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Correlation between Ultrasonography and MRI in Ankle Joint Pathology

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Abstract: ***Introduction: Normal ankle function is essential for day-to-day life and many popular sports. As the ankle joint has a complex anatomy, imaging of the ankle and its dysfunction is one of the most challenging regions for all orthopedic and medicine practitioners. The ankle is commonly affected in trauma as well as overuse disorders and inflammatory conditions. Ultrasound is a cheap, non-invasive investigative tool for evaluating ankle joint pathologies. Magnetic resonance imaging has been proven to provide excellent evaluation of ligaments around the ankle, with the ability to show various types of soft tissue and bone abnormalities. Materials and Methods: This observational (prospective) study was conducted on 50 patients for 1 1/2 years from October 2020 to April 2022 in Department of Radiology, PDU Government Medical College and Civil Hospital, Rajkot, Gujarat after taking proper consent from patients. Results: Most common age group of the patient participating in this study is 36 to 40 years. Males contribute to 52% of study population and female contribute to 48% of study population. The most common pathology of ankle joint was Ligament tear followed by Tendon tear and Tenosynovitis. Tenosynovitis is the most common pathology diagnosed on Ultrasonography with 100% diagnostic sensitivity. Overall Diagnostic Sensitivity of USG as compared to MRI was 78% in this study. Conclusions: Ultrasound has comparable diagnostic Sensitivity as MRI in many commonly encountered Ankle joint pathology like Plantar fasciitis, Tenosynovitis, Tendinosis, Ganglion cyst, Bursitis, Tendon tear, so USG can be used as primary imaging modality for screening and diagnosis of various Ankle joint pathology, however MRI remains gold standard investigation for imaging of ankle joint pathology.***

Keywords: MRI, USG, Ankle, Ligament, Tendon

1. Introduction

Normal ankle function is essential for day-to-day life and many popular sports. As the ankle joint has a complex anatomy, imaging of the ankle and its dysfunction is one of the most challenging regions for all orthopaedic and medicine practitioners. Ankle joint is a very complex synovial joint in the body. The components of ankle joint include bones, surrounding muscles, synovium, articular cartilage, ligaments and other soft tissues.

The ankle is commonly affected in trauma as well as overuse disorders and inflammatory conditions. Various imaging techniques may be used to assess the ankle including Xray, USG, CT and MRI. Imaging plays a crucial role in the evaluation of ankle tendons and ligaments.

Magnetic resonance imaging has been proven to provide excellent evaluation of ligaments around the ankle, with the ability to show various types of soft tissue and bone abnormalities.

Ultrasonography performed with high-resolution linear-array probes has become advanced in the assessment of ligaments around the ankle joint. USG can provide a detailed depiction of normal anatomic structures and is effective for evaluating ligament and tendon. Ultrasound is a cheap, non-invasive investigative tool for evaluating ankle joint pathologies. In the hands of dedicated musculoskeletal sonologist, ultrasound can produce comparable results with MRI. It is very much useful for claustrophobic patients and patients with contraindications of MRI. Major disadvantage of ultrasound is that it is of limited value in diagnosing bony and osteochondral changes of ankle joint. It is also very much difficult to diagnose the structures affected in case of severe complex traumatic injury with altered structural morphology.

MRI imaging is the gold standard for assessing the pathologies of ankle joint . It is non-invasive, radiation free and provides excellent contrast resolution.Long duration of scan and higher cost are the major disadvantages of MRI.

One might even hypothesize that despite the cost of MRI, it could be cost saving from a social perspective, detailed information in the early stage of the disease, may result ina more-timely diagnosis and treatment in patients who would otherwise have been followed up. Conversely, it may identify patients who do not need specific treatment and can be discharged from follow-up. In a patient population that consists young and physically active persons, this may lead to shorter absence from work, reduced loss of productivity and hence to lower costs to society. Moreover, MRI has played an increasingly important role as a non-invasive

investigation for determining which patients may benefit from surgery.

2. Review of Literature

High resolution ultrasonography and magnetic resonance imaging in the evaluation of tendino-ligamentous injuries around ankle joint. [35]

This study included 35 patients, 25 females and 10 males. 20 patients showed tendon pathology that was diagnosed into 21 pathological entities by both USG and MRI imaging modalities with no difference in interpretation between them. 21 patients had pathological ligaments which were diagnosed by both USG and MRI. However, 2 ligamentous lesions were diagnosed as partial tear by USG, while MRI diagnosed them as complete tear. Associated findings were also diagnosed as retrocalcaneal bursitis in 2 patients, joint effusion in 4 patients.

