Original Research Article

High-Resolution 3-Tesla MRI in the Evaluation of Ankle and Hindfoot Pain

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Abstract

Background: Ankle and hindfoot pain can be due to a myriad of conditions including both traumatic causes such as fractures, tendon or ligamentous injuries and nontraumatic causes such as osteomyelitis, impingement syndromes, entrapment neuropathies, plantar fasciitis, etc. However, most of these conditions present with nonspecific and overlapping signs and symptoms. Therefore, imaging plays a pivotal role in the diagnosis and management of ankle and hindfoot pain. **Aim and Objective:** 1. Study roll of High-Resolution 3-Tesla MRI in the Evaluation of Ankle and Hindfoot Pain. 2 Proportion of etiological agent in ankle and hindfoot pain. **Methodology: Study design:** A Cross Sectional Study. **Study setting:** Radio diagnosis department of Dr. D.Y Patil Medical College and Research Institute, Kolhapur. **Study duration:** from March 2022 to March 2023. **Study population:** The study population included all the cases with ankle and hindfoot pain patients admitted at a tertiary care center and referred to radiodiagnosis department for investigation. **Sample size:** 100 **Results:** majority of cases found in 46-55 years age group followed by 31-45 years group 22 cases, above 65 age group 20 cases, 18 cases in 56-65 age group and 13 cases in 18-30 years age group. Most of cases were males71 and females 29 cases. majority of cases diagnosed with achilles tendinosis 22 cases followed by complete rupture of Achilles tendon 17,plantar fasciitis 15,haglund syndrome 11,ankle impingement 10,plantar fibromatosis 7,ankle tuberculosis 6,complex regional pain syndrome 5,sinus tarsi syndrome 4 cases and pigmented villonodular synovitis 3 cases **Conclusions:** MRI is an excellent imaging modality in the evaluation of ankle and hindfoot pain. MRI can also aid in early detection of few osseous abnormalities seen in the bones constituting the ankle joint.

Keywords: Ankle, Hindfoot, Magnetic resonance imaging

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INTRODUCTION

Ankle and hindfoot pain can be due to a myriad of conditions including both traumatic causes such as fractures, tendon or ligamentous injuries and nontraumatic causes such as osteomyelitis, impingement syndromes, entrapment neuropathies, plantar fasciitis, etc. However, most of these conditions present with nonspecific and overlapping signs and symptoms. Therefore, imaging plays a pivotal role in the diagnosis and management of ankle and hindfoot pain. Various imaging modalities can be used for the diagnosis of ankle and hindfoot pain such as plain radiographs, ultrasonography, computed tomography, and magnetic resonance imaging (MRI). Imaging of the ankle and foot usually begins with plain radiographs. However, plain radiographs are nonspecific and have low sensitivity in the detection of soft tissue injuries, while ultrasonography is operator dependent. Computed tomography is useful in the detection of bone pathologies but has limited role in soft tissue injuries. MRI with its excellent soft tissue contrast resolution, noninvasive nature, and multiplanar capability with no radiation hazard, has now assumed center stage in the evaluation of ankle and hindfoot pain.

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NORMAL ANATOMY

Ankle joint is made of two joints − the true ankle joint and the subtalar joint .Three ligamentous groups provide support to the ankle joint, namely,[1] the syndesmotic ligament complex which is made of anterior and posterior tibiofibular and interosseous ligaments the lateral ligament complex composed of anterior talofibular, posterior talofibular ligament , and the calcaneofibular ligament and the medial ligament/deltoid ligament complex composed of deep tibiotalar ligament and superficial tibiocalcaneal, tibiospring , and tibionavicular ligament .

The various tendons around the ankle joint can be arranged in four major groups: the flexors on the medial side include tibialis posterior, flexor digitorum longus, and flexor hallucis longus tendon; the extensors on the anterior side include tibialis anterior, extensor hallucis longus tendon, and extensor digitorum longus tendon; the peroneal tendons on the lateral side include peroneus longus and peroneus brevis tendon; and posteriorly the Achilles and plantaris tendon.

