Ligaments and genetics: Marfan's and Ehlers Danlos

A Offiah (UK)

Marfan's and Ehlers Danlos syndromes are the two most common disorders of connective tissue, with the former having a reported incidence of approximately 2 – 3 per 10,000 and the latter a prevalence of 1 in 5000 births. Neither appears to have racial predisposition.

Marfan's syndrome (MFS) is inherited as an autosomal dominant disorder and has been linked to the fibrillin-1 gene on chromosome 15q(21.1) – FBN1. 15% of cases are due to sporadic mutations and therefore there will be no accompanying family history in these individuals - which may delay the diagnosis. Fibrillin-1 (a glycoprotein) is a major component of microfibrils found in many connective tissues, and hence explaining the multisystem involvement in MFS. The major systems involved are musculoskeletal, cardiac and ocular. Clinical diagnosis is based on fulfilment of the Ghent criteria.

Ehlers Danlos syndromes (EDS) comprise a clnically and genetically heterogenous group of connective tissue disorders affecting skin, blood vessels, ligaments and other organs to varying degrees. Most are autosomal dominant, some recessive and there is an X linked dominant form. A simple classification system identifies 6 major types of EDS; with major and minor criteria identified for each. Type I and type V collagen mutations have been described in patients with classical EDS (EDS I and II).

The presentation will outline the genetic mutations found in MFS and EDS and discuss the sensitivity, methods and clinical indications for mutation analysis of the FBN1 and FBN2 genes in MFS and Marfan-like syndromes.

Welcome: D O’Keeffe/C Heron/A Karantanas

Ligaments: anatomy function and imaging

F Kainberger (Austria)

Spinal ligaments

FM Vanhoenacker, PM Parizel (Belgium)

Learning objectives

1. To review the basic imaging findings of diseases involving the spinal ligaments, including degenerative, inflammatory, metabolic and tumoral conditions.

2. To discuss the clinical significance of these imaging findings.

3. To emphasize the merit of each imaging modality.

4. To discuss the differential diagnosis of calfications and ossifications of the spinal ligaments and paraspinal tissues.

Axial enthesitis imaging

V Pullicino (UK/Malta)

Spine ligaments and trauma: clearing the cervical spine

P Richards (UK)

Peripheral enthesitis imaging

N Boutry (France)

Entheses (i.e., sites of tendon and ligament attachment to bone) are frequently involved in seronegative spondyloarthropathies (ankylosing spondylitis, psoriatic arthritis, and Reiter's syndrome). Radiography shows bone erosions and spurs but this modality is insensitive to early bone damage. Until recently, the absence of effective treatment to preserve structural integrity has limited the need for more sensitive imaging techniques. This situation changed after the development of new therapeutics, such as the anti-tumor necrosis factor (TNF) - agents. Availability of these powerful and expensive drugs has created new demands on radiologists to identify patients with seronegative spondyloarthropathies at an early stage to affect their therapeutic management. Magnetic resonance (MR) imaging and ultrasonography (US) can be useful tools in evaluating patients with seronegative spondyloarthropathies. Both imaging techniques can be used in diagnosing early bone damage before it becomes apparent on radiography. US is a quick and inexpensive way to detect multiple sites of enthesitis. It shows swelling and inflammation of the entheses and the adjacent bursae. MR imaging reveals similar findings but it is the only modality capable of assessing bone marrow changes. It shows edema and inflammation of the bone marrow adjacent to the entheses. In this regard, the presence of extensive bone marrow changes is a good indicator of rheumatic disorders. Later in the course of the disease, MR imaging and, to a lesser degree, US can be useful in assessing disease activity.

Treatment response in spondyloarthropathy

P O'Connor (UK)

Ankylosing spondylitis (AS) is a chronic inflammatory enthesopathy of the axial skeleton with sporadic involvement of the appendicular skeleton.

This lecture reviews the scoring systems available for assessing damage and disease activity in AS. Spinal and sacroiliac involvement are the main areas that have developed disease activity and damage assessment tools with radiography and MRI the modalities utilised.

Radiography

New York criteria for sacroiliitis

0) normal,

1) suspicious changes,

2) minimal abnormality in the form of small areas of erosions or sclerosis without alteration in the joint width,

3) unequivocal abnormality - moderate or advanced sacroiliitis consisting of erosions, sclerosis, widening, narrowing, and/or partial ankylosis, and

4) severe abnormality in the form of total ankylosis (3).

There is also a Modified New York diagnostic criteria for AS that takes into clinical criteria and radiography.

The BASRI score

The Bath Ankylosing Spondylitis Radiological Index (BASRI) comprises three components: radiographs of the sacroiliac joints that are graded according to the New York criteria (stages 2-4) (3) and anteroposterior and lateral views of the lumbar spine (score of 0-4) and cervical spine (score of 0-4), resulting in a total score of 2 to 12. The changes in each region are globally classified as normal, suspicious, moderate, or severe .

0 normal No lesions

1 suspicious No definite change

2 mild Any number of erosions, squaring, or sclerosis, with or without syndesmophytes, on ≤2 vertebrae

3 moderate syndesmophytes on ≥3 vertebrae, with or without fusion involving 2 vertebrae

4 severe Fusion involving ≥3 vertebrae

The Stokes Ankylosing Spondylitis Spine Score (SASSS) is a detailed scoring system that uses lateral views of the lumbar spine . Each vertebral from the inferior endplate of T12 to L5 is evaluated for the presence of erosions, sclerosis, squaring, syndesmophytes, and total bony bridging (score of 0-72)

0 Normal

1 Erosions, sclerosis, or squaring

2 Syndesmophyte

3 Total bony bridging

The modified SASSS (mSASSS) grades changes of the cervical spine as well and seems to be most suitable for use in clinical trials. It is the most reliable of the three scoring systems and is most sensitive to changes of disease over time.

Conventional radiography remains an effective imaging method in the diagnosis, management and follow-up of spinal involvement in patients with AS. Radiographic grading of sacroiliitis according to the modified New York classification has some weaknesses but continues to play an important role in diagnosis and cohort definition.

The modified Stokes Ankylosing Spondylitis Spine Score is currently preferred for the follow-up of spinal changes.

Magnetic resonance imaging

Various scoring systems have been proposed to quantify the acute and chronic MRI changes of the sacroiliac joints and spine to enable robust and sensitive monitoring of the course of early and established disease under treatment. Much of the interest in developing imaging outcome measures arises because of the proliferation of expensive biologic treatments into the seronegative arthritides. This lecture will detail the strengths and weaknesses of the currently utilised scoring systems.

Six scores have been proposed to grade acute inflammatory changes of the SIJs:

I. Leeds score

II. MISS score (MR Imaging of Seronegative Spondyloarthropathies)

III. Aarhus score

IV. Hermann/Bollow SIJ score

V. Rudwaleit/Sieper SIJ score

VI. SPARCC SIJ index (Spondyloarthritis Research Consortium of Canada)

Four different scoring systems have been developed for classifying spinal changes:

I. Leeds score

II. ASpiMRI score

III. Berlin score (modification of the ASpiMRI)

IV. SPARCC MRI spinal inflammation index

MRI has opened up new horizons for the early detection of spinal inflammation and quantifying structural damage. There is an much debate about the most suitable scoring method and different ones may be preferable in different situations. The SPARCC grading systems for the sacroiliac joints and spine yield robust results in short-term and mid-term clinical studies and have low interobserver variation. Good interobserver agreement is due to the fact that these scores only take into account the six most severely inflamed discovertebral units or the six most relevant slices of the sacroiliac joints. Very small and potentially misleading lesions are thus excluded. To evaluate the natural course of AS, the Berlin Score (a modification of the ASspiMRI-a method) seems to be most suitable for acute changes and the ASspiMRI-c for grading chronic changes.

Role of ligaments in pathogenesis of OA

A J Grainger (UK)

The changes we see as osteoarthritis represent a common endpoint of joint degeneration that can be brought about through a number of mechanisms including trauma. It is now well recognised that ligament injury or laxity is a cause of osteoarthritis. For example patients are at risk of developing progressive osteoarthritis of the knee following ACL disruption. However it is also known that a subset of osteoarthritis (generalised osteoarthritis) has no clear precipitating factor. This condition is relatively highly prevalent, polyarticular and has a recognised genetic contribution. In addition to the knees and hips the disease targets the small joints of the hand, joints which are not clearly subject to the biomechanical stresses that the hips and knees receive. These joints present an opportunity to investigate the earliest changes seen in joints developing non-traumatic osteoarthritis. Increasingly evidence from MRI studies, microanatomical studies and animal models points towards the earliest structural abnormalities in generalised OA occurring in the ligaments and at the ligament insertion (enthesis). This evidence will be reviewed during this presentation.

Glenohumeral ligaments

M Reijnierse (Netherlands)

Glenohumeral ligaments

Anatomy

The glenohumeral ligaments are thickenings of the anterior joint capsule. Their appearance may vary from well-developed ligaments to bundles of collagen fibres in the capsule with an orientation different from other capsular fibres. Their function is to provide stability and depends on collagenous integrity, site of attachment and position of the arm.

The glenohumeral ligaments extend from the anterior part of the glenoid to the proximal portion of the humerus. They form a Z-shaped configuration within the anterior capsule, with the superior component representing the superior glenohumeral ligament (SGHL), the diagonal component representing the middle glenohumeral ligament (MGHL), and the inferior portion representing the inferior glenohumeral ligament (IGHL)(2)

The number of ligaments is variable in any person and their size varies considerably.

The SGHL is present in 90-97% of shoulder studies and is variable origin. The MGHL is present in 73-92% and the IGHL is present almost 100% of shoulder studies (3).