Evaluation of plantar fascia using high-resolution ultrasonography in clinically diagnosed cases of plantar fasciitis. [37]

This study included 44 clinically diagnosed patients of plantar fasciitis. 42 females and 2 males in the study group. 38 patients had unilateral disease and 6 patients had bilateral disease. The thickness of the plantar fascia was measured just anterior to its calcaneal attachment using Ultrasound.

Aims and Objectives

Primary Objective:
1) To correlate Ultrasound imaging findings with MR imaging findings of ankle joint pathologies.
2) To study the extent of ankle joint pathologies by Ultrasonography and MRI.

Secondary Objective:
1) To study common structures involved in various ankle joint pathologies.

3. Material and Methods

- Sample Size – 50 Patients
- Study Design – Observational Study
- Type Of Study – Prospective Study
- Duration Of Study - 1.5 years (Oct'20-Apr'22)
- Place Of Study - P.D.U Medial College And Civil Hospital, Rajkot.
- Instruments Used - 1.5t Gemri Machine, Rs Evo80 Samsung Colour Doppler Usg Machine
- Consent Of Participants – Yes
- Patient Will Be Drawn From Opd / Indoor Cases Referred For Usg And MRI To Radiology Department Civil Hospital Rajkot From Orthopedic Department Civil Hospital, Rajkot.
- Follow Up Frequency: Single time study
- Role of Orthopedic Doctors in Diagnosis Of Ankle Pathology-By Providing Clinical Findings & Provisional Diagnosis.
- I Will Correlate Between Usg And MRI By Comparing Findings of Both Modalities In Detecting Ankle Joint Pathology.

Inclusion Criteria:
Patient clinically suspected to have ankle pathology referred to Department of Radiodiagnosis.

Imaging Technique:
- Ankle Magnetic Resonance is performed in the axial, coronal, and sagittal planes parallel to the table top.
- The foot is imaged in the oblique axial plane (i.e., parallel to the long axis of the metatarsal bones), oblique coronal plane (i.e., perpendicular to the long axis of the metatarsals), and oblique sagittal plane.
- The patient is supine with the foot in about 20° of plantar flexion. An extremity surface coil is used to enhance spatial resolution.
- T1-weighted (repetition time msec/echo time msec = 600/20) and T2-weighted (2,000/20,80) Magnetic resonance images are obtained with a 12–16-cm field of view,a 256´192–512 acquisition matrix, 1–2 signals acquired, and a 3–5-mm section thickness with 1-mm intervals.
- Marrow abnormalities are best evaluated with fat suppression techniques such as fat-suppressed proton-density–weighted imaging or with short inversion-time inversion recovery (STIR) sequences (1,500/20; inversion time msec=100–150). However, susceptibility to gradient in homogeneity makes fat suppression techniques less optimal than STIR techniques in imaging the ankle and foot.
- Cartilage abnormalities can be visualized with two-dimensional or three-dimensional (3D) gradient-echo sequences.

TABLE I: Routine MRI Protocol to Evaluate for Ligament Injury

Sequence	Plane	Frequency-Selective Fat Saturation	TR	TE	Inversion Time (ms)	Section Thickness / Interval (mm)	Echo Train Length	Matrix
Spin-echo T1-weighted	Sagittal	No	400–700	10–20	—	4/1		256 × 256
STIR	Sagittal	No	4,000	50	150	4/1		256 × 256
Fast spin-echo proton density–weighted	Oblique axial[a]	Varies	2,000–3,000	15	—	3–4/1	5–6	512 × 512
Fast spin-echo proton density–and T2-weighted	Axial	Yes	3,500–6,000	80	—	4/1	5–6	256 × 256
Fast spin-echo proton density–weighted	Coronal	Yes	2,000–3,000	15	—	3–4/1	5–6	256 × 256

[a]45 degrees between coronal and sagittal planes.

TABLE I Basic Pulse Sequences for Magnetic Resonance Imaging of the Ankle*

Image Type	Repetition Time	Echo Time	Fat	Water	Advantages	Disadvantages
T1	Short	Short	Bright	Dark	Best anatomic detail, rapid acquisition	Poor demonstration of abnormality/edema
T2	Long	Long	Intermediate	Bright	Moderately sensitive for abnormality/edema, good myelographic effect	Decreased soft-tissue detail, time-consuming
Fat-suppressed T2 or STIR†	Long	Short	Very dark	Very bright	Most sensitive for abnormality/edema, excellent myelographic effect	Decreased soft-tissue detail, time-consuming
Gradient echo	Short	Short	Intermediate	Intermediate	Evaluation of articular cartilage, degenerative changes, and ligaments; excellent for blood	Very susceptible to metallic artifacts (prostheses), exaggerates effect/appearance of osteophytes

4. Results

This study included 50 patients with any form of pathologies of ankle joint. Most common age group of the patient participating in this study is 36 to 40 years. Sex distribution in this study group is 26 males and 24 females. Males contribute to 52% of study population and female contribute to 48% of study population.