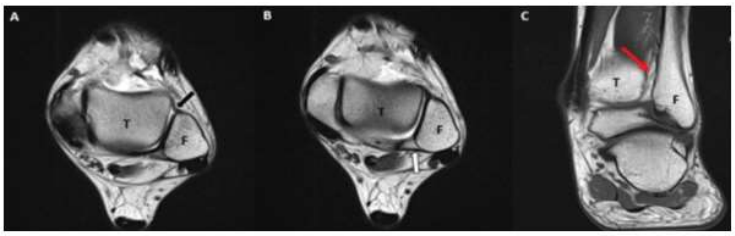

Figure 1

Figure 1: (A and B) Axial T2W images of the ankle show the normal anterior inferior tibiofibular (black arrow with white outline) and posterior inferior tibiofibular (white arrow with black outline) ligaments. (C) Coronal T1W image shows the normal interosseous ligament (red arrow) between tibia (T) and fibula (F) − normal syndesmotic ligament complex

LIGAMENT ABNORMALITIES

Ligament injuries around the ankle joint are commonly seen and can involve both the lateral ligament complex and/or medial ligament complex. Out of these, the lateral ligament complex injuries are more frequent and constitute nearly 75% of all sports-related injuries.[2] Among the ligaments constituting the lateral ligament complex, ATFL is the most commonly injured ligament.[3] The high frequency of ATFL tears can be attributed to its biomechanics. Most ATFL tears occur in forced plantar flexion with inversion of foot when it assumes a more vertical orientation and is strained; moreover, there is absence of the stabilizing effect of CFL in this position, exposing the ATFL to injuries.[4]

Calcaneofibular ligament is the second most commonly injured lateral ligament[5] and most injuries are seen in conjunction with tears of ATFL or other ligaments. PTFL is the least commonly injured ligament, isolated injuries are rare and most PTFL tears occur in presence of ATFL, CFL tears with extreme ankle dislocation. Medial ligament complex/deltoid ligament injuries occur infrequently in isolation and are mostly associated with other ligament injures and medial malleolar fractures.[6] There is a higher rate of injury in the superficial deltoid compared to the deep deltoid component. The strongest ligaments are the posterior deep TiTL and TiSL, whereas the weakest component is the TiNL. Injuries can be acute, which on MRI are seen as ligaments with replacement of normal hypointense signal by hyperintense signal on T2-weighted (T2W)/proton density (PD) images; ill-defined, fuzzy margins; irregular contours; discontinuous/lax fibers/wavy fibers; and ankle joint effusion and surrounding soft tissue edema. There can also be loss of normal striations owing to edema and hemorrhage. Chronic ligament injuries on MRI show either a thin, hypoplastic or a thick, hyperplastic ligament with irregular contours and resolution of edema and joint effusion.

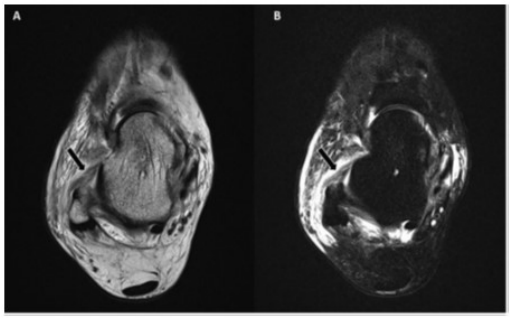

Figure 2

Figure 2: Axial T2W(A) and T2Wfat saturated (B) MR images of the right ankle showing thickening of the anterior talofibular ligament with intrasubstance high signal intensity (black arrow with white outline) and fluid in the anterolateral recess−partial tear of anterior talofibular ligament

TENDON ABNORMALITIES

On MRI, it is seen as fluid accumulation (hypointense on T1W and hyperintense on T2W images) surrounding the entire circumference of the tendon, synovial proliferation, and scarring of the tendon sheath. Excessive synovial proliferation and scarring around the tendon, manifesting as low to intermediate signal intensity soft tissue around tendon on magnetic resonance (MR) images can cause entrapment or rupture of the tendon.

