic images and functional information.

Historically, from the discovery of X-rays by Roentgen in 1895, to the introduction of MRI by Damadian in 1969, radiological advances have revolutionised the practice of modern medicine. The last few decades have witnessed dramatic innovations and improvisations in MR imaging technology.

1. Technological advances
2. Practical applications

RECENT ADVANCES IN MR NEURO-IMAGING²

Newer advances in MR, neuroimaging include MR spectroscopy, diffusion and diffusion tensor imaging with tractography, perfusion imaging and functional imaging using the bold technique.

The advent of intra-operative MRI has made a significant contribution to neurosurgery. Neuroimaging plays a central role in the management of all diseases of the central nervous system including epilepsy, stroke, infections, dementia, movement disorders and neuro-oncology, by improving diagnostic accuracy, affecting patient care and monitoring dynamic changes within the brain during therapy.

Neuroimaging is presently utilised in clinical practice for initial diagnosis and mapping of disease extent and distribution, pre-operative grading of tumours, biopsy planning, surgery and radiation portal planning for tumours, judging response to therapy and finally prognostication. The next decade will witness further sophistication of these techniques and with data available from larger studies, it is expected that imaging will continue to provide new and unique insights in neurology and neurosurgery which should hopefully contribute to the better management of patients with diseases of the central nervous system.

DIFFUSION & DIFFUSION TENSOR IMAGING

Diffusion-weighted MR imaging can detect an acute infarct (stroke) in less than 30 minutes after the occurrence of the clinical event. This enables neurologists to treat and reverse the effects of a stroke before significant damage can occur.

A more sophisticated extension of diffusion imaging is diffusion tensor imaging or DTI. DTI is a non-invasive in-vivo method for mapping white matter fibre tract trajectories in the human brain and spinal cord. The demonstration of white matter tracts by DTI can provide critical information to the neurosurgeon in cases of brain tumours by displaying the relation of a tumour to an adjacent white matter tract.

PERFUSION IMAGING

Perfusion imaging with MRI is an exciting new radiologic technique for non invasive evaluation of cerebral haemodynamics in certain definite clinical settings. Cerebral perfusion imaging describes the passage of blood through the brain's vascular network. It involves the dynamic injection of an intravenous contrast agent that is tracked by serial MR imaging during its first pass circulation through the brain tissue capillary bed.

Perfusion imaging, especially with MRI, has become an integral component of the complete radiological assessment of brain tumours. MR perfusion studies in combination with diffusion images are used in the setting of acute ischemic stroke to establish the presence of brain tissue at risk (penumbra) for dying if ischemia continues without recanalisation of an intravascular thrombus. Reversal of penumbra is associated with a significant decrease in morbidity and mortality in patients of stroke. Stroke remains a leading cause of mortality and morbidity in India and the world.

MR SPECTROSCOPY

MR Spectroscopy (MRS) is the only non-invasive technique capable of measuring chemicals within the human brain. MR spectroscopy equipment can be tuned (just like a radio receiver) to pick up signals from different chemical nuclei within the body. The metabolic information received is displayed as peaks in a graph or a visually appealing colour map showing concentrations of various chemicals in diseased tissues. These colour maps are overlapped or fused with conventional MR techniques to improve anatomical localisation. This helps to diagnose various pathologies and distinguish tumours from other mass lesions such as infections. A common example is elevated choline in a mass suggests the diagnosis of an aggressive tumour, whereas the presence of lipid often leads to the diagnosis of a tuberculous abscess.

FUNCTIONAL MRI (f MRI)

The evolution of Magnetic Resonance Imaging (MRI) as a technique for assessment of brain function, as opposed to its more conventional role as a tool for studying brain anatomy and pathology, has been quite remarkable over the past decade. Functional MRI has contributed to improve our insight into how the human brain works, both in the normal and diseased states. Functional MRI refers to the demonstration of brain function with neuro-anatomic localisation on a real time basis. The vast majority of these studies are performed using 'Blood Oxygen Level Dependent' contrast or BOLD which requires the detection of very small signal intensity changes - zero to three per cent at 1.5 Tesla and up to six per cent at 3Tesla for voxel volumes as small as 3 x 3 x 5 mm. The principle of the BOLD technique of F-MRI is