The pathologies around the ankle joint were elaborately studied. The most common pathology of ankle joint was Ligament tear followed by Tendon tear and Tenosynovitis. Tenosynovitis is the most common pathology diagnosed on Ultrasonography with 100% diagnostic sensitivity.

Table: Depicting the age wise distribution of ankle joint pathologies.

Age Category	Number of Patients	Percentage
Less than 20years	1	2%
21-25 years	4	8%
26-30 years	3	6%
31-35 years	5	10%
36-40 years	12	24%
41-45 years	8	16%
46-50 years	5	10%
51-55 years	5	10%
56-60 years	3	6%
More than 60 years	4	8%
Total	50	100%

Our study shows that most common age group affected in ankle pathologies is 36-45 years which contributes to about 40% of total study population.

Table: Classification of Ankle joint Pathologies in the study

Ankle joint Pathology	No. of Cases	Percentage
Tenosynovitis	6	12%
Tendinosis	4	8%
Ligament Tear	8	16%
Tendon Tear	6	12%
Ganglion	4	8%
Bursitis	3	6%
Plantar Fasciitis	5	10%
Diabetic Foot	4	8%
Impingement Syndrome	1	2%
Stress Fracture	2	4%
Osteochondral Fracture	1	2%
Arthritis	3	6%
Morton Neuroma	1	2%
Sinustarsi Syndrome	1	2%
Avascular Necrosis	1	2%
Total	**50**	**100%**