Acute partial tears show incomplete disruption in continuity of the tendon fibers with increased signal within the tendon on T2W/proton density fat saturated (PDFS) sequences. Chronic tears show low signal intensity on T2W sequences owing to scarring and fibrosis. Complete tears show complete disruption of tendon fibers with fluid filled gap. MRI is also useful to assess the condition of tendon remnants as well as degree of retraction in such cases.

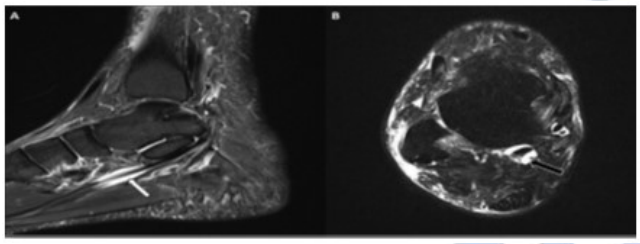

Figure 3

Figure 3: (A) Sagittal STIR image of the right ankle shows fluid collection along the tendon sheath of flexor hallucis longus tendon inferior to the navicular bone (white arrow with black outline). (B) Coronal STIR image shows fluid collection along the tendon sheath of flexor hallucis longus tendon inferior to the navicular at the knot of Henry (black arrow with white outline) – flexor hallucis longus tendon tenosynovitis

ACHILLES TENDON

Achilles tendinosis can present as fusiform thickening of the Achilles tendon on sagittal images, with loss of normal concavity of anterior tendon margin on axial images and areas of increased signal within the tendon on T2W/ short tau inversion recovery (STIR) sequences. Tear of Achilles tendon is common with ankle injuries.[7] In complete tear, there is retraction of tendoachilles fibers with a fluid-filled gap between the proximal and distal ends of the tendon, along with extensive fraying of the tendon edges. MRI accurately detects complete tear as well measures the width of the diastasis between the ends of the torn tendon.

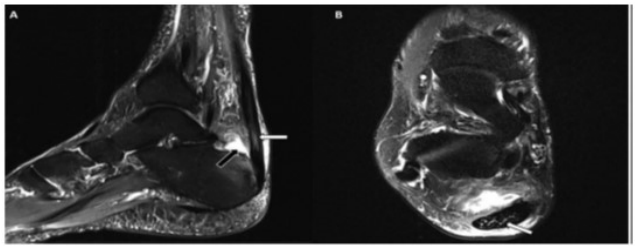

Figure 4

Figure 4: (A) Sagittal STIR image of the right ankle shows bulky distal end of Achilles tendon with linear hyperintensities within its fibers (short white arrow) and fluid in Kager fat pad (black arrow with white outline).
(B) Axial T2W fat saturated image shows thickening of distal Achilles tendon with intrasubstance high signal intensity (white arrow with black outline) – Achilles tendinosis

HAGLUND SYNDROME

Haglund deformity is defined as a bony projection on the posterosuperior aspect of the calcaneal tuberosity which can be seen on the lateral view radiographs of ankle. [8] On MRI, Haglund deformity presents as a "bony bump" along the posterior superior corner of the calcaneal tuberosity best appreciated on sagittal T1W images; T2W sequence show excessive fluid in retrocalcaneal bursa, retro-Achilles bursa, and increased signal or partial tear of Achilles tendon at its insertion site, completing the constellation of findings in Haglund syndrome.

Figure 5

Figure 5: (A) Lateral radiographic view of the right ankle shows hypertrophy of the posterosuperior aspect of calcaneum (white arrow). (B) Sagittal STIR image in the same case shows bony prominence of posterosuperior aspect of calcaneal tuberosity/ Haglund deformity (white arrow) with thickening and linear hyperintensities in distal tendoachilles (white arrowhead). Fluid in the retrocalcaneal bursa (black arrow with white outline) and edema in the
calcaneum is also seen – Haglund syndrome

IMPINGEMENT SYNDROME

Ankle impingement is defined as entrapment of an anatomical structure which causes pain and restricted motion of the ankle, and results from repetitive or acute forced plantar flexion of foot. MR findings can reveal an os trigonum, a Stieda process causing impingement on the flexor hallucis longus tendon, bone marrow edema in the

lateral talar tubercle, and os trigonum and tenosynovitis of flexor hallucis longus tendon. Inflammatory changes and fluid can be in the posterior recess of subtalar and tibiotalar joints.

