MR Imaging of the Hand and Wrist; Sports Medicine.

MR imaging can be a useful tool in the evaluation of the hand and wrist of the injured athlete. Often, however, providing helpful and diagnostic images can be challenging due to the need for high spatial resolution and the unique difficulties presented by imaging this anatomic region. In contrast to imaging the knee, for example, routine positions, protocols and imaging planes frequently do not suffice. Appropriate, clinically helpful, imaging requires an accurate understanding of the clinical history, the use of imaging protocols optimized for the specific clinical scenario under consideration and the use of appropriate scanners, coils and sequences.

Hardware:

Due to the small size and difficulty visualizing important structures of the hand and wrist, high spatial resolution is required. As a result, the use of high field scanners is advantageous. Unfortunately, however, the benefits of increased signal to noise associated with increased field strength may be compromised by the magnified susceptibility artifact when scanning post-operative patients. Positioning of the hand and wrist may be considerably easier in a scanner with a wide bore. Greater patient comfort when using small dedicated extremity scanners can also help to provide superior images and fewer scans degraded by motion artifact. Regardless of the scanner, optimized imaging requires efficient coils. A dedicated wrist coil is generally necessary, though small surface coils can be also be used to provide high resolution small field of view images of smaller structures like the interphalangeal joints or the nail bed.

Sequences:

As with all musculoskeletal imaging, T1 weighted and fluid sensitive images are required. Three dimensional images may be acquired using gradient echo or fast spin echo techniques. Given the spatial resolution requirements in the hand and wrist, these sequences are often useful, particularly when optimized for evaluation of articular cartilage. Because three dimensional images may require considerable time when scanning at 1.5 Tesla, this is another reason to consider the use of a 3Tesla scanner if available. When imaging the hand and wrist, standard imaging planes may not be adequate. Evaluation of a particular structure can be optimized by acquiring in oblique planes defined by the anatomy under consideration. For example, when imaging a flexor tendon after repair, it is better to optimize the sagittal plane by obtaining a smaller number of thin scans aligned with the tendon in question rather than simply acquiring sagittal images of the entire hand.

Positioning:

It is difficult to place the wrist in the center of the magnetic field and, as a result, image quality may be compromised by heterogeneity at the margins of the field. Particularly in wide bore scanners placement of the hand at the patient's side may be adequate but this is not always possible, particularly when imaging large patients. The use of a "superman" position with the hand held over the head while the patient is prone can be used, though many patients find this to be an uncomfortable position. Positioning of the patient should take into consideration the area of

interest being imaged and the patient's ability to maintain the position for the duration of the examination.

Fractures and chondral injuries;

A well-designed MR study is sensitive to bone injury through the use of fluid sensitive sequences as radiographically occult bone injuries are common. Such injuries may be overlooked on the radiographic exam due to their location or small size. At other times, the injury may simply be a contusion of bone, without cortical disruption. Scaphoid fractures are a common and clinically very important example. Small avulsion fractures such as volar plate fractures in the fingers may be difficult to discern on MR images and direct correlation with x-ray imaging is required if abnormal bone marrow signal is identified . Avulsion injuries at the metacarpal phalangeal joints and at the carpal ligaments are also difficult to see due to the small size of these fractures and the large amount of abnormal soft tissue signal adjacent to the fracture. When imaging children, physeal injuries must be considered. Such injuries are commonly seen in the setting of stress injury – a particularly common injury in gymnasts.

When there is evidence of a significant articular injury such as an effusion or marrow edema in a periarticular distribution, particular care should be taken to search for chondral injuries. These may be extremely difficult to identify due to the very thin cartilage surfaces and the volume averaging associated with the curved surfaces typical of the small joints of the hand and wrist.

Tendon injuries:

MR imaging is a particularly useful technique for the diagnosis of tendon injuries and for planning surgical intervention. Tendons are easily identified; though magic angle effect may compromise tendon evaluation particularly if GRE sequences are employed. This artifact can be addressed through the use of more heavily T2 weighted images. In the setting of a complete rupture and tendon retraction, an accurate estimation of the amount of retraction is needed to determine whether or not a tendon transfer will be used. MR imaging also provides assessment of the status of the margins of the torn tendon - additional information which the surgeon will find helpful in choosing a particular treatment. When describing flexor tendon injuries, localization of the tear to one of the five zones will facilitate communication with the surgeon.

Zone 1	Distal to the insertion of the Flexor Digitorum Superficialis
Zone 2	FDS insertion to the distal palmar crease
Zone 3	Palm
Zone 4	Carpal Tunnel
Zone 5	Wrist to forearm

Assessment of the restraining structures necessary for normal flexion and extension is also required. At the extensor surface, injuries of the sagittal band at the MCP joints are particularly important. When injured, the presence of subluxation or frank dislocation of the extensor tendon

should be noted. Proximally at the wrist, injuries to the Extensor Carpi Ulnaris are relatively common, especially among tennis players. Disruption of the ECU subsheath and associated subluxation may occur in the absence of obvious tendon pathology and can be assessed with dynamic imaging using either MRI or, more easily, with ultrasound. The flexor tendons are held in place by a series of pulleys and cruciate ligaments. Rupture or attrition of these retaining structures is a common injury among rock climbers. On MR images it is important to note the extent of injury and the specific ligaments and pulleys which have been disrupted.

Ligament injuries;

At the wrist, injuries to the intrinsic ligaments can be assessed provided images are thin and of high quality. This will often require the use of 3D sequences and is more easily done when imaging with a high field scanner. Evaluation of the extrinsic ligaments is particularly challenging in part due to the normal variation in the size and location of these ligaments. Intraarticular contrast can also be valuable in identifying small ligamentous injuries especially when the quality of the imaging is limited.

In the hand, collateral ligament injuries are characterized by increased signal on T2 weighted images and the presence of a gap when the tear is displaced or the joint stressed. When these tears are identified, a search for additional injuries including extension into the dorsal and palmar structures as well as chondral injuries and fractures is indicated.

References:

Clinical:

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Anantomy:

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