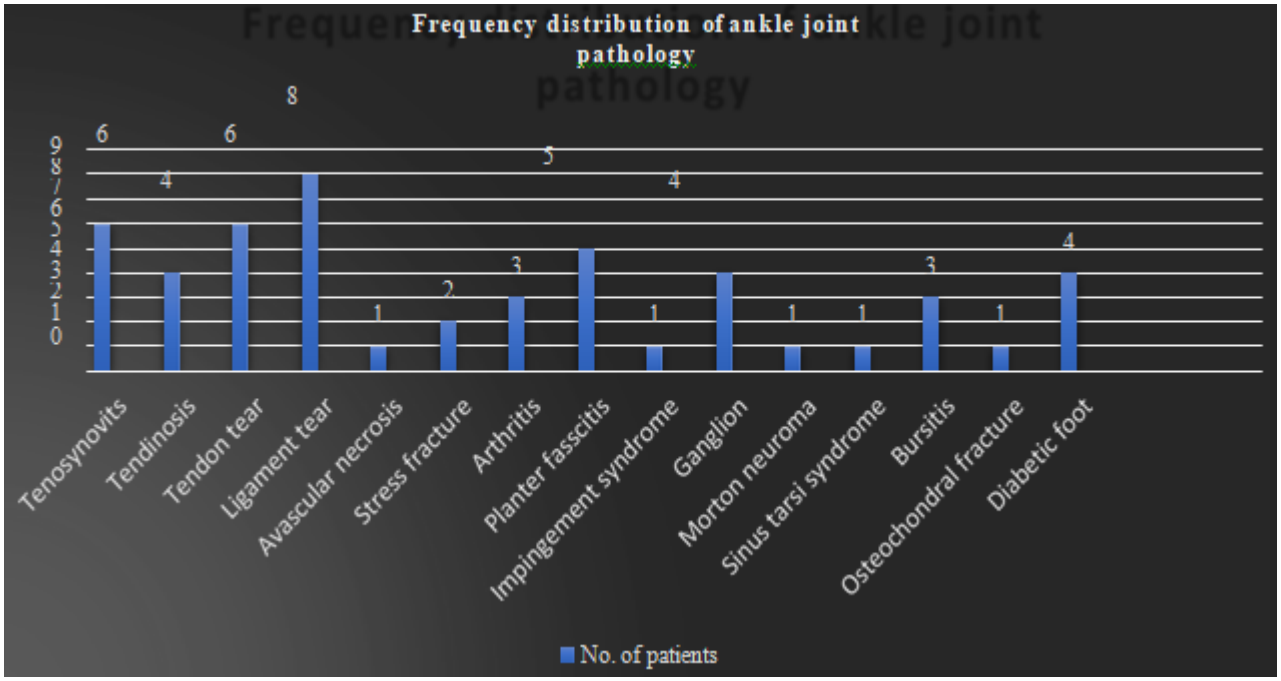

Chart: Depicting the Frequency distribution of pathologies of ankle joint

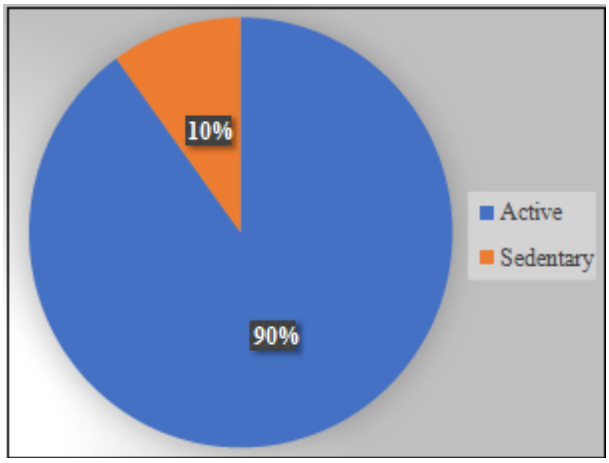

Chart: Depicting the lifestyle of patients with Ankle joint pathologies.

- Active population were more common these dentary population.

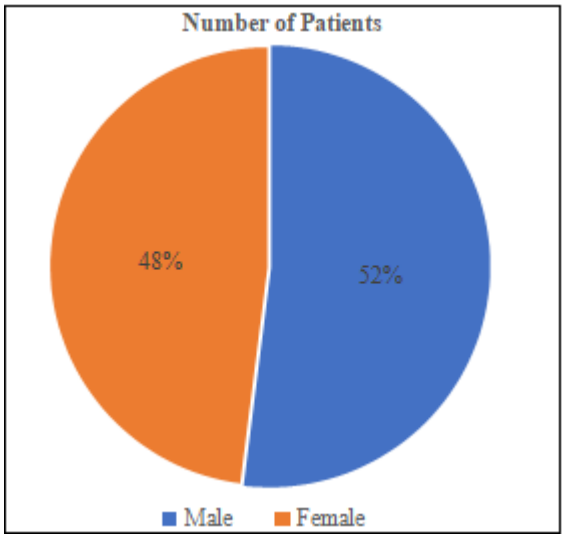

Chart: Depicting the Sexwise Population Distribution of Ankle joint pathologies.

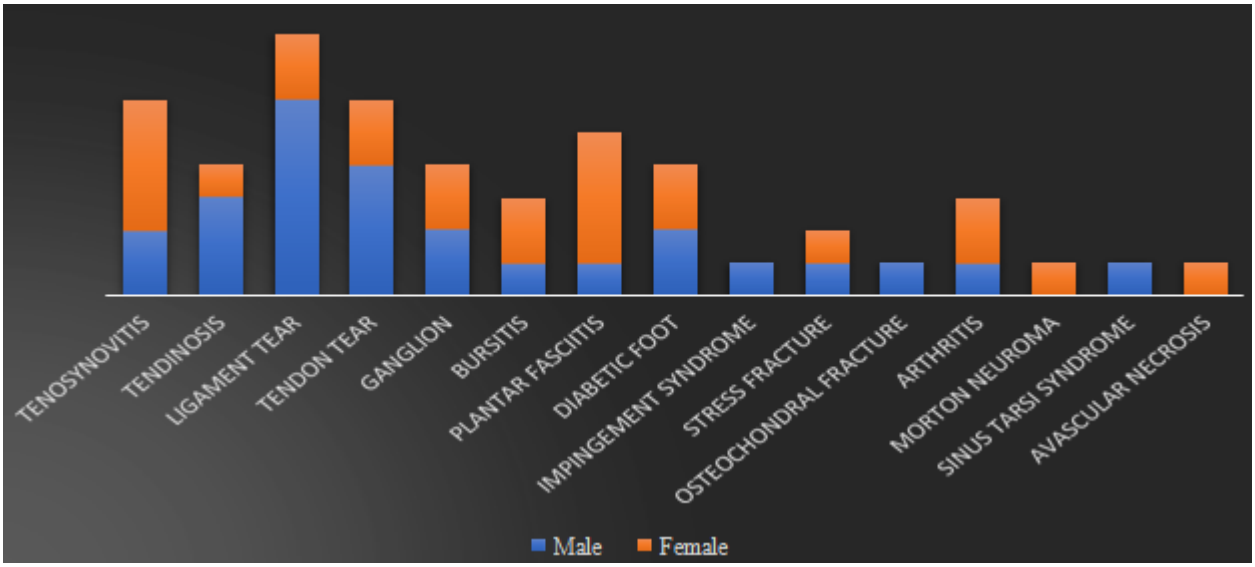

Chart: Depicting Sexwise Distribution of Ankle joint pathologies.