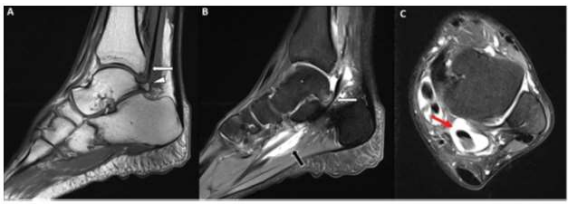

Figure 6

Figure 6: Sagittal T1W (A) and STIR (B) images of the left ankle show a Stieda process (white arrowhead) causing impingement of the flexor hallucis longus tendon (white arrow with black outline) with loculated collection along the tendon sheath of flexor hallucis longus tendon (black arrow with white outline). (C) Axial T2W fat saturated image shows fluid along the flexor hallucis longus tendon posterior to the talus (red arrow) – posterior impingement syndrome

PLANTAR FASCIITIS

Plantar fasciitis refers to the inflammation and microtears of plantar fascia due to repetitive mechanical stress and trauma. The normal plantar fascia is usually seen as a thin linear hypointense structure with thickness ˷ 3.22mm± 0.53mm on sagittal and coronal MR images with slight expansion at its calcaneal end.[2] In plantar fasciitis, the plantar fascia shows fusiform thickening (up to 7–8mm) along with intermediate signal intensity on T1W and PD images and hyperintense signal on T2W and STIR images within it.

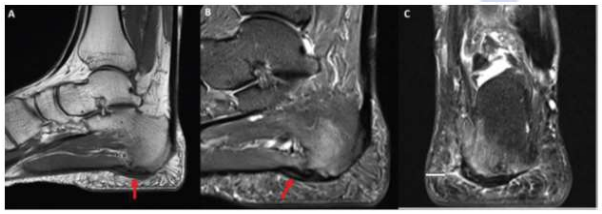

Figure 7

Figure 7: Sagittal T1W (A) and STIR (B) images of the left ankle show thickening of the proximal part of plantar fascia with intrasubstance high signal intensity (red arrow). (C) Coronal STIR image shows similar findings with perifascial edema which has high signal intensity (white arrow with black outline). Edema in the calcaneum is also seen – plantar fasciitis

PLANTAR FIBROMATOSIS

Plantar fibromatosis is a rare, benign, hyperproliferative disorder of the plantar aponeurosis.[10] On MRI, plantar fibromatosis is usually seen as an ill-defined, infiltrative mass involving the deep aponeurosis along the plantar muscles on medial aspect of foot. It is of low signal intensity on T1W and low to intermediate signal on T2W images owing to the presence of collagen tissue.

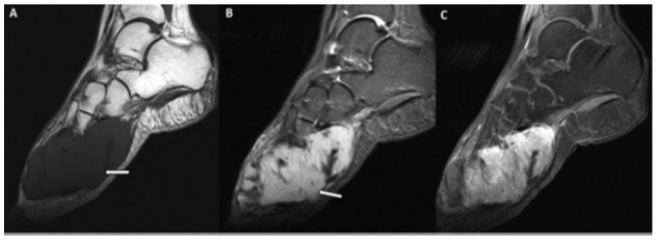

Figure 8

Figure 8: Sagittal T1W (A) and STIR (B) images of the left ankle show a well-defined lobulated lesion adjacent to the plantar fascia, appearing hypointense on T1W and hyperintense on STIR images with hypointense foci within (white arrow with black outline). (C) Sagittal postcontrast image shows avid enhancement of the lesion with few areas of low signal within – plantar fibromatosis