The SGHL originates from the upper pole of the glenoid cavity and base of the coracoid process and is attached to the anterior labrum, to the biceps tendon and the MGHL. It inserts just superior to the lesser tuberosity.

The SGHL lies just medial and parallel to the coracoid and is located in the rotator interval, just underneath the extra-articular coracohumeral ligament. Together they can prevent posterior and inferior translation of the humeral head, however its functional importance is debated. The SGHL is best seen on axial images in external rotation directly beneath or adjacent to the long head of the biceps tendon.

The MGHL has a variable origin from the anterior portion of labrum (most common) and scapular neck. This structure can be identified between the subscapularis tendon and the anterior labrum or anterior band of the IGHL. It attaches to the anterior aspect of the proximal humerus, the lesser tuberosity, just below the attachment of the SGHL. Distally it merges with the subscapularis tendon. The MGHL is the least constant in size and it can be absent in up to 27% of individuals. Its absence is not associated with increased incidence of instability, but the subscapular recess may be enlarged, and the IGHL usually originates more superiorly than when it is present. A well-recognized variant is the Buford complex, which represents a cordlike thickening of the MGHL, with absence of the anterior superior portion of the labrum. This variant is seen in up to 6.5% of patients (4).

It limits anterior translation of the humeral head when the arm is abducted between 60 and 90 degrees. When it is thick it is an important stabilizer (especially in case of IGHL injury). It is visualised on axial and oblique sagittal MR images.

The IGHL originates from either the glenoid labrum or glenoid neck and inserts into the humeral neck at the periphery of the articular margin. It is composed of an anterior and posterior band and joined by a fibrous thickening of the capsule called the axillary recess. This ligament is inseparable from the labrum, forming a labroligamentous complex. The humeral insertion has two distinct patterns, the collar-like attachment in which the entire IGHL inserts slightly inferior to the articular edge of the humeral head and the V-shaped attachment in which the axillary pouch attaches at the V, distal to the articular edge (5,6). The anterior band is usually thicker than the posterior band.

The IGHL complex is the main stabilizer of an abducted glenohumeral joint. It functions as a sling to support the humeral head and prevent abnormal anterior and posterior instability. The subscapularis muscle and tendon also provide anterior stability to the shoulder.

It is assessed on oblique sagittal images. With the arm held in abduction and external rotation (ABER position) the anterior band is stretched.

MR imaging

The glenohumeral ligaments are best assessed in the presence of capsular distension, MR arthrography. The addition of the ABER position optimises visualisation of portions of the biceps-labral complex including the anterior labrum and IGHL.

Pathology

The accuracy of MR arthrography for the evaluation of the GHL specifically was reported by Chandnani et al (7) in a series of 46 patients with arthroscopic correlation.

Lesions of the superior, middle and inferior GHL were depicted with sensitivity and specificity of 100/94%, 89/88% and 88/100% respectively. The most frequently injured capsule-ligamentous structure is the anterior band of the IGHL. Avulsion of the IGHL complex from the humerus is termed HAGL: humeral avulsion of the glenohumeral ligament. It typically results from a first-time dislocation in persons older than 35 years of age. On oblique coronal images the fluid distended U-shaped axillary pouch is conversed to a J-shaped structure, with contrast extravasation across the torn humeral attachment. A large number of patients with HAGL lesion present with associated abnormalities (4). Sometimes a bony fragment is avulsed from the humeral attachment called a bony HAGL or “BHAGL”(2,3,4). The combination with a Bankart lesion is called a floating anterior inferior GHL , “AIGHL” . A rotator cuff tear can be assessed, 94% of which involve the subscapularis tendon.

Lesions of the SGHL are closely related to those affecting the rotator cuff interval.

Tears of the MGHL are unusual in patients with glenohumeral instability, but their frequency may be higher than previously recognized (4). Two different patterns of rupture of the MGHL have been identified. The first is detachment of the ligament from its scapular insertion. The second is a split longitudinal tear. The most commonly associated lesion is a tear of the superior labrum.

References

1. De Maeseneer M, Van Roy F, Lenchik L. CT and MR arthrography of the normal and pathologic anterosuperior labrum and labral-bicipital complex. Radiographics 2000;20:S67-81.

2. Steinbach L.S. Magnetic resonance imaging of glenohumeral joint instability. Seminars in musculoskeletal radiology 2005;9:1:44-55

3. Stoller DW. Magnetic resonance imaging in orthopaedics and sports medicine.Vol.2, Wolters Kluwer, Phaladelphia, pp 608-620

4. Bencardino JT, Beltran J. MR imaging of the glenohumeral ligaments. Radiologic Clinics of North America 2006;489-502

5. O’Brien SJ,et al. The anatomy and histology of the inferior glenohumeral ligament complex of the shoulder. Am J Sports Med 1990;18:449

6. Bui-Mansfield LT, Taylor DC, Uhorchak JM, Tenuta JJ. Humeral avulsions of the GHL:imaging features and a review of the literature. AJR 2002,179:649-55

7. Chandnani VP, Gagliardi JA, Murnane TG et al. Glenohumeral ligaments and shoulder capsular mechanism : evaluation with MR arthrography. Radiology 1995;

196:27-32.

Biceps pulley

K Bohndorf (Germany)

Lesions of the rotator cuff interval will result in damage of the biceps tendon. In this respect the so called “reflection pulley” is of great importance as stabilizer of the intraarticular portion of the biceps tendon.

The rotator interval is located between the supraspinatus and subscapularis tendon. It is formed by the coracohumeral ligament (CHL) and the superior glenohumeral ligament (SGHL). The triangular shaped CHL has its origin at the base and the lateral facet of the coracoid process. It connects the anterior border of the supraspinatus and upper border of the subscapularis tendon, resulting in a capsulo-ligamentous bridge between both tendons (1). The CHL inserts at the minor tubercule and also at the major tubercle. The SGHL is a band, enforcing the capsule and has its origin at the tuberculum supraglenoidale. It lies anteriorly to and below the biceps tendon, enclosing this tendon, and inserts at the minor tubercle. The SGHL is the major anatomical structure to stabilize the intraarticular portion of the biceps tendon (2).

In front of the sulcus intertuberculare CHL and SGHL blend together and form a ring-like structure covering the biceps tendon before entering the sulcus. This reflection pulley is additionally supported caudally by the subscapularis and superiorly by the supraspinatus tendon (3).

So called pulley lesions can be the result of acute trauma or longstanding overuse. A fall backwards on the extended arm may cause a tear of the pulley (4). Outward rotation and extension of the humerus may tear the CHL (5). One has to keep in mind the role of the reflection pulley to redirect the force between the horizontally orientated intraarticular biceps tendon and its vertical course in the sulcus intertuberculare. This results in maximum stress at the entrance of the sulcus intertuberculare above and behind the minor tubercle.

According to Habermeyer (6) damage of the rotator cuff interval are precursors of supraspinatus tendon lesions. In the majority of cases the lesion starts at the common insertion of CHL and supraspinatus tendon. Even small intraarticular tears of the supraspinatus tendon may result in failure of the function of the pulley, which may end up in a medial subluxation of the long biceps tendon. Chronic subluxation of the tendon will be followed by tendinitis, synovitis, intratendinous defects and eventually rupture. Instability of the tendon also may cause mechanical abrasion of the humeral cartilage.

References:

1. Harryman D.T., Sidles J.A., Harris S.L., Matsen F.A.: The role of the rotator interval capsule in passive motion and stability of the shoulder. J Bone Joint Surg (1992) 4:53-66.

2. Werner A., Müller T., Böhm D., Gohlke F.: The stabilizing sling for the long head of the biceps tendon in the rotator cuff interval. A histoanatomic study. Am J Sports Med(2000) 1:28-31.

3. Walch G., Nove-Josserand l., Levigne C., Renaud E.: Tears of the supraspinatus tendon with "hidden" lesions of the rotator interval. J Shoulder Elbow Surg. (1994)3:353-360.

4. Peterson J.: Spontaneous medial dislocation of the tendon of the long biceps brachii. Clin Orthop(1986) 211:224 – 227.

5. Slätis P., Alto K.: Medial dislocation of the tendon of the biceps brachii. Acta Orthop Scand (1979) 50:73 – 77.

6. Habermeyer P: Schulterchirurgie, 3rd ed. Urban und Fischer, München 2002, p 365-368

Further reading:

Stoller DW: Magnetic Resonance Imaging in Orthopaedics and Sports Medicine. Vol. 2, 3ed. Wolters Kluwer, Philadelphia, pp 1293-1305

Lunch – Lecture by ONI

Elbow ligaments: MRI

J Beltran (USA)

Normal Anatomy

Ulnar Collateral Ligament Complex

Anterior oblique ligament

Anterior band

Posterior band

Posterior oblique ligament

Transverse ligament (Cooper's)

RadialCollateral Ligament

Lateral Ulnar Collateral Ligament

Annular Ligament

UCL: Biomechanics and Mechanism of Injury

• Primary valgus stabilizer

• Injuries generally chronic, repetitive

• Acute trauma (dislocation)

• Chronic pain, valgus instability

• Throwing athletes

• Acceleration phase causes greatest valgus stress

• Valgus stress may exceed strength of the anterior band of the UCL

• Valgus Extension Overload Syndrome (VEOS)

• Repetitive microtrauma (mid substance injury)

• Acute macrotrauma (humeral origin or ulnar insertion-avulsion sublime tubercle)

Chronic Repetitive Microtrauma

• Partial or complete MCL tear (AOL) (mid substance lesion)

• Capitelar contusion, OCD

• Physeal injury in children

• Common flexor, pronator, tendinitis, tear

• Ulnar nerve traction injury

• Posteromedial impingement (osteophytes)

• Loose bodies

UCL Injuries: MRI Accuracy

Schwartz et al. (Saline MR Arthro)

– 40 athletes, surgical correlation

– Sensitivity 95% (complete) 86% (partial)

– Specificity 100%

Timmerman et al. (Conventional MRI)

– 25 athletes, surgical correlation

– Sensitivity 57%

– Specificity 100%

UCL Injuries: MRI Accuracy

Nakanishi et al. (MR vs. Saline MR Arthro)

– 10 athletes, surgical correlation

– 5/10 leakage (4 related to avulsion fx)

Cotton et al. Gadolinium MR Arthro

– Cadaveric studies, normal anatomy

Carrino et al. (2001)

– MR Arthro more accurate.