Table: Depicting % Sex distribution of Ankle joint pathology

Ankle Joint Pathology	Male	Female	Total
Tenosynovitis	2(4%)	4(8%)	6(12%)
Tendinosis	3(6%)	1(2%)	4(8%)
Ligamenttear	6(12%)	2(4%)	8(16%)
Tendontear	4(8%)	2(4%)	6(12%)
Ganglion	2(4%)	2(4%)	4(8%)
Bursitis	1(2%)	2(4%)	3(6%)
Plantarfasciitis	1(2%)	4(8%)	5(10%)
Diabeticfoot	2(4%)	2(4%)	4(8%)
Impingement Syndrome	1(2%)	0(0%)	1(2%)
Stressfracture	1(2%)	1(2%)	2(4%)
Osteochondral Fracture	1(2%)	0(0%)	1(2%)
Arthritis	1(2%)	2(4%)	3(6%)
Mortonneuroma	0(0%)	1(2%)	1(2%)
Sinustarsisyndrome	1(2%)	0(0%)	1(2%)
Avascularnecrosis	0(0%)	1(2%)	1(2%)
Total	26(52%)	24(48%)	50(100%)

Table: Depicting Diagnostic Sensitivity of USG as compared to MRI in Ankle joint pathology.

Ankle Joint Pathology	Diagnosed on MRI	Diagnosed on USG	Sensitivity of USG
Tenosynovitis	6	6	100%
Tendinosis	4	4	100%
Ligament Tear	8	6	75%
Tendon Tear	6	5	83%
Ganglion	4	4	100%
Bursitis	3	3	100%
Plantar Fasciitis	5	5	100%
Diabetic Foot	4	4	100%
Impingement Syndrome	1	1	100%
Stress Fracture	2	0	0%
Osteochondral Fracture	1	0	0%
Arthritis	3	0	0%
Morton Neuroma	1	1	100%
Sinus Tarsi Syndrome	1	0	0%
Avascular Necrosis	1	0	0%
Total	**50**	**39**	**78%**

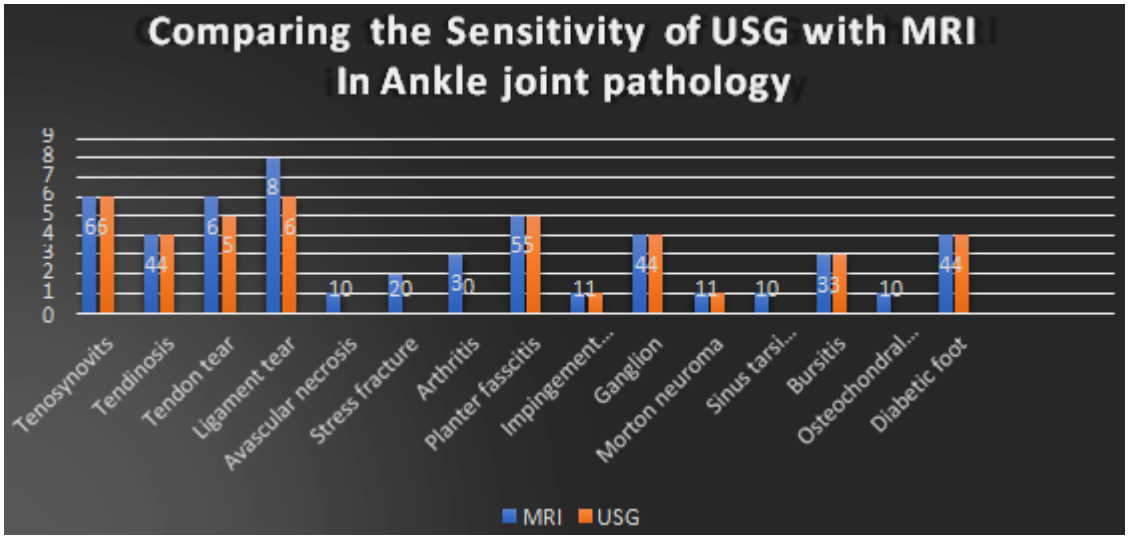

Chart – Demonstrating the number of patients diagnosed by MRI vs USG.