ANKLE TUBERCULOSIS

Extrapulmonary tuberculosis (TB) is seen to affect 20% of patients with TB and musculoskeletal TB accounts for only 1% to 3% of extrapulmonary tuberculous infections.[12] On MRI, most cases of ankle joint TB show synovial thickening, intraosseous and soft tissue abscess/phlegmon formation with joint effusion commonly affecting the subtalar joint. The most commonly affected bone is talus with bone involvement in the form of signal alteration of bone marrow (appearing hypointense on T1W and hyperintense on T2W images) and areas of lytic bone destruction[13]

MATERIAL AND METHODS

Study design: A Cross Sectional study

Study setting: Radio diagnosis department of Dr. D.Y Patil Medical College and Research Institute, Kolhapur

Study duration: From March 2022 to March 2023

Study population: The study population included all the cases with intractable epilepsy patients admitted at a Radio diagnosis department of Dr. D.Y Patil Medical College and Research Institute, Kolhapur

Inclusion criteria: All patients with ankle and hindjoint pain admitted in Radio diagnosis department of Dr. D.Y Patil Medical College and Research Institute, Kolhapur

Exclusion criteria: Not willing to participate in the study.

Approval for the study: Written approval from Institutional Ethics committee was obtained beforehand. Written approval of Radio diagnosis department was obtained. After obtaining informed verbal consent from all patients with ankle and hindjoint pain admitted in radio diagnosis department of Dr. D.Y Patil Medical College and Research Institute, Kolhapur such cases were included in the study.

Sample Size: 50

Sampling technique: Convenient sampling technique used for data collection.

Methods of Data Collection and Questionnaire:

Predesigned and pretested questionnaire was used to record the necessary information. Questionnaires included general information, such as age, sex, religion, residential address, and date of admission. Medical history- chief complain, past history, general examination, systemic examination

Data on demographic profile of ankle and hindjoint pain patients, investigation, personal history, medical past history data collected from patients admitted in radio diagnosis ward.

All the procedures and investigations conducted under direct guidance and supervision of pg guide. Proforma of ankle and hindjoint pain notes maintained.

Data entry and analysis

The data were entered in Microsoft Excel and data analysis was done by using SPSS demo version no 21 for windows. The analysis was performed by using percentages in frequency tables and correlation of stroke. $p<0.05$ was considered as level of significance using the Chi-square test

RESULT AND OBSERVATION

Table 1: Distribution of Cases According to Age (N=100)

Age in years	Frequency	Percentage
18-30	13	13%
31- 45	22	22%
46- 55	27	27%
56-65	18	18%
Above 65	20	20%
Total	**100**	**100 (100%)**

The above table shows majority of cases found in 46-55 years age group followed by 31-45 years group 22 cases, above 65 age group 20 cases, 18 cases in 56-65 age group and 13 cases in 18-30 years age group.

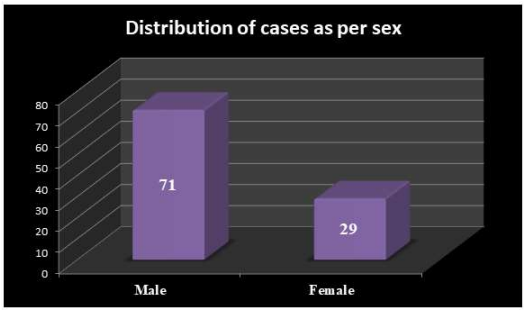

Figure 8

Above picture shows most of cases were males71 and females 29 cases

Table 2: Distribution of Cases According to MRI Diagnosis

MRI Diagnosis	Frequency	Percentage
Achilles tendinosis	22	22%
Complete rupture of Achilles tendon	17	17%
Haglund syndrome	11	11%
Ankle impingement	10	10%
Plantar fasciitis	15	15%
Plantar fibromatosis	07	07%
Ankle tuberculosis	06	06%
Complex regional pain syndrome	05	05%
Sinus tarsi syndrome	04	04%
Pigmented villonodular synovitis	03	03%
Total	**100**	**100 (100%)**

The above table shows majority of cases diagnosed with achilles tendinosis 22 cases followed by complete rupture of Achilles tendon 17, plantar fasciitis 15, haglund syndrome 11, ankle impingement 10, plantar fibromatosis 7, ankle tuberculosis 6, complex regional pain syndrome 5, sinus tarsi syndrome 4 cases and pigmented villonodular synovitis 3 cases.

