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Role of MRI in the evaluation of different ankle and foot pathologies

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Abstract

Introduction: Ankle injuries have been reported to be the most common type of lesion in 24 of 70 sports, ankle sprain being the most frequent. Osteochondral lesions of the ankle are being recognized as an increasingly common injury and have been reported in as many as 50% of acute ankle injuries, particularly sports-related injuries.

Objective: The purpose of this study is to provide musculoskeletal imaging techniques for ankle and foot evaluation, targeting clinical questions and diagnostic challenges.

Materials and methods: This is a prospective, observational and descriptive study conducted in the Department of Radiodiagnosis, Subbaiah Institute of Medical Sciences and tertiary care hospitals, Shivamogga over a period of 9 months. This study includes 70 patients with different complaints in the ankle including, pain around the ankle, decreased movement of ankle joint, difficulty in walking, swelling around the ankle, tenderness in the ankle and trauma to the ankle. The patients underwent Magnetic Resonance Imaging (MRI) of the ankle joint.

Results: In our study 70 patients with different ankle complaints were subjected to MRI of the affected ankle after initial examination and basic investigation including plain radiography. Patients were broadly grouped into different categories based on their etiology as traumatic, neoplastic, infective/inflammatory, degenerative and miscellaneous. We found that traumatic etiology was more common, seen in 24 patients (34.2%) followed by Infective/inflammatory etiology seen in 18 patients (25.7%) while least common was neoplastic seen in 6 patients (8.5%). Degenerative etiology was seen in 13 patients (18.5%) and other miscellaneous causes was seen in 9 patients (12.8%).

Conclusion: MRI provides a means of depicting ligament injuries and can be used to differentiate ligament tears from other causes of ankle pain and injury.

Keywords: MRI, bones, traumatic, neoplastic, infective

Introduction

Ankle injuries are common among high-performance athletes and the general population, accounting for as many as 10% of emergency department visits^[1]. Ankle injuries have been reported to be the most common type of lesion in 24 of 70 sports, ankle sprain being the most frequent.^[2] Osteochondral lesions of the ankle are being recognized as an increasingly common injury and have been reported in as many as 50% of acute ankle injuries, particularly sports-related injuries^[3]. Achilles tendon injury is one of the most common overuse injuries in athletes, and it includes the tendon and surrounding soft tissues^[4].

Pathologic entities that commonly affect the ankle vary in tissue type, mechanism of injury, and acute versus chronic presentation. When the complex anatomy of the ankle is factored into these components of the equation of MRI diagnosis, it is necessary to leverage all tools at our disposal for accurate characterization of disease^[5]. The acquisition of optimal MR images of the ankle has inherent challenges beyond complex anatomy. The ankle is the transition point between the distal leg and foot, with structures oriented at right angles to one another. Because of this configuration, imaging at or near this magic angle is difficult to avoid^[6].

The peripheral position of the ankle calls for attention to maintaining imaging at the isocenter of the bore to leverage homogeneous field strength and gradients. Although consideration of imaging plane and pulse sequence choice is primarily emphasized for both routine and tailored protocols, the coils for image acquisition cannot be taken for granted^[7]. Use of dedicated surface coils improves spatial resolution and field homogeneity, particularly for the imaging of small peripheral joints.

Dedicated extremity coils are generally used to optimize Signal-to-noise ratio (SNR) ^[8]. Local transmit coils reduce radiofrequency power and the associated specific absorption rate compared with the effects of receive-only coils. This allows more slices per acquisition. Use of multichannel coils increases SNR and the ability to use parallel imaging techniques ^[9].

Although not crucial, there are significant advantages to ankle MR image acquisition with a 3-Tesla (3-T) system. The main advantage of higher field strength results from a near linear increase in SNR, which can be used to improve resolution, decrease acquisition time, or both ^[10]. There are also possible limitations to increased field strength. Metallic susceptibility increases with increasing field strength, resulting in greater signal loss, geometric distortion, and heterogeneous fat suppression, among other things. Chemical shift and pulsation artifacts are also more pronounced. T1, and to a lesser degree, T2 relaxation times are affected by field strength, requiring alterations in pulse sequence parameters ^[11].

The goal of this study is to provide musculoskeletal imaging techniques for ankle and foot evaluation, targeting clinical questions and diagnostic challenges. We offer guidance and considerations for routine protocols, provide indication-driven protocols addressing specific clinical concerns, and profile the application of Ultra short Echo Time (UTE) MRI techniques in the ankle and foot.