Table: Depicting the cases that have been misinterpreted in USG

Disease	No of patients diagnosed by MRI	No of patients diagnosed by USG	Misdiagnosed on USG as
Avascular Necrosis	1	0	Misdiagnosed As Joint Effusion
Stress Fracture	2	0	NAD
Osteochondral Fracture	1	0	NAD
Arthritis	3	0	Misdiagnosed As Joint Effusion
Sinus Tarsi Syndrome	1	0	NAD
Ligament Tear	8	6	NAD
Tendon Tear	6	5	One Complete Tendon Tear Misdiagnosed As Partial Tendon Tear

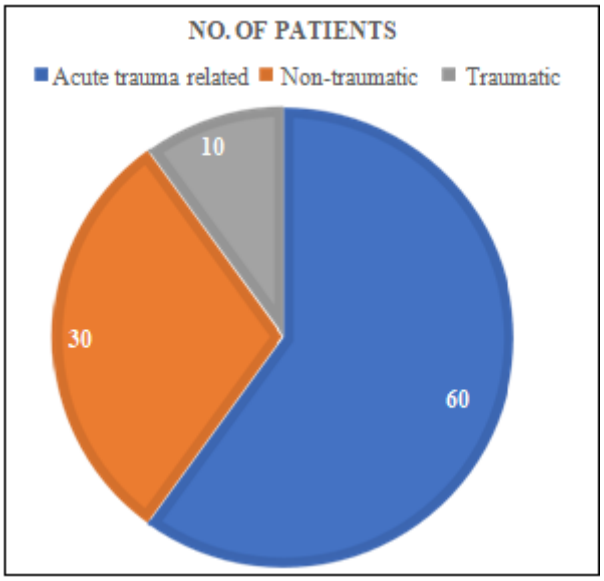

Chart: Depicting the Incidence of traumatic and non-traumatic causes of Ankle joint pathologies.

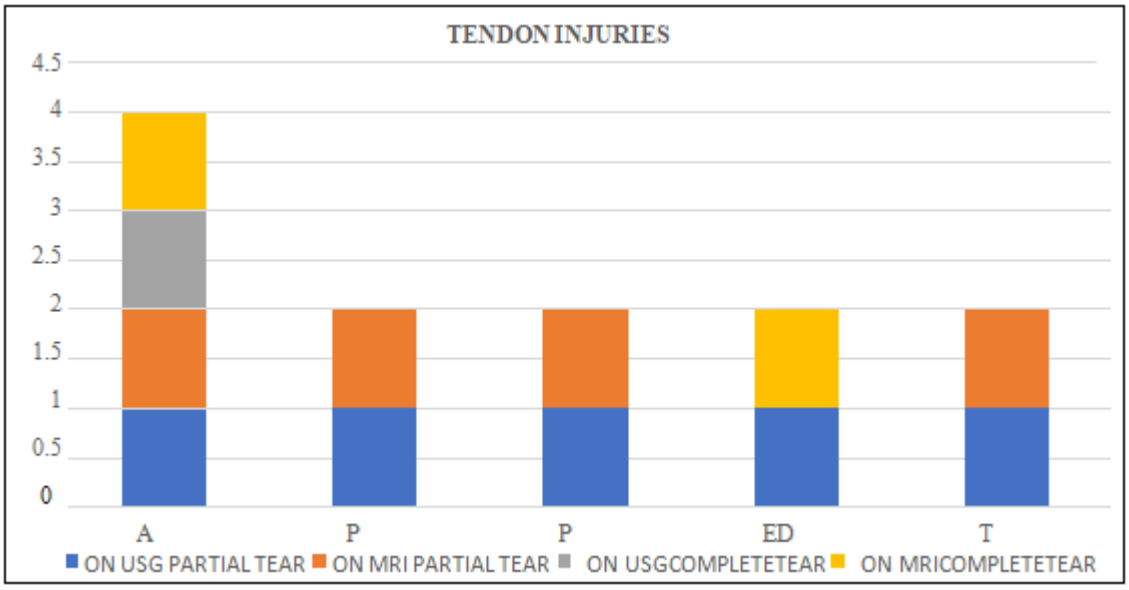

Chart: Depicting the Incidence of Tendon injuries of Ankle joint diagnosed on USG & MRI.