UCL Injuries: Treatment

• Rehabilitation, physical therapy

• Surgery

– Ligament repair

– Palmaris longus tendon autograph

– Ulnar nerve transposition

Evaluation of elbow and shoulder problems in professional baseball pitchers.

Am J Orthop. 2007 Jun;36(6):308-13.

Increased risk of later injury in patients having elbow surgery (4.6 times increase)

o 42% patients receiving UCL surgery had shoulder injury

o Shoulder surgery (RC) did not increase incidence of elbow or subsequent shoulder problems

Posterolateral Rotatory Instability (PLRI)

Lateral ulnar collateral ligament injury

Associated with radial collateral ligament and annular ligament injuries

Difficult to asses clinically and with MRI

Surgical reconstruction may be necessary

Associated patterns of soft tissue injury in elbow dislocation and fracture-dislocation

McKee et al. J Elbow Shoulder Surg, 2003 Jul-Aug;12(4):391-6.

Disruption Lateral Collateral Ligament Complex (100%)

Proximal avulsion

Bony avulsion lateral epicondyle

Midsubstance rupture

Ulnar detachment of the LUCL

Ulnar bony avulsion

Combined patterns

Disruption of the common extensor tendon origin (66%)

Radial head fractures: MRI evaluation of associated injuries

Itamura et al. Shoulder Elbow Surg. 2005 Jul-Aug;14(4):421-4.

Department of Orthopaedics, University of South California, Los Angeles, CA, USA

• 24 patients with an acute radial head fracture (Mason type II and III) without documented dislocation or tenderness at the distal radioulnar joint.

• Medial collateral ligament not intact in 13 of 24 (54.16%)

• Lateral ulnar collateral ligament not intact in 18 of 24 (80.1%)

• Both collateral ligaments not intact in 12 of 24 (50%)

• Capitellar osteochondral defects in 7 of 24 (29.1%)

• Capitellar bone bruises in 23 of 24 (95.83%)

• Loose bodies in 22 of 24 (91.67%).

Snapping Elbow

• Synovial fold

• Triceps tendon

• Loose body

• Annular ligament

• Subluxing ulnar nerve (with triceps tendon: “double snap”

Elbow ligaments: US

T Miller (USA)

The elbow is stabilized medially against valgus stress by the ulnar collateral ligament (UCL), and stabilized laterally against varus and posterolateral stress by the radial collateral ligament complex. These ligaments are superficial and amenable to sonographic evaluation.

The anterior band of the UCL is a fan-shaped echogenic fibrillar structure, extending from a broad attactment on the undersurface of the medial epicondyle to a thin attachment on the sublime tubercle of the coronoid process (Ward, Jacobson). In throwing athletes, the normal UCL is thicker in the dominant elbow but is more lax than the non-dominant side, allowing widening of the humeroulnar articulation with stress (Nazarian, Sasaki). Calcification and hypoechoic foci may be seen in asymptomatic ligaments (Nazarian), but lateral subluxation of the ulna in pitchers, with resultant angulation of the UCL over the trochlea, correlates with pain (Sasaki). Mild sprain of the ligament may demonstrate adjacent hypoechoic edema, while rupture is demonstrated as ligament disruption and discontinuity (Miller, Jacobson). Dynamic sonography during stress may make tears more conspicuous (De Smet). Experience with power Doppler sonography is limited; one article showed no hyperemia in or around the UCL of two baseball pitchers with ligamentous laxity even though MR imaging demonstrated surrounding edema in one patient (De Smet).

The radial collateral ligament complex is composed of the radial collateral ligament (RCL), which resists varus stress, the lateral ulnar collateral ligament (LUCL) which resists posterolateral stress (O'Driscoll), the annular ligament which maintains the integrity of the proximal radioulnar joint by keeping the radial head in the sigmoid notch of the proximal ulnar, and small accessory slips. The RCL and the annular ligament are well visualized but the LUCL is not well seen because of its curved oblique course. Injury of the RCL is often concomitant with lateral epicondylitis, but the ligament may also be injured during too aggressive debridement of lateral epicondylitis (Bredella). Tears are demonstrated as partial disrutions and complete discontinuity. Tear of the annular ligament may be seen in "nursemaid elbow" when the radial head dislocates from the ligament (Kim), but the primary sonographic finding of "nursemaid elbow" is widening of the radiocapitellar distance (Kim, Kosuwon, Shabat).

Ward SI, Teefey SA, Paletta GA et al. Sonography of the medial collateral ligament of the elbow: a study of cadavers and healthy adult male volunteers. AJR 2003;

180:389–394.

Jacobson JA, Propeck T, Jamadar DA, Jebson PJL, Hayes CW. US of the anterior

bundle of the ulnar collateral ligament: findings in five cadaver elbows with MR arthrographic and anatomic comparison—initial observations. Radiology 2003; 227:561–566.

Sasaki J, Takahara M, Ogino T, Kashiwa H, Ishigaki D, Kanauchi Y. Ultrasonographic assessment of the ulnar collateral ligament and medial elbow laxity in college baseball players. J Bone Joint Surg 2002; 84-A:525–531.

Nazarian LN, McShane JM, Ciccotti MG, O'Kane PL, Harwood MI. Dynamic US of the anterior band of the ulnar collateral ligament of the elbow in asymptomatic major league baseball pitchers. Radiology 2003; 227:149–154.

De Smet AA, Winter TC, Best TM, Bernhardt DT. Dynamic sonography with valgus stress to assess elbow ulnar collateral ligament injury in baseball pitchers. Skeletal Radiol 2002;31:671–676.

Miller TT, Adler RS, Friedman L. Sonography of injury of the ulnar collateral ligament of the elbow—initial experience. Skeletal Radiol (2004) 33:386–391

Bredella MA, Tirman PF, Fritz RC, Feller JF, Wischer TK, Genant HK. MR imaging findings of lateral ulnar collateral ligament abnormalities in patients with lateral epicondylitis. AJR Am J Roentgenol. 1999 Nov;173(5):1379-82.

O'Driscoll SW. Classification and evaluation of recurrent instability of the elbow. Clin Orthop Relat Res. 2000 Jan;(370):34-43.

Shabat S, Folman Y, Mann G, Kots Y, Fredman B, Banian M, Liberman N, Nyska M. The role of sonography in detecting radial head subluxation in a child. J Clin Ultrasound. 2005 May;33(4):187-9.

Kim MC, Eckhardt BP, Craig C, Kuhns LR. Ultrasonography of the annular ligament partial tear and recurrent "pulled elbow". Pediatr Radiol. 2004 Dec;34(12):999-1004.

Kosuwon W, Mahaisavariya B, Saengnipanthkul S, Laupattarakasem W, Jirawipoolwon P. Ultrasonography of pulled elbow. J Bone Joint Surg Br. 1993 May;75(3):421-2.

Wrist ligaments

M Shahabpour , B Allemon, P Ceuterick (Belgium)

Carpal stability depends on the integrity of the bones and of the surrounding extrinsic and intrinsic wrist ligaments.

1. Anatomy and technical considerations:

The extrinsic ligaments mainly include the volar radiocarpal ligaments, the triangular fibrocartilage, the ulnotriquetral and ulnolunate ligaments and the dorsal ligaments (radiotriquetral).

The volar radiocarpal and intercarpal ligaments are the most important stabilizers.

The intrinsic ligaments (scapholunate and lunotriquetral) are located deeper and course between carpal bones (= interosseous).

On the anteroposterior radiographic view, the normal intercarpal relationships are defined by three carpal arcs, roughly parallel without disruption, with equal interosseous spaces. On the lateral view, a continous line is drawn through the axes of the radius, lunate and capitate, intersecting a line through the longitudinal axis of the scaphoid, creating an angle of 30 to 60 degrees.

Arthrography combined to multidetector computed tomography (MDCT) seems to be an efficient method for the diagnosis of partial tears of the scapholunate and lunotriquetral ligaments, TFCC tears and cartilage abnormalities.

According to the literature, MR arthrography allows a better analysis of the extrinsic ligaments than plain MRI, thanks to the distension of the wrist compartments. Study of those ligaments requires MR images in the 3 planes using very thin slices (0.5 to max 2mm).

2. Pathology:

Dissociative and nondissociative instability patterns are described; the second type is less common and is characterized by intact interosseous ligaments. DISI = dorsal intercalary segment carpal instability (more common); VISI = volar intercalary segment carpal instability (palmar flexion instability).

After a detailed anatomic review of the wrist ligaments, the oral course will focuse on the pathological MRI findings in traumatic carpal instability, based on clinical outcome and surgical correlation.

