ROLE OF MRI IN ORTHOPAEDICS

Maravi P.* **Maravi D.S.**** **Uikey S.***** **Kaushal L.******

Musculoskeletal (MSK) imaging is an important diagnostic and teaching tool. Magnetic resonance imaging (MRI) in particular holds great potential for clinical and research purposes due to the ability to display high definition images of the MSK system. While the potential uses of MRI are exciting there are also reasons to be cautious primarily due to the expense and situations where the evidence for improved patient outcomes with increased use of MRI is lacking.

PRINCIPLE OF MRI

MRI is based on the reemission of an absorbed radio frequency (rf) signal while the patient is in a strong magnetic field. An external magnetic field is usually generated by a magnet with field strengths of 0.2 to 1.5 tesla (T). When the patient's tissues are subjected to this strong magnetic field, protons align themselves with respect to the field. In this steady state, a radiofrequency pulse is applied, which excites the magnetized protons in the field. After application of this pulse, a receiver coil or antenna listens for an emitted radiofrequency signal that is generated as these excited protons relax or return to equilibrium. This signal, with the help of localizing gradient fields and Fourier transformation, creates the MRI image.

The T1 relaxation time (longitudinal relaxation time) - used to describe the return of protons back to equilibrium after application and removal of the rf pulse 300-2000msec - Provide good anatomic detail T2 relaxation time (transverse relaxation time) used to describe the associated loss of coherence or phase between individual protons immediately after the application of the rf pulse 30-150 msec - used for evaluation of pathologic processes.

CLINICAL ASPECTS

Whenever an MRI is considered for orthopaedic condition, it is essential that the need for the imaging be based on the comprehensive patient examination, as gross diagnostic confusion can result from referred pain leading to MRIs of unrelated structures.

Another issue which should considered is whether or not the patient is likely to be better off as a result of the MRI.

APPLICATION IN ORTHOPAEDICS

Knee Joint

Knee MRI studies are frequently used to diagnose acute and chronic injuries to a variety of structures. Most important of them are the Meniscal injuries, however it has been shown that carefully performed clinical examinations may provide equal or better diagnostic information than MRI. Hence, MRI was generally more useful to rule out injuries than to diagnose them.

Detection and proper management of articular cartilage defects is important to preserve joint health particularly in weight bearing joints. MRI can supplement clinical examination in these cases.

In osteoarthritis, treatment decisions should be based on the clinical judgement and not on the MRI findings.

* Asst Professor, Dept. of Radiodiagnosis
** Professor, Dept. of Orthopaedics
*** Asstt. Prof., Dept. of Orthopaedics
**** Professor, Dept. of Radiodiagnosis

Address for correspondence:
Dr. Poornima Maravi,
Asstt. Prof., Dept. of Radiodiagnosis,
GMC & Hamidia Hospital, Bhopal

Shoulder Joint

MR can obtain high quality images of the rotator cuff, glenoid labrum & other soft tissue structures. Rotator cuff attrition and long term instability can be assessed but CT is a better choice for bony lesions.

Hip

MR can assess acetabular labrum and quality of hyaline cartilage and hence finds application in adult AVN, Perthes' disease, Developmental dysplasia of hip (DDH) to ascertain the vascularity.

Ankle & Foot

To diagnose the osteochondritis dissecans of talar dome, integrity of tendons & ligaments, and in diagnosing tendinitis.

Avascular Necrosis

AVN is demonstrated in MR as a result of death of fatty marrow showing a altered/ high intensity signal in T2W images under the subarticular region. MRI changes become apparent only after several weeks.

Spinal Disorders

MRI allows a non-invasive evaluation of the spine and spinal canal, including the spinal cord. Most common indication for MRI of the spine being the Intervertebral disc disease. High soft-tissue contrast and high resolution allows ideal evaluation of the intervertebral discs, nerve roots, posterior longitudinal ligament, intervertebral foramen and spinal cord.

Normal disc appears as Low signal intensity on T1W images, slightly lower signal than adjacent normal red marrow and very similar to muscle. T2W images show diffuse high signal intensity throughout the disk except for the outer fibers of the annulus, which are homogeneously low signal intensity. Normal disks typically do not extend beyond the margins of the adjacent vertebral bodies.

In diseased conditions, here will be diffuse decreased signal intensity on T2W images from the increased collagen content in the nucleus and loss of disc height. However distinction need to be done among Disc protrusion, Disc extrusion, Sequestered Disc and other conditions which mimics prolapsed disc like Synovial cyst, Conjoined nerve root, Arachnoid diverticulum, Perineural (Tarlov) cyst, Nerve sheath tumors, Small epidural hematoma which can be readily made through MRI.

Infection

Acute osteomyelitis appears as low signal on T1W and high signal on T2W images, but have a non specific appearances and can be confused with transient osteoporosis.

Chronic Osteomyelitis displays the degree and extent of soft tissue involvement and any sinus tracks.

Trauma

MR in trauma is useful in showing fatigue/ stress fractures, epiphyseal bridging across the growth plate in pediatric population, acute muscle necrosis & hematoma.

Tumors

Excellent bone marrow delineation is most helpful in defining tumor extent and planning surgical and radiation therapy. Imaging should be performed in at least two planes, one of which should be axial (or transverse). This plane is most helpful in defining the relationship of lesions to nearby muscles and neurovascular structures and best shows extraosseous extension of bone tumors. Compartmental anatomy also is best shown in this imaging plane. The sagittal or coronal images define the proximal and distal extents of bone or soft-tissue involvement.

PATIENT SAFETY ISSUES

Devices whose function could be disrupted by the magnetic field as well as ferromagnetic implants or foreign bodies are considered contraindications for MRI studies.

Absolute contra-indications: Intracerebral aneurysm clips, Cardiac pacemakers, Automatic defibrillators, Biostimulators, Certain implanted infusion devices, Internal hearing aids, Metallic orbital foreign bodies.

Relative contraindications: First-trimester pregnancy, Middle ear prostheses, Penile prostheses.

CONCLUSION

Selective and appropriate use of MRI holds great potential for orthopaedic practice. MR can virtually replace all invasive investigations, dramatically improve diagnostic accuracy and provide management options.

As a result, scope and application MR in all aspects of orthopaedic practice is increasing drastically. However, Clinical examination should use the most appropriate clinical tests and measures first and then combine MRI, if indicated.

Inappropriate early use of MRI may complicate patient management and increase patient exposure to risk.

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