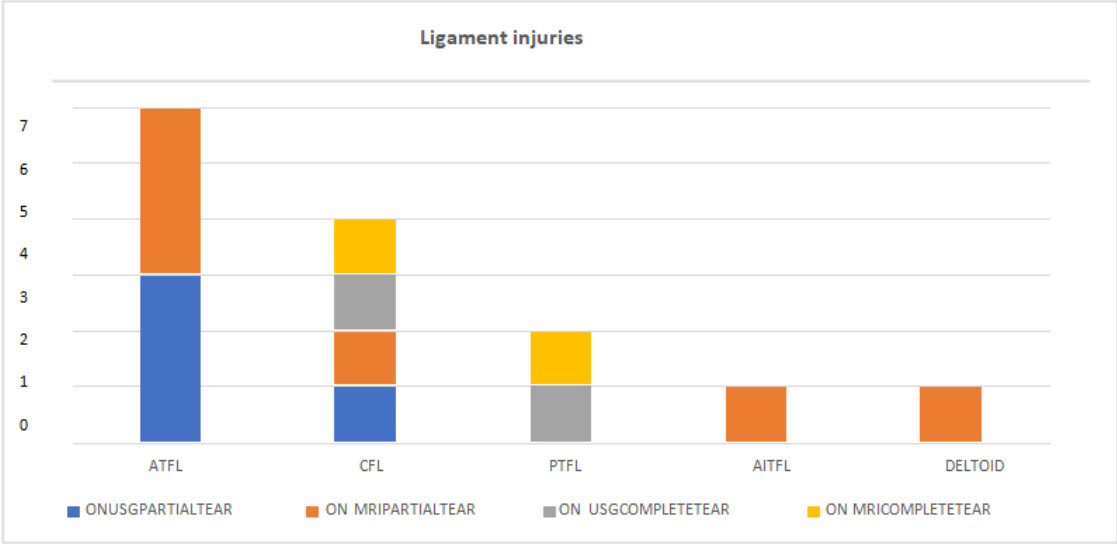

Chart: Depicting the Incidence of Ligament injuries of Ankle joint diagnosed on USG & MRI.

Table: Depicting the common ultrasound findings in pathologies of ankle joint

Findings	Number of patients
Abnormal Echogenicity	19
Abnormal Vascularity	11
Thickening of Tendon	5
Soft Tissue Oedematous Changes	8
Discontinuity In Structures	12
Ganglion	4
Bursitis	3
Joint Effusion	4
Synovial Thickening	2
Bony Irregularity	3
Fluid Collection	17
Plantar Fascia Thickening	5

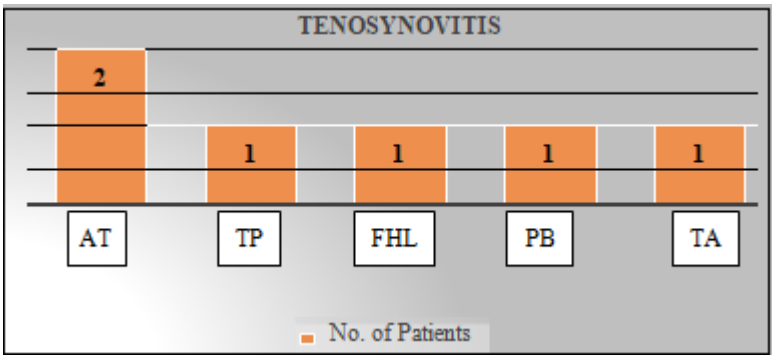

Chart: Depicting Distribution of TENOSYNOVITIS.

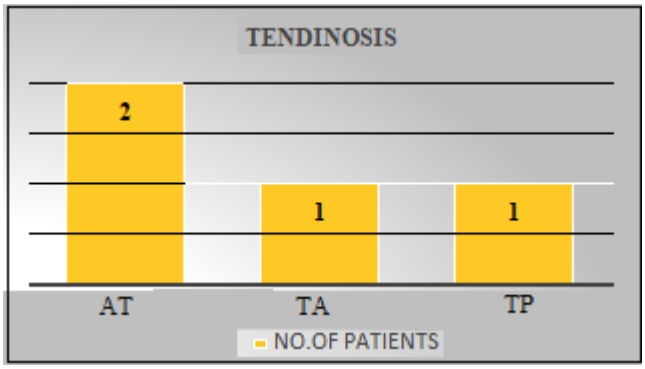

Chart: Depicting Distribution of TENDINOSIS

Table: Depicting Distribution of BURSITIS

Bursitis			
No. of Patients	Retrocalcaneal	Lateral Malleolar	Total
	2	1	3

Table: Depicting Distribution of Plantar fasciitis

	Plantar Fasciitis				
	Unilateral	Bilateral	Male	Female	Total
No. of Patients	4	1	1	4	5

5. Discussion

Table: Comparison of Ageand Sex Distribution in our study with study done by NevienEl-Liethyand Heba Kamal.[35]

	Age In Years		Sex		
	Range	Mean	Male	Female	Total
Our Study	18-70	43.78	26(52%)	24(48%)	50(100%)
Comparison Study	18-60	37	10(28.57%)	25(71.43%)	35(100%)

- Slight Male predominance noted in our study.