Fingers and pulleys

A Klauser (Austria)

Knee collateral ligaments

A Karantanas (Greece)

Early diagnosis and treatment of the injured knee collateral ligaments, whether conservative or surgical, is important in the proper management to prevent long-term sequelae. MR imaging with its inherent high soft-tissue contrast has proven very useful for depicting and grading these injuries. Since in the immediate post-injury period the clinical assessment is not reliable, MR imaging is an important diagnostic tool able to assess also the intra-articular structures.

A high magnetic flux scanner matched with a dedicated knee or extremity coil with T1-w, STIR and fat suppressed PD sequences in axial and coronal planes are considered important for assessing the ligamentous injuries.

The medial collateral ligament (MCL) extends from the medial femoral condyle approximately 5cm above the joint space down to the medial tibia approximately 6-7cm below the joint space posterior to the insertion of the pes anserinus. The MCL, a main valgus stabilizer of the knee, consists of two layers separated by a small bursa and peribursal fatty tissue. MCL is normally seen as a linear low-signal intensity structure on all pulse sequences. Its injuries are graded 1-3 based on MR imaging findings and are commonly associated with medial retinaculum injury, medial meniscal tears and meniscocapsular separation.

The lateral stabilizers of the knee consist of structures, known as the lateral collateral ligamentous complex (LCLC), which act against varus stress and external rotation. The most important of these structures, from anterior to posterior, are the iliotibial band (ITB), a continuation of the tensor fascia lata inserting on Gerdy's tubercle on the anterolateral tibia, the fibular or true lateral collateral ligament, and the tendon of the biceps femoris muscle which converges with the fibular collateral ligament to form the conjoined tendon prior to inserting on the fibular head. MRI findings of LCLC, either normal or injured, is similar to that seen with the MCL. In general, its injury is rather rare. Inflammation, adjacent to the ITB, secondary to its impingement against the condyle, is known as the ITB friction syndrome or "runner's knee".

Learning objectives

1. To learn an appropriate MR imaging protocol for studying the lateral collateral ligaments.

2. To become familiar with the MR imaging appearance of the normal and injured collateral ligaments of the knee.

3. To understand the biomechanics of the injured collateral ligaments as well as the associated injuries that may be found in other intra and extra-articular structures.

Knee cruciate ligaments

R Arkun (Turkey)

Knee post op: cruciates

C Masciocchi, A. Barile, G. Lanni (Italy)

The knee after surgical reconstruction of the cruciate ligaments may give rise to a variety of problems. A successful surgery depends on several factors such as patient selection, correct performance of the surgical procedures (choice of the graft, positioning of the bony tunnels, fixation of the graft, intercondylar notchplasty, ligamentous strength), appropriate post-surgical rehabilitation, and observance of the time needed for allograft incorporation. Failure of surgical reconstruction results in patients complaining of pain and/or articular instability, presence of increased articular laxity or stiffness clinically evaluated.

Three etiological categories of surgical failure can be defined: 1) failure due to surgical technique; 2) biological failure (unsuccessful incorporation of the graft); 3) new trauma.

Diagnostic imaging is fundamental in the study of the operated knee and its post-surgical complications. Magnetic Resonance (MR) is considered today the best imaging technique in the study of patients with ACL reconstruction, due to its multiplanar imaging possibility and high contrast resolution. Plain film still remains the method of first approach, because it provides information on both position and size of femoral and tibial osseous tunnels, as well as type of fixation chosen (bio absorbable or metal interference screws, buttons, cramps). Computed Tomography (CT) allows for evaluation of the position and size of the osseous tunnels, shows the new ligament and provides morphologic and densitometric information.

Ankle: MRI

M Zanetti (Switzerland)

Supination injury of the ankle is one of the most common injuries in the general population and athletes. 15–20% of sports injuries can result in persisting symptoms and MR imaging may be required for evaluation of the collateral ligaments on the ankle. The lateral collateral ligament complex consists of three ligaments: the anterior talofibular, the calcaneofibular ligament, and the rarely torn posterior talofibular ligament. The anterior talofibular ligament is easily seen on transverse MR images. The course of the calcaneofibular ligament is variably oblique. Secondary reconstructions of CF ligament may be useful for evaluation. Injury to the medial collateral ligaments – also called deltoid ligaments - is much less common than lateral collateral ligament injuries, accounting for approximately 15% of ligament trauma. Insufficiency of the medial collateral ligaments may lead to ankle instability, posteromedial impingement, and osteoarthritis. The deltoid ligament is composed of the superficial layer with the tibionavicular ligament, tibiospring ligament, and the tibiocalcaneal ligament, and deep layer with the anterior and posterior tibiotalar ligaments. The tibionavicular ligament –an important biomechanic stabilizer - runs oblique to the main imaging planes.

The distal tibiofibular syndesmosis is a complex structure characterized by four separate ligaments: the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament, the transverse tibiofibular ligament, and the interosseous ligament. A tibiofibular syndesmosis tear is characterized by increased signal through the anterior tibiofibular syndesmosis. Contrast enhanced sequences may increase accuracy of tibiofibular syndesmosis tears.

Learning objectives:

1. To know the anatomy and variants of the ankle ligaments on MR images.

2. To know the appropriate MR imaging technique for evaluation of the ankle ligaments.

3. To know the MR appearance of abnormal ankle ligaments.

Ankle: US

E Silvestri (Italy)

Recent technological advances have improved the possibilities of US in the evaluation of ankle ligaments. The anterior talofibular ligament (ATF) and the calcaneofibular ligament (CF) are well demonstrated with US. The ATF ligament runs from the anterior of the talus, is hyperechoic when its fibres are perpendicular to the US beam and it is approximately 2 mm thick. The CF ligament runs in a slightly posterior oblique direction toward the heel. The ligament lies on the deep surface of the peroneal tendons, between the inferior part of the malleolus and the calcaneous bone. It is hyperechoic in the distal part and hypoechoic in the proximal part, because of the obliquity (anisotrophy). A dynamc study of these ligaments is mandatory because they can be seen clearly. Moreover, a US dynamic study of ATF and CF ligaments allows to differentiate partial from complete rupture. The posterior talofibular ligament is difficult to see on US, because it is partially or completely hidden by the bone. The deltoid ligament consists of: posterior talotibial ligament, calcaneotibial ligament, tibionavicular ligament and anterior talotibial ligament. These ligaments are best seen with a dynamic study (eversion manoeuvre). The anterior inferior tibiofibular ligament (AITFL) is visible using US axial scans just above the insertion of the ATF.

Ligaments and skin: SKIBO Diseases

J Freyschmidt (Germany)

Ligaments and skin : SKIBO ¡V diseases

J. Freyschmidt

The concept of SKIBO (Skin ¡V Bone) diseases includes at least 100 entities that typically involve the musculoskeletal system as well as the skin and mucous membranes, syn-or metachronously. Empirically many patients with SKIBO ¡V diseases do not suffer from disease associated symptoms alone but also or even more from a long odyssey between different medical specialities (i.e. dermatology, orthopaedic surgery,

rheumatology, radiology) who do not come to a correct diagnosis and ¡V not rare ¡V violate the patient by not indicated biopsies and other surgical procedures. It is important to know that many SKIBO ¡V diseases have a high potential of mimicking malignant bone lesions. But the results of biopsies are usually sobering and can at best help to exclude a certain diagnosis, not to confirm a correct diagnosis. Many times histologic changes are unspecific (reactive) and the pathologist is unable to define the etiology. In such cases the radiologist - who principally works interdisciplinary ¡V is challenged and he should have a look to the patient`s skin. If he detects any suspicious findings, he should consult a dermatologist. If the suspected disease or syndrome is confirmed, further diagnostic procedures often are unnecessary and therapy can be started right away.

A subgroup of SKIBO ¡V diseases especially involve the various entheses and may lead to confusing clinical and radiological symptoms and signs. To this subgroup belong the socalled spondyloarthritides :

„« Psoriasis ¡V associated changes of the axial and appendicular skeleton

„« PPP (Pustulosis Palmo-Plantaris) ¡V associated changes of the axial and appendicular skeleton and the anterior chest wall (Pustulotic Arthroosteitis / PAO or SAPHO)

„« Reiter`s syndrome

„« Ancylosing spondylitis

„« Enteritis (Crohn`s disease, Colitis ulcerosa) ¡V associatred changes of the axial and appendicular skeleton and

„« Undifferentiated spondyloarthritis.

The cardinal X-ray and CT ¡V features of all of these entities in their late early and intermediate stage are a mixture of simultaneous appearing destructive and osteoproliferative changes at the entheses of the spine and appendicular skeleton . At the spine they are located predominantly at the edges (endplates) and corners (discovertebral junctions) of the vertebral bodies, at the appendicular skeleton at and adjacent to the insertions of joint capsules. Histologically one can find an unspecific inflammatory process and chronic osteitis. An involvement of synovial joints is secondary and does not represent a primary synovitis as with rheumatoid arthritis .

In the cases of psoriasis¡¨arthritis¡¨ or ¡V spondyloarthritis , PAO and Reiter`s syndrome the periosteum may be involved with signs of destruction and new bone formation. The periosteum may represent an enthesis, if entheses - in general - are understood as transition zone between bone and nonbony structures . In late stages osteosclerotic changes may spread over the affected bone, from the surface to the bone marrow.

At the spine late changes consist of excrescences, called syndesmophytes and parasyndesmophytes, as well as of ossifications of the longitudinal ligaments.

In an early stage X ¡V rays are negative, but with MRI one can detect edemalike enthesitic changes at the edges and corners of the vertebral bodies and at the various entheses of the appendicular skeleton.