Aims and objective

To categorize different ankle pathologies using MRI based on their etiology and to evaluate the prevalence of different pathologies in different age groups and the involvement of different structures in various ankle pathologies.

Materials and Methods

This is a prospective, observational and descriptive study involving 70 patients, in the Department of Radiodiagnosis, Subbaiah Institute of Medical Sciences and tertiary care hospitals, Shivamogga over a period of 9 months.

Inclusion Criteria

- Patients above the age of 18 years of either gender presenting with ankle joint and foot related complaints.
- Patients with fractures/dislocations around the ankle joint and foot, tumorous conditions involving the foot and the ankle joint, patients with infections, amputations, and inflammatory arthritis were included in the study.

Exclusion criteria

- Patients having any type of orthopaedic implants in the ankle region.
- Patients with metallic hip implants and cardiac pacemakers.
- Pregnant women.

Methods

Clinical information included a brief history of the patient, with a whole spectra of varied symptom including pain in and around ankle and foot, restriction of joint movement, difficulty in walking, swelling with or without tenderness

around the ankle and foot which caused the clinician to get MRI ankle done.

MRI Examination

- MRI was performed using GE 1.5 tesla MRI machine.

Patient position and coils

- Imaging was done with the foot in about 20° of plantar flexion with the patient in a supine position. A standard knee coil was used.

Scanning protocol

- The MR imaging criteria for the diagnosis of acute rupture of ligament include morphologic and signal intensity alterations within and around the ligament. ^[12]
- The imaging planes, sequences, and even the selection of which coil to use varied depending on the clinical circumstances. The lower extremity was externally rotated and the plane of imaging was oriented to the anatomy of the foot, rather than to the magnet. Only the extremity with a suspected abnormality was imaged to employ a small field of view to increase the detail and resolution of the images.
- The Field of view (FOV) included the distal tibia and fibula, all of the tarsal bones, and the bases of the metatarsals.

MRI Sequences

- T1-Weighted (T1-W) images: It was evaluated for normal anatomy of bones, ligaments, tendons, joints, synovium, soft tissue and neurovascular bundles in axial, coronal and sagittal planes.
- T2-Weighted (T2-W) images: It was evaluated for pathologies of bones, ligaments, tendons, joints, synovium, soft tissue and neurovascular bundles in axial, coronal and sagittal planes.
- Proton Density Fat Saturation (PDFS) images: It is particularly important when tendons and ligaments are the site of clinical concern and evaluated in axial, coronal and sagittal planes.
- Short T1 Inversion Recovery (STIR) images: It is particularly done to evaluate the bone marrow, bone tumours and metastasis in axial, coronal and sagittal planes.
- Post contrast T1-W images: It is used to evaluate bone or soft tissue mass and other infectious etiologies as and when required.

Statistical analysis

Data analysis: Was done in Microsoft Excel by descriptive analysis of different ankle and foot pathologies on MRI sequences.

Result

MRI features of different ankle and foot pathologies were evaluated using various conventional as well as specific Magnetic Resonance (MR) sequences and characterized based on their etiology, structures involved in the pathology and other associated abnormalities. After careful evaluation of different MR sequences and patient's clinical complaints, final diagnosis was made.

Table 1: Classification according to different age groups

Age Groups (Years)	No. of patients (n=70)	Percentage (%)
Below 20	3	4.3
20-40	17	24.3
41-60	29	41.4
>61	21	30
Total	70	100

In table 1, out of the 70 cases studied, 29 (41.4%) patients were in the age group of 41 to 60 years, followed by more than 60 years age in 21 (30%) patients and 20-40 years in 17 (24.3%) patients and least were 3 (4.3%) patients whose age was less than 20 years.

Table 2: Distribution of gender (n=70)

Gender	No. of patients	Percentage %
Male	41	58.6
Female	29	41.4
Total	70	100

In table 2, a total of 70 subjects were included out of which 41 (58.6%) were males and 29 (41.4%) were females.