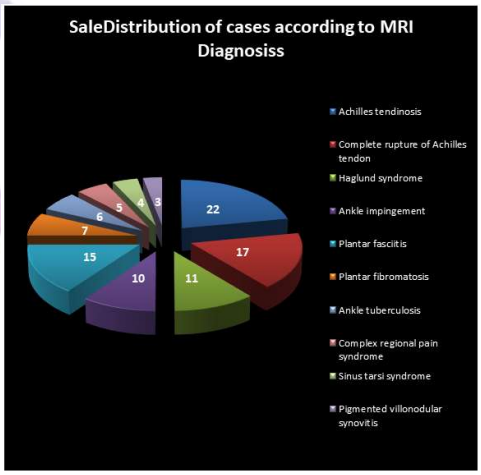

Figure 9

DISCUSSION

Magnetic resonance imaging is an efficient investigation in ankle joint assessment. It has excellent resolution, soft tissue contrast and provides multiplanar imaging. It is a reliable technique and offers excellent depiction of both soft tissue and osseous structures. MRI also has been used for the observation of extraarticular anatomy. This study included fifty cases with ankle pain to evaluate the role of MRI in assessment of different pathologies of the ankle joint especially those related to ankle tendons and ligaments. Rosenberg *et al.* found MRI for diagnosing ruptures of the tendons to be sensitive in (95%) of cases and specific in (100%). Although the achillis tendon is the strongest tendon in the human body, all literature agreed that it is the most commonly injured ankle tendon. In a

severe injury of the Achilles tendon, too much force on the tendon can cause it to tear partially or rupture completely. In our study 39 cases (39% of all tendinous pathologies) were diagnosed as Achilles tendon injuries. Of all the tendon of the ankle, the Achilles is the only one for which disorder have a male predominance. In our study also this finding was corroborated. Complete ruptures of the Achilles tendon observed in 17 cases. Helms *et al.* stated that the anterior talofibular ligament is the most commonly torn ligament of the ankle. It is often an isolated tear, but if the traumatic forces are great enough, the other ligaments may tear in a sequential fashion. That is, after the anterior talofibular ligament tears, the calcaneofibular ligament tears, followed, only rarely, by the posterior talofibular ligament. The sinus tarsi syndrome is a pain syndrome characterized by lateral foot pain and the subjective feeling of hindfoot instability. MRI does not consistently show the ligaments of the sinus tarsi even when they are present and intact, so not identifying these ligaments has no significance. Abnormalities of the sinus tarsi on MRI include obliteration of the fat by low signal intensity material on T1W images and either high or low signal intensity (or a combination) on T2W images. In our study, 4 patients were diagnosed with findings consistent with sinus tarsi syndrome. Plantar fasciitis is an inflammatory condition of the plantar fascia that causes pain and tenderness, usually near its attachment to the anteromedial calcaneal tuberosity. The two groups most commonly affected by this condition are running athletes and obese middle-aged women because of chronic repetitive microtrauma and overuse. MRI of plantar fasciitis shows thickening of the fascia, usually near the attachment to the calcaneus, with intermediate signal on T1W and high signal on T2W images. In our study, 15 patients were diagnosed as having plantar fasciitis.

CONCLUSION

MRI is an excellent imaging modality in the evaluation of ankle and hindfoot pain. MRI with its exquisite soft tissue contrast resolution, can demonstrate a large spectrum of pathologies around the ankle joint affecting the various soft tissue structures like ligaments, tendons, muscles, synovium, vascular tissue, and cartilage. MRI can also aid in early detection of few osseous abnormalities seen in the bones constituting the ankle joint.

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