In the case of ancylosing spondylitis and psoriasisspondyloarthritis the sacroiliac joints may be involved. They ¡V in general ¡V represent a predominantly synchondrotic junction with an abundance of ligaments and their entheses in the retroarticular space. In our opinion in at least 15 ¡V 20 % of all cases of the socalled ancylosing spondylitis and of undifferentiated spondyloarthritis the disease starts in the spine and not in the sacroiliac joints (axial spondyloarthritis) as can be demonstrated by early MRI studies. Before the era of MRI it was believed that in 99 % of all cases of ancylosing spondylitis the disease starts in the sacroiliac joints.

PAO represents an inverse form of psoriasis but the osseous changes do not follow the usual trait of classic psoriasis : In 60% of all cases the anterior chest wall is involved, that is rich in ligaments and their insertions (ligg. costoclaviculare, ligg. costosternale, etc.). A sternocostoclavicular hyperostosis (SCCH) can develop. By the way : the sternocostoclavicular region may be regarded as the cranial counterpart of the sacroiliac junctions. In 10 ¡V 15 % of all cases of PAO the appendicular skeleton may be involved with bony changes that look like that of chronic multifocal osteomyelitis and that may mimic sclerosing bone tumors and tumor like lesions.

Literature :

JurikAG (1990) Anterior chest wall involvement in patients with pustulosis palmoplantaris. Skeletal Radiol 19 : 271

Kasperczyk A, Freyschmidt J, Ostertag H (1990) Pustulotic arthroosteits :

Spectrum of bone lesions with palmoplantaris pustulosis. Radiology 191:207

Bollow M, Braun J, Hamm B (1994) Early sacroiliitis in patients with spondylarthropathy : evaluation with dynamic Gadolinium ¡V enhanced MR-imaging. Skeletal Radiol 194 : 529

Freyschmidt J, Sternberg A (1998) The bullhead sign ¡V scintigraphic pattern of sternocostoclavicular hyperostosis and pustulotic arthroosdteitis. Eur Radiol 8
Freyschmidt J, Freyschmidt G (1999) SKIBO ¡V Diseases . Disorders affecting the Skin and Bone. Springer Berlin, Heidelberg, New York:807

Freyschmidt J, Freyschmidt ¡V Paul, P (2001) SKIBO ¡V diseases : a concept to avoid bloody diagnostic procedures in ambiguous skeletal lesions. Eur.Radiol. 1729 - 1742

Ligaments and metabolic disorders

R Whitehouse (UK)

Ligaments, tendons, fascia and aponeuroses are all collagen containing structures with more similarities than differences. Anatomically, ligaments and tendons differ only by what they connect to what. Chemically, the range of compositions of different ligaments is so broad as to make the distinction between ligament and tendon rather arbitrary. Ligamentous pathology almost invariably presents as structural and functional failure, with treatment orientated to achieving repair without lengthening, or management of the biomechanical consequences. Repetitive stress or overuse, sports injury and "degeneration" are the pathologies recognised by most clinicians. Where these structures attach to bone (the enthesis) is a site of other diseases, so characteristic that some authors believe the enthesis should be considered an organ in its own right.

In the light of the above, how ligaments respond to the presence of metabolic disease has consequently been paid little attention. Mineralisation in X-linked hypophosphataemic osteomalacia, thickening in diabetes and the metabolic responses of ligaments will be described with reference to the similarities and differences between collagen containing structures indicated above.

Ligaments and nerves: entrapment neuropathies

C Martinoli (Italy), Stefano Bianchi (Switzerland)

With technologic advances obtained over the past years, the role of ultrasound and MR imaging in the assessment of peripheral nerve disorders is now becoming commonplace, influencing the diagnosis and the clinical management in the symptomatic patient. In entrapment neuropathies, the conflict of nerves with ligaments and retinacula often occur within or in proximity to osteofibrous tunnels. At these sites, ligaments and/or retinacula form the roof of the osteofibrous tunnel and may be responsible for nerve compression by restricting the space and reducing the compliance of the tunnel or causing direct impingement to the nerve. In some instances, anomalous muscles may replace retinacula as a result of congenital anomaly, thus predisposing the nerve to be compressed. In the absence of a ligament or a retinaculum, nerves may sublux or dislocate outside the tunnel: the subsequent nerve instability may lead to chronic symptoms and functional deficit (friction neuritis). Outside osteofibrous tunnels, nerves may be entrapped where they pierce fascial planes. These entrapments are usually related to stretching injuries and traumas occurring even far from the compression site. Anomalous ligaments along the course of a neurovascular bundle, such as the Struthers ligament, can cause nerve compression as well. Similarly, abnormal fibrous bands may compress nerves where they pass across muscles. Some nerves and body areas seem to be intrinsically predisposed to compressive neuropathies by anomalous fibrous bands.

Ligaments and tumours and pseudotumours

J Vilanova (Spain)

Ligaments are composed of bundles of collagen fibrils, which are part of the “non living” matrix and the acellular component of the connective tissue. Thus, tumours originated primarily from a ligament is exceptional in the musculoskeletal system. The most common tumour or mass within or about a ligament is a pararticular cyst. This group comprise synovial cysts, ganglia, distended bursae, meniscal cyst or myxoid ligament degeneration. A pseudotumoral lesion related to a complication from cruciate ligaments repair is known as arthrofibrosis or “cyclops” lesion. Calcification or hematoma within a ligament might appear as a pseudomass lesion. The close relationship of the ligaments with the synovium and the tendon sheath of the joint requires the recognition of the most common synovial benign tumours or pseudotumours such as giant cell tumors of tendon sheath, pigmented villonodular synovitis (PVNS) , chondroma, lipomatosis arborescens, hemangioma or chondromatosis. The most common pararticular malignant tumor is the misnomer term of “synovial” sarcoma, a malignant tumor of uncertain differentiation.

US of ligament sports injuries

N Boutry (France)

Ultrasonography (US) is a quick and inexpensive way to detect ligament sport injuries. The recent technical developments of US equipments, particularly the increase in transducers'frequency, allow an accurate and dynamic assessment of superficial ligamentous structures. The purpose of this presentation is:

1. To briefly review the normal anatomy of the ligamentous structures.

2. To illustrate the usefulness of US in diagnosing superficial ligamentous injuries, grading the severity of the lesions, precising the number of ligaments involved, and detecting associated lesions (i.e., tendinous or retinacular injuries).

3. To emphasize the added diagnostic value of US in the diagnosis of small avulsion fractures which are difficult to detect on radiography and nearly impossible to see on magnetic resonance imaging.

4. To precise the main limitations of US in the assessment of ligament sport injuries.

5. To discuss the role of US in the management of ligament sport injuries.

Insertional enthesopathies in sports: an integrated approach

M Court-Payen (Denmark) / M de Jonge(Netherlands)

Retinacular-related disorders in sports medicine

J Kramer (Austria)

Retinacula are strong fascial bands in the region of joints that prevent tendons from „bowstringing“ away from the joint. MR imaging allows detailed anatomic visualization of anatomical structures and accurate diagnosis of pathologic alterations in the retinacular region of different joints. Therefore, nowadays if an exact clinical examination is inconclusive MR imaging is the imaging methode of choice for further evaluation and is not rarely needed to gain sufficient information for a tailored therapy.

In the wrist the focus has to be put on the flexor retinaculum (transverse carpal ligament) and the adjacent median nerve, because in Carpal tunnel syndrome the retinaculum demonstrates bowing and signal alteration of the nerve. Injuries of the patellar retinacula (condensations in tissue planes rather than discrete structures) are a very common finding in patients having suffered patellar dislocation. At the ankle, the crural fascia condenses to form retinacula (superior et inferior extensor and superior et inferior peroneal retinaculum), for the tendons of the extensor, flexor, and peroneal muscles. In most patients with dislocations and tears of the tendon in the ankle joint injuries of the retinacula are visible. Knowledge of the anatomy, MR findings of injured structures and a reasonable clinical and biomechanical (trauma mechanism) understanding are a prerequisite for an accurate diagnosis.

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Presentation on Genoa Meeting 2009

C Martinoli/E Silvestri (Italy)

Award of honorary membership to V Jevtic + lecture

Ligamentous lesions in young athletes: an US and MRI approach

M Padron (Spain) / C Martinoli (Italy)

Ageing athlete

E Llopis (Spain)

Pubalgia/sports hernias

P Robinson (UK)

IMAGING OF ATHLETIC PUBALGIA

Dr Philip Robinson

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This lecture will focus on the imaging features of subacute and chronic pathology involving the;

1. Symphysis pubis and adductor muscles

2. Inguinofemoral soft tissues – hernias and aponeurotic tears/strain

1. SYMPHYSEAL AND ADDUCTOR PAIN

SYMPHYSIS PUBIS

Osteitis pubis is a term used for an non-infectious inflammatory condition of the joint characterised by joint and enthesopathic inflammation which is presumed to be mechanical in origin.

ADDUCTOR MUSCLES

These muscles originate from the pubic body and inferior pubic ramus and are functionally important in sports where frequent changes of direction as well as kicking are required (eg soccer, ice hockey, Australian rules football).

MR imaging has been evaluated in presumed clinical symphyseal and adductor group abnormality with studies showing that marked pubic bone marrow and adductor longus origin edema significantly correlates with current symptoms.

2. INGUINAL PAIN – Hernia and Sportman's Hernia

2A. INGUINAL HERNIA

Inguinal hernias are thought to account for up to 4% of groin abnormality in athletes with chronic pain. Herniography and ultrasound will be discussed.

2B. SPORTSMAN'S HERNIA ('PRE-HERNIA COMPLEX)

This is a controversial clinical area. The pathologies described include posterior inguinal wall weakness, aponeurosis tear and neuralgia. Although some authors have proposed that posterior inguinal wall bulging on ultrasound occurs in this condition we commonly see this feature in asymptomatic athletes. The microtears described at surgery cannot be reliably diagnosed on imaging and therefore this condition remains a clinical diagnosis. Imaging is performed to exclude other conditions that affect the groin (see above).