Table 3: Classification based on types of etiology (n=70)

Type of etiology	Number	Percentage %
Traumatic	24	34.2
Neoplastic	6	8.5
Infective/inflammatory	18	25.7
Degenerative	13	18.5
Miscellaneous	9	12.8

In table 3, patients were broadly grouped into categories based on their etiology as traumatic, neoplastic, infective/inflammatory, degenerative and miscellaneous. We found that traumatic etiology was more common seen in 24 patients (34.2%) followed by Infective/inflammatory etiology seen in 18 patients (25.7%) while least common etiology was neoplastic seen in 6 patients (8.5%). Degenerative etiology was seen in 13 patients (18.5%) and other miscellaneous causes seen in 9 patients (12.8%) which include synovial chondromatosis, os trigonum, focal marrow edema, isolated joint effusion and reflex sympathetic dystrophy.

Table 4: Site of the tendon pathologies

Site of the tendon pathologies	No. of patients	Percentage %
Achilles tendon	12	17.1
Flexor tendons	21	30
Extensor tendons	4	5.7
Peroneus tendons	25	35.7

Table 5: Site of the ligamentous pathologies

Site of the ligamentous pathologies*	Number	Percentage %
Anterior talofibular ligament	12	17.1
Posterior talofibular ligament	4	5.7
Calcaneofibular ligament	5	7.1
Deltoid ligament complex	2	2.8
Tibiocalcaneal ligament	1	1.4
Tibionavicular ligament	1	1.4

*Multiple responses allowed

Table 6: Magnetic resonance imaging findings – tendon pathologies

MRI findings tendon pathologies*	Number	Percentage %
Tenosynovitis	22	31.4
Complete rupture	9	12.8
Encased	2	2.8
Partial thickness tear	4	5.7
Tendinopathy	11	15.7
No lesions	34	48.6

*Multiple responses allowed

Table 7: Magnetic resonance imaging findings – ligament pathologies

MRI findings ligament pathologies	Number	Percentage %
Full thickness tear	12	17.1
Partial tear	6	8.5
Grade I sprain	7	10

Discussion

MRI of the ankle is one of the frequent investigations faced in daily radiological practice. This approach is an example of how to create a radiological report of an MRI of the ankle with coverage of the most common anatomical sites of possible pathology, within the ankle without claim for completeness.

Non-traumatic cause represented the most common etiology of pathologies of the ankle joint and foot and rest were due to trauma. We sub classified non-traumatic etiologies into infective, inflammatory, and neoplastic with infective etiology being the most common. However, detailed history of the patients revealed little over one-third of the patients with non-traumatic pathologies had a prior history of trauma.

Out of the 70 cases studied, we came to know that different etiologies were common in different age groups. In our study, traumatic etiology was most commonly seen in the patients of 41-60 years age group involving 24 patients (34.2%) which matched with Flick AB et al. who reported that tendon ruptures are commonly affecting the middle aged between 35 and 60 years [12]. However, they have included only traumatic tendon injury among the different age groups which is lacking the prevalence of other etiologies in different age groups which were included in our study. De Smet AA et al. found that there was a stronger positive association of foot and ankle pain with age (over 45 years) among females than males [13]. Our study with 25 patients with age of more than 40 years showed a difference in the pattern from Mesgarzadeh M et al., with male patients more frequently complaining of pain of the ankle joint and foot [14].

Clinically, the posterior impingement syndrome presents with chronic pain and swelling within the posterior ankle. Classically, this is seen with activities that cause extreme plantar flexion, such as ballet, soccer, football and downhill running [15]. The two main proposed mechanisms of posterior impingement are: (1) an acute plantar hyperflexion injury and (2) chronic repetitive microtrauma [16]. The similarity between the two mechanisms revolves around the posterior soft tissues, which may become secondarily hypertrophied and compressed between the posterior talus and the calcaneus. The presence of an osseous body (os trigonum or prominent Stieda's process) can further narrow

this space, which has led to its other name of “os trigonum syndrome”^[17]. This increased compression leads to damage to the regional tendons and ligaments. Flexor hallucis longus tenosynovitis is commonly encountered. Important differentials include Achilles tendinosis/tear, arthrosis, acute posterior talar process fractures, Haglund's syndrome, osteochondral lesions and retro calcaneal bursitis^[18-20].

Conclusion

Knowledge of anatomy and imaging appearance of normal and abnormal ankle ligaments on MRI with an understanding of biomechanics of injury aids in achieving accurate diagnosis and appropriate treatment of ankle sprains. MRI provides a means of depicting ligament injuries and can be used to differentiate ligament tears from other causes of ankle pain and injury.

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