QUIZ

Training: US

J Kaye (USA)

In the US, there are 8,472 training programs with 109,569 positions; all of these are overseen by the Accreditation Council of Graduate Medical Education (ACGME). These nunmbers include 187 diagnostic radiology residency training programs with some 4,458 positions. Oversight of all programs is done through Residency Review Committees. There are common program requirements and program specific requirements. Assessment of programs by the Residency Review Committees is done through regular site visits, and adherence to all program requirements is strictly enforced. In the US, training in diagostic radiology includes 1 year of clinical experience and 4 years of diagnostic radiology training. Admission to diagnostic radiolgy training programs is highly competitive, and applicants come from among the best students from the best medical schools. In the course of residency, trainees receive 3-4 months of training in musculoskeletal radiology. Among the local variables that affect training are the presence of trauma centers, children's hospitals, cancer centers and orthopedic hospitals, which have an effect on the breadth and depth of training in those areas. There are also some program variables that affect training, including the size of the program, the depth of subspecialty training of their teachers, and, specifically for musculoskeletal radiology, how much musculoskeletal interventional training and musculoskeletal ultrasound experience the training program provides. At the end of training, all US graduates take the certifying examination given by the American Board of Radiology, a member of the American Board of Medical Specialists. In their qualifying examination, there are 11 separate areas of examination, one of which is musculoskeletal radiology.

Many graduating residents choose to take an additional year of fellowship training in a subspecialty area. There are 64 musculoskeletal radiology fellowship programs in the US, with a total of 135 fellows. Musculoskeletal fellowships are among the most competitive in the US, and about 12% of graduating diagnostic radiology residents take musculoskeletal radiology fellowships. As in the case of residency programs, there are local variables that affect the amount and nature of teaching material, including trauma centers, children's hospitals, cancer centers and orthopedic hospitals. There are more program variables in musculoskeletal radiology fellowships related to the amount of training in ultrasound, interventional procedures and how much experience fellows get in spine imaging and intervention (often in the province of neuroradiology) and pediatric musculoskeletal radiology (often in the the province of pediatric radiologists). There are also some fellowships that are almost purely musculoskeletal MRI, with limited training in other areas. In addition, many musculoskeletal radiology fellows serve as junior faculty or junior attendings, and there is a variable amount of work and education.

Even though there may be less training in musculoskeltal ultrasound and in some interventional procedures, in general the training in virtually every institution for both residents and fellows in musculoskeletal radiology is excellent, and graduating residents and fellows are highly knowledgeable about musculoskeletal disorders.

Training: UK/Europe

A Dixon (UK)

Training in the UK and Europe has become much more structured over the last few years, with both the RCR and the ESR producing precise training curricula and handbooks. The amount of clinical training before embarking on a career in radiology varies from country to country; in the UK at least two years are required. Five years is generally regarded to be the minimum time for radiological training throughout Europe although this proposal has not yet been fully implemented in all countries. Ideally three years should be spent on core training and two years on gaining further experience in one or more subspecialties. Thus a musculo-skeletal radiologist could, in the future, have pursued muscular-skeletal interests for over two years (including the time taken during core training). This should allow close integration with the clinical aspects of musculoskeletal work and involvement in some research / publications. It is desirable that most radiologists should retain core skills to be able to provide on-call cover as an integrated radiological team.

Training: EU Curriculum

F Vanhoenacker (Belgium)

Introduction

Musculoskeletal imaging involves all aspects of medical imaging which provide information about anatomy, function, disease states and those aspects of interventional radiology or minimally invasive therapy appertaining to the musculoskeletal system. This will include imaging in orthopaedics, trauma, rheumatology, metabolic and endocrine disease as well as aspects of paediatrics, oncology and sports imaging.

Aims

The aim of subspecialised training in MSK imaging is to prepare a radiologist for a career in which a significant portion of his/her time will be devoted to MSK imaging. Such individuals will be expected to provide and promote MSK imaging and interventional methods.

The aims of establishing a subspeciality training in MSK radiology is to ensure

• An in-depth understanding of diseases of the MSK system.

• A clear understanding of the role of imaging in the diagnosis and treatment of MSK diseases.

• Development of the necessary clinical and management skills.

• The ability of the MSK specialist to perform (complex) MSK interventional procedures.

• The ability of the MSK specialist to act as a consultant in regular multidisciplinary meetings in the field of MSK imaging.

• The ability of the MSK specialist to transmit his specific knowledge to his/her colleagues in general radiology and to assume the continuity and evolution of radiological diagnosis in the field of MSK radiology (teaching skills).

Discussion

This lecture will give a short overview of the recommendations made by the European Society of Radiology in conjunction with the Union of European Medical Specialists (UEMS), regarding subspecialty training in MSK radiology.

The following items will be emphasized:

1. Recommendations regarding expertise and facilities for training departments.

2. Recommendations regarding practical training.

3. Recommendations regarding technical, communication and decisionmaking skills.

References

1.UEMS. European Training Charter for Medical Specialists, UEMS, Vienna 2003

2.European Society of Radiology, Publications en Media, European Training Charter for Clinical Radiology, brochure VI, 2005. http://www.myesr.org/cms/website.php?id=/en/publications/Brochures1-8.htm

3.Working Group of the British Society of Skeletal Radiology (BSSR). Curriculum for subspeciality training Musculoskeletal Radiology, 2000

Turf battles

T Pope (USA)

This presentation will outline the past history of imaging "turf battles" in various subspecialties mainly in the US but anecdotal discussions of other countries will be included. A discussion of the definition of "turf" and the perception of this term by the non-imagers and imagers will be presented.

Particular attention will be paid to the subspecialty of musculoskeletal radiology and how we must continue to define the role of radiologists in the "value-added" contribution to the care of our referring physicians' patients.

This subject is complex and there are a myriad of reasons that the issue exists. The most prominent contributors are economic, patient convenience and perception. The radiology community has a responsibility to continue to encourage subspecialy differentiation within our specialty if we anticipate continuing to have an impact in the future.

It is hoped that the presentation will stimulate substantial audience discussion and interaction.

Commercial

S Blease (UK)

Communication of doubt in radiological reports

A Dixon (UK)

Radiologists vary in their style of reporting; some provide fairly dogmatic opinions; others express less certainty. Certain terms are fairly clear cut; these include: ‘absent’, ‘excludes’, ‘unlikely’, ‘probable’, ‘certain’, ‘definite’. Indeed most clinicians receiving such reports have a firm understanding of what such terms mean. Others have less clear meaning: ‘no evidence of’, ‘appears absent’, ‘unable to exclude’. In a recent audit of a hundred thousand MR examinations the language of the report of was often a cause for potential confusion. Furthermore the radiologist was often reluctant to qualify the report when the images were less than perfect. It is suggested that more uniform terminology would be helpful, especially for radiologists and clinicians working in multiple clinical environments in different countries.

Avoiding ambiguity in radiological reports

J Kaye (USA)

Ambiguity, which occurs when radiological reports have more than one meaning or can be understood more than one way, insidiously creeps into practice. Reports that are vague, unclear, equivocal and confusing to our clinical colleagues are all too common. Ambiguity in radiological reports is dangerous because it may result in additional consultations, may lead to additional and unnecessary studies, and may have the net effect of suboptimal patient care. From the standpoint of radiologists, reporting with ambiguity may lead to loss of credubility of the radiologist. Moreover, reporting with ambiguity has a significant negative effect on our training in the specialty.

Ambiguity in radiological reports may be accidental, intentional, habitual and can be learned. Included among the many ways a report may contain ambiguity are the radiologists favorites of the hedge, the waffle, the weasel and the fudge. Once habits that relate to radiological reporting are acquired (which is usually during training), they are exceedingly hard to correct. Radiological colleagues, who have usually not seen our reports, are unlikely to bring ambiguity to our attention, and our clinical colleagues will often seek the advice of another and different radiologist to resolve ambiguity.

In this discussion, we will consider a number of ways to avoid ambiguity in radiological reporting: (1) Take the time to look at the images prior to beginning dictation; (2) Formulate your thoughts prior to beginning dictation; (3) Structure the report; (4) Be brief; (5) Avoid nmeaningless words and phrases; (6) Limit differential diagnostic possibilities; (7) Indicate how additional studies may be helpful; (8) Force yourself to give an impression; and (9) Be sure to carefully read tranbscribed reports prior to signing/authentication.

The radiologist plays multiple roles in patient care. Interpretation of images is one of these roles, but without communication, the interpretation is meaningless. Creation of the radiological report, which is the main way that we convey information, is equally as important as the interpretation of images. Ambiguity in radiological reports has many negative consequences in terms of patient care and in the overall perception of the importance of the radiologist in patient care, and it is exceedingly important that the radiologist makes every effort to avoid it.

Reporting non-accidental injury

A Offiah (UK)

In the UK, the diagnosis of child physical abuse is currently a controversial and topical issue. Radiologists play an important role both in the initial diagnosis and in the subsequent legal processes that may ensue.

Apparent discrepancies between radiologists are often a result of misinterpretation of the radiological report. It is important that findings and conclusions are clearly and unambiguously conveyed.

The reporter's level of experience should be stated, and if necessary it should be explicit that a second opinion of a more experienced / paediatric radiologist will be sought; clearly stating the name, position and place of work of that radiologist.

It is good practise to double report all imaging either independent of or in conjunction with a colleague.

The presentation will touch on key points to consider when reporting the skeletal imaging of a child in whom physical abuse is suspected. These include quality of the skeletal survey, fracture dating, mechanism of injury, and timing and projection of additional radiographs.

New fracture risk language of the WHO

G Guglielmi (Italy)

WEB open publishing and semantic searching

F Gilbert (UK)

The development of the internet and world wide web (www) in early nineties as a method of communication allowed written and visual content to be accessed electronically and read. Early search engines were developed to find specific information. “Open publishing” was developed in the late nineties where information could be posted electronically online and commented on and altered (for example Wikipedia – a collaborative encyclopaedia project). WWW 2.0 (the second decade 2000-2009) has allowed improved methods for publication of academic papers but there is an abundance of information which is disorganised and despite vastly improved search engines information can be difficult to find. WWW 3.0 (the third decade 2010-2019) aims to make data within documents more accessible by using improved pathways of information retrieval. The aim is to create giant databases. However information is presented in natural language designed to be read by people. This is difficult for software programmes to interpret, interrogate and collate. Semantics is the study of the meaning of language and how meaning is constructed, clarified, interpreted and illustrated. A resource description framework (RDF) is created making natural language understandable by computer software. RDF works with various ontologies which have agreed terminology for a particular subject and core vocabulary. The Health Care and Life Sciences Interest Group was created in 2004 to develop core medical vocabularies to allow sharing of database and web information. In the UK, SNOMED-CT has been adopted for clinical terminology with the Unified Medical Language System (UMLS) developed in parallel. RSNA has developed *Radlex* which combined these and other lexicons for use by Radiology departments. These various tools offer radiologists the opportunity to place and retrieve image related data on the Web and hopefully more rapidly advance knowledge.

Hanging protocols and reporting

D Wilson (UK)

Language based radiological decision support systems

S Stivaros (UK)

Radiology and the media

S Burnett (UK)

Overview of the research process

I Watt (Netherlands/UK)

Research in MSK radiology

M Reiser (Germany)

Designing a study including power calculations and statistical considerations

A Sramek (Netherlands)

A complete and well written protocol is essential for every research project. A research protocol is a written plan that outlines the research question, the background and rationale for performing the study, the chosen study design to answer the research question, the methods what data and how the data should be collected and how the results should be analyzed. This lecture will focus on parts of the research protocol: study design, power calculation and statistical analysis.

The choice of an appropriate study design depends on the research question. If the research question requires an observation (e.g. observed characteristic is compared within or between groups of patients) a cross-sectional, case-control or cohort study design can be selected. When the research question requires that the effect of an intervention is studied, a randomized controlled trial study design should be selected.

Statistical analysis is used to test whether the observed results are real or based on chance (i.e. random variation). In most cases observed differences between groups are tested. Whether a difference is considered real depends on the chosen size of α (i.e. the chance that the observed difference is caused by random variation). Usually an α (or type I error) of 0.05 is accepted. A type II error (β) is the chance of missing a true difference because of small sample sizes and is usually set at 0.20. The power of a test is defined as 1-β (i.e. the chance of correctly rejecting the hypothesis that there is no real difference). Power calculations are usually performed to calculate the sample sizes that are needed for a study with a pre-specified α and β. Other variables that are needed to perform a power calculation are the minimum expected or clinically relevant difference and the expected measurement variability (i.e. standard deviation).

The choice of the statistical analysis depends on the research question, study design, type of variable that is studied (i.e. categorical or continuous) and the distribution of the variable that is studied. When diagnostic tests are compared sensitivity, specificity, positive and negative predictive values can be calculated from a 2x2 table and compared. When the diagnostic tests are measured on a numeric scale Receiver Operating Characteristic (ROC) curves can be constructed and compared between the tests for varying cut-off points. To test the amount of agreement between tests or observers the Kappa statistic can be calculated when discrete observations are concerned. For continuous measurements Bland-Altman plots can be used. The choice of statistical analysis for studies in which a hypothesis was formulated is larger. The following table may serve as a guide which statistical test should be selected for a specific goal.

Selecting a statistical test

Goal	Type of data			
	Continuous (normal distr.)	**Categorical or continuous**	**Binomial**	**Survival**

		(no normal distr.)		
Compare two unpaired groups	Unpaired *t*-test	Mann-Whitney	Chi-square or Fischer’s	Kaplan Meier
Compare two paired groups	Paired *t*-test	Wilcoxon	McNemar’s	Cox proportional hazard regression
Compare more than two unpaired groups	One-way ANOVA	Kruskal-Wallis	Chi-square	Cox proportional hazard regression
Compare more than two paired groups	Repeated-measures ANOVA	Friedman	Cochrane Q	Cox proportional hazard regression
Association between two variables	Pearson correlation	Spearman correlation	Contigency coefficients	
Predict value from another measured variable	Linear regression	Nonparametric regression	Logistic regression	Cox proportional hazard regression
Predict value from several measured variables	Multiple linear regression		Multiple logistic regression	Cox proportional hazard regression

After performing a statistical test it is tempting to just mention the p-value and conclude that the found difference is true or not. The p-value, however, only indicates how likely the result could have arisen by chance alone and does not indicate how true the difference is. Furthermore a p-value gives no information about the magnitude of the found difference. Confidence intervals (e.g. CI 95%), on the other hand, give information about the magnitude of the found difference and how precise the difference is. Therefore conclusions should be based on confidence intervals rather than on the p-value only.

Ethical considerations

A-G Jurik (Denmark)

Ethical considerations are important when planning and performing research. Within radiology general rules must always be fulfilled and when using ionising radiation also those specified for this.

Learning Objective

1: Reason for ethical rules - Nürnberg Code. http://www.ushmm.org/research/doctors/Nuremberg_Code.htm

2: General rules defined in the Declaration of Helsinki http://www.wma.net/e/ethicsunit/helsinki.htm. It was fist adopted in 1964 and has been amended five times since, most recent in 2000. Notes of clarifications were added in 2002 (§29) and 2004 (§30). Thus the 2004 version is the only official one today.

3: General rules for National and local Ethical Committees.

4: Special rules for ionising radiation.

5: How to handle the rules including application for ethical approval.

Communicating results: writing a paper, preparing abstracts, giving presentations

J Hodler (Switzerland)

Communicating results

General advice

• Be focused (concentrate on the most relevant hypothesis, methods, results and conclu-sion)

• Be precise (give numbers instead of general terms, provide complete inclusion and exclu-sion data, use references correctly, …)

• Be consistent (identical message from the title to the conclusion, consistent data)

• Grammar, style and image quality matter

• Proper scientific conduct matters (a lot) (Avoid plagiarism, duplication, give proper credit, never ever falsify data or figures, …..)

10 Steps for preparing a paper

• Select an adequate journal

• Read the instructions for authors and stick to them

• Choose a title (short, complete, one major idea)

• Write an abstract (This is the outline for the entire study. Provide numbers. Make sure that the title, the abstract and the main body of the text give the same message)

• Write the introduction (Keep it short. Limit your text to: Relevance of the study subject, cur-rent knowledge, your potential contribution and your hypothesis)

• Write the materials and methods section (Readers should be able to understand the study setup and to reproduce the results at their institutions)

• Write the results section (Provide guidance to the reader: Start with the most relevant data, summarize findings, choose the best presentation format such as text, tables, figures, and graphs)

• Write the discussion (Keep it short. Start with your hypothesis and your answer, discuss the relevance of your findings, discuss differences to previously published studies, discuss study limitations, provide a short conclusion)

• Select references (They must be up-to-date, must cover all relevant previously published studies and must be correctly cited)

• Select figures (good quality, format according to instructions to authors, illustration of the relevant findings)

Imaging at 3T

S Trattnig (Austria)

MR IMAGING at 3.0T

Siegfried Trattnig

High-field MRI at 3.0T is rapidly gaining clinical acceptance and experiencing more widespread use. The recent development of 3 Tesla MRI (3T MRI) has been fuelled by promise of increased signal-to-noise ratio (SNR). Fundamentally, an increased SNR is responsible for improved imaging at higher field strength. Increased SNR allows more room to adjust parameters that affect image resolution and examination time. There are, however, significant obstacles to 3T MRI presented by the physics at higher field strengths. For example, the T1 relaxation times are prolonged with increasing magnet field strength. Further, the larger chemical shift and the stronger susceptibility effect have to be considered as challenges. It is critical that one looks at both the advantages and disadvantages of using 3T. Consequently, scanner parameters require adjustment for optimization of images. Thus the repetion time (TR) has to be increased and the echo time (TE) shortened. Doubling of the receiver bandwidth helps to reduce the chemical shift artifact. Spectral fat saturation techniques can take advantage of the increased chemical shift. Short TE, reduction of the voxel size and use of FSE instead of GRE sequences minimizes magnetic susceptibility artifacts. The increased RF-energy deposition (SAR) and acoustic noise thresholds must be kept in mind at these higher fields. The ability to increase resolution for musculoskeletal imaging has provided previously unseen detail. Imaging applications can use the gain in signal-to-noise for increased spatial resolution or gain in speed. This comes at a trade off in increased sensitivity to field inhomogeneities and changes in relaxation times, which lead to changes in image contrast. It is clear that even with current coil technology, much of the gain in signal can be harnessed effectively; however, continued coil development is necessary to realize the full potential of 3T, especially with the optimal synergy that can be achieved with the use of parallel imaging and multiple-channel phased-array extremity coils.

Furthermore, despite the theoretic imaging challenges at higher field strengths (eg, susceptibility, chemical shift, SAR, pulsation, T1 time prolongation, and T2 time shortening), techniques and methods mentioned above can eliminate any obstacles to clinical imaging. This creates excellent opportunities to improve image quality, spatial resolution, and diagnostic accuracy in the musculo-skeletal system. Radiologists have enjoyed great success in assessing joint disease with current MR imaging field strengths; however, many intrinsic joint structures remain poorly evaluated, which leads to a good opportunity for 3T MR imaging. The articular cartilage of the hip, ankle and shoulder joint, the glenoid labrum of the shoulder and hip, the intrinsic ligaments and TFC of the wrist, the collateral ligaments of the elbow and the ankle have been evaluated suboptimally on 1.5T systems using routine nonarthrographic MR images. Because of the enhanced SNR, the higher spatial resolution, and the greater contrast-to-noise-ratio (CNR)of intrinsic joint structures at higher field strengths, 3T MR imaging has the potential to improve diagnostic abilities in the musculoskeletal system vastly, which translates into better patient care and management.

New isotropic 3D-gradient echo sequences based on GRE and newly developed on FSE technique provide reformatting in all planes after one acquisition without loss of resolution. At 3T this technique can be used for isotropic high-resolution imaging with a voxel size down to 0.5mm in the knee joint and 0.3 mm in the ankle joint which is very promising for cartilage imaging and for the evaluation of complex meniscal tears, injuries of ligaments and evaluation of the femoro-acetabular impingement of the hip. New functional cartilage imaging techniques such as T2 mapping, dGEMRIC and diffusion also benefit from the higher signal to noise ratio at 3.0T and can be performed with high sensitivity within clinical acceptable scan times in patients with early osteoarthritis and in the monitoring of surgical cartilage repair procedures.

In summary 3T imaging of the musculo-skeletal system means a another important step forward in advanced MR imaging.

Molecular imaging

P Lang (USA)

Cartilage imaging

B Vande Berg (Belgium)

MR imaging of the cartilage

MR imaging of the cartilage has two main development branches. The morphological approach used in clinical practice aims at providing information on several aspects of the cartilage including its surface, its substance and its neighbourghood. The quantitative approach used for research purpose aims at determining several parameters including the cartilage volume or thickness or biochemical composition (T2 measurements or T1 measurements after intraarticular contrast injection). It is likely that, in the future, these two approaches will join because cartilage volume assessment may be irrelevant to the disease course in a biomechanically preserved area.

Morphological assessment of the cartilage by using MR imaging, the imaging modality of choice, requires high spatial resolution and a sequence that is sensitive to alteration in water content (mainly T2 sequences or T1 with fat-saturation).

Target areas

MR imaging is the imaging modality of choice for the assessment of hyaline cartilage. The technical prerequisite include high spatial resolution (3D imaging with 1-mm-thick sections) and a sequence that is sensitive to alteration in water content (mainly T2-weighted sequences or T1-weighted with fat saturation). The 3 target areas to image in cartilage disease are (a) the cartilage surface, (b) the cartilage substance and (c) the subchondral bone marrow. Up to now, no single sequence enables accurate depiction of these three areas. Cartilage assessment implies assessment of the cartilage surface (interrupted? fibrillations?), the cartilage substance (abnormal signal intensity? substance loss?) and of the adjacent marrow (edema?).

MR imaging techniques

MR imaging can be used for quantitative and morphological assessment of the hyaline cartilage. Quantitative MR imaging techniques are used in clinical studies and for research purpose. Determination of T2 relaxation times, of T1 relaxation time after intraarticular injection of gadolinium, of cartilage volume and cartilage thickness mapping all enable valuable assessment of biochemical or physical characteristics of the cartilage.

Morphological assessment of the cartilage is performed in clinical practice and is less reproducible. In our practice, we use the fat-saturated proton-density sequence with a slice thickness of 1 to 3mm to assess the cartilage because it also enables assessment of the other components of the joint. It is sensitive to bone marrow changes and cartilage lesions show variable signal intensity. Dedicated sequences like the fat-saturated T1-weighted gradient-echo sequence in the 3D mode are commonly recommended. However, they do not enable assessment of the subchondral bone marrow and all cartilage lesions show decreased signal intensity.

MR imaging of the normal cartilage

Articular hyaline cartilage signal is low on T1-, intermediate on proton-density- and low on T2-weighted spin-echo sequences. It is low to intermediate on fat-saturated intermediate-weighted fast spin-echo sequence. MR imaging is the unique technique that enables assessment of the deep layer of the cartilage. However, one must take into account significant variations in the cartilage MR appearance depending on the used sequence, the articular area and the orientation of the articular surface with respect to the main magnetic field

Chemical shift artifact secondary to error in spatial determination of water and fat components due to differences in Larmor frequency can interfere with the depiction of the water-fat interface in other words of the interface between cartilage (water-equivalent) and bone marrow (fat-equivalent). The real cartilage thickness is therefore difficult to assess on conventional SE sequences and the low signal intensity line at the interface between marrow and cartilage does not correspond to the subchondral bone plate but to an artifact.

Truncature artifact secondary to insufficient sampling can generate low signal intensity lines within the cartilage substance. Magic angle artifact induces increase in signal intensity of the cartilage in fibrillar structures when they show a 55° angulation with respect to the longitudinal magnetic field.

MR appearance of cartilage lesions

In theory, a cartilage defect is filled by articular fluid. Therefore, a cartilage defect should appear as a high signal intensity area on T2-weighted images and presence of fluid-like signal intensity in the cartilage on T2-weighted SE sequence is probably the most specific sign indicative of a cartilage defect. Unfortunately, this sign is not sensitive. Other sequences that are more sensitive to subtle alteration in the cartilage content must be used for better accuracy. Other signs suggestive of cartilage lesions include thinning of the cartilage and loss of the sharpness on the cartilage contours.

On intermediate-weighted spin-echo images, the signal intensity of cartilage defects can vary from low to high signal intensity. In a series of 83 cartilage defects demonstrated at knee CT-arthrography, 70% of the defects showed an MR signal intensity that was higher than that of adjacent cartilage, 20% showed MR signal intensity equivalent to that of adjacent cartilage (lesions not seen on MR images) and 10% of lesions showed an MR signal intensity lower than that of adjacent cartilage. Lesions with MR signal intensity superior to that of normal cartilage were more extensive than those with MR signal intensity equivalent to or lower than that of adjacent cartilage.

Accuracy of MR imaging and spiral CT-arthrography

Accuracy of MR imaging for the detection of cartilage lesions varies greatly depending on the study population, the lesion classification system, the MR technique, and the statistics. To summarize, neither MRI nor CT-arthrography are able to detect superficial fibrillations without substance loss of the cartilage. Both techniques are highly accurate for the depiction of “down-to-bone” lesions. They show variable performance in the depiction of not “down-to-bone” cartilage defects. In a cadaver knee study, CT-arthrography was found to enable more accurate extent of the depth of the cartilage defect.

Take-home points

1. MR imaging of cartilage is an on-going challenge that requests higher spatial resolution and better tissue contrast than what is obtained in routine clinical practice if the cartilage surface, the cartilage substance and the subchondral marrow are to be assessed.

2. The fat-saturated intermediate-weighted FSE sequence is an acceptable compromise for cartilage assessment in clinical practice.

Developments in US

A Klauser (Austria)

The role of hybrid modalities (PET/CT and SPECT/CT) in MSK

M Reiser (Germany)

MRI assessment of the failing prosthesis

S Eustace (Ireland)

Traditional evaluation of failing hip prostheses integrates the use of radiographs, scintigraphy, ultrasound and aspiration/subtraction arthrography. Reflecting concerns re safety and metal induced image degradtion there has been little use of MRI as a problem solving tool in this setting.

This talk reviews safety issues, artefact reduction techniques and clinical use of MRI as a problem solving tool in patients with failed hip prostheses.

The talk specifically outlines the use of MRI as an adjunct to the assessment of prostheses infection, muscle integrity, and in the evaluation of unusual causes of persistent discomfort following hip replacement such as trochanteric bursitis, ileopsoas bursitis, hamstring tendinopathy and occult osseous injury.

Insufficiency fractures

J Bauer (Germany)

Learning Objectives:

1. To understand the importance of correctly diagnosing osteoporotic insufficiency fractures.

2. To be familiar with the typical morphologic criteria of insufficiency fractures.

3. To know typical criteria of benign versus malignant disease.

4. To be familiar with strengths and weaknesses of MR versus CT imaging of insufficiency fractures.

Femoro-acetabular Impingement

M Zanetti (Switzerland)

Femoroacetabular impingement (FAI) or acetabular rim syndrome refers to a conflict be-tween the proximal femur and the acetabular rim. FAI is a reason for premature os-teoarthritis of the hip. Two different types of FAI, the “cam” and the “pincer” type of FAI can be differentiated based on the predominance of a femoral or acetabular abnormality. In cam FAI aspherical shape of the femoral head and a reduced depth of the femoral waist leads to an abutment of the femoral head-neck junction against the acetabular rim. In Pincer impingement an acetabular over-coverage limits range of motion and leads to a conflict between the acetabulum and the femur. It is important to identify the type of FAI because surgical treatment is different. In cam impingement the basic surgical concept is a reshaping of the femoral waist and restoring the lateral sphericity of the femoral head. In pincer FAI a reduction of the acetabular over coverage by trimming of the acetabular rim will be performed. The role of MR imaging is to assess the degree of labrum and cartilage damage within the joint. Another important task for the radiologist is to quantify the extent of osseous abnormality (alpha angle, acetabular retroversion in the two types of FAI).

Learning objectives:

1. To know the concept of FAI.

2. To know the damage pattern in the two types of FAI.

3. To show the most commonly performed measurements in FAI.

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