Table: Comparison of Tendon pathologies diagnosed by USG and MRI in our study with study done by NevienEl-Liethy and Heba Kamal.[35]

Tendon	No. of Pathology Diagnosed By MRI		No. of Pathology Diagnosed By USG	
	Our Study	Comparison Study	Our Study	Comparison Study
Achilles	6	11	6	11
TP	3	3	3	3
FHL	1	1	1	1
TA	2	1	2	1
EDL	1	1	1	1
Peroneal	3	3	3	3
Total	16	21	16	21

- Almost all the tendon pathologies diagnosed on MRI were also diagnosed on USG.

Table: Comparison of Ligament tear diagnosed by USG and MRI in our study with study done by Nevien El-Liethy and Heba Kamal.[35]

Modality	Pathology		ATFL	CFL	DL	Total
USG Diagnosis	Partial Tear	Our Study	3	1	0	4
		Comparison Study	6	2	0	8
	Complete Tear	Our Study	0	1	0	1
		Comparison Study	3	1	2	6
MRI Diagnosis	Partial Tear	Our Study	3	1	1	5
		Comparison Study	5	1	0	6
	Complete Tear	Our Study	0	1	0	1
		Comparison Study	4	2	2	8

- 75% of ligament tears were diagnosed on USG as compared to MRI in our study.

Table: Comparison of Incidence of Tendon and Ligament pathologies in our study with study done by Nevien El-Liethy and Heba Kamal.[35]

Diagnosed By USG/MRI	Tendon Pathologies		Ligament Pathologies	
	No. of Cases			
	Our Study	Comparison Study	Our Study	Comparison Study
	16(32%)	21(60%)	8(16%)	21(60%)

- Overall Tendon pathologies were more common than ligament pathologies in our study.

Table A & B: Comparison of Incidence of Ligament tear diagnosed in our study with study done by Nevien El-Liethy and Heba Kamal.[35]

Table A

Ligament	Frequency	
	Our study	Comparison Study
ATFL	3(42.86%)	12(57.14%)
CFL	2(28.57%)	3(14.28%)
PTFL	1(14.28%)	4(19.05%)
Deltoid	1(14.28%)	2(9.52%)
Total	7(100%)	21(100%)

Table B

Injury	Partial Tear		Complete Tear	
	Our Study	Comparison Study	Our Study	Comparison Study
ATFL	3	5	0	4
PTFL	0	0	1	0
CFL	1	1	1	2
Total	4	6	2	6

- ATFL was most commonly injured ligament.

Table: Comparison of Retrocalcaneal bursitis in our study with study done by Nevien El-Liethy and Heba Kamal.[35]

Modality	Joint effusion		Retrocalcaneal Bursitis	
	No. of Patients			
	Our Study	Comparison Study	Our Study	Comparison Study
USG	4(8%)	4(11.43%)	2(4%)	2(5.71%)
MRI	4(8%)	4(11.43%)	2(4%)	2(5.71%)

- Retrocalcaneal bursitis was more common.

Table: Comparison of Plantar fasciitis in our study with study done by Purnima Aggarwal, Vivek Jirankali and Sudhir K Garg.[37]

Study Comparison			
Plantar Fasciitis		Our Study	Comparison Study
	Male	1(20%)	2(4.54%)
	Female	4(80%)	42(95.46%)
	Total	5(100%)	44(100%)

- Plantar fasciitis was more common in female population.

Study Comparison			
Plantar Fasciitis		Our Study	Comparison Study
	Unilateral	4 (80%)	38 (86.36%)
	Bilateral	1 (20%)	6 (13.64%)
	TOTAL	5 (100%)	44 (100%)

- Unilateral Plantar fasciitis was more common than Bilateral Plantar fasciitis.

6. Conclusion

Ultrasound has comparable diagnostic Sensitivity as MRI in many commonly encountered Ankle joint pathology like Plantar fasciitis, Tenosynovitis, Tendinosis, Ganglion cyst, Bursitis, Tendon tears and it is cheap and widely available and cost effective, so USG can be used as primary imaging modality for screening and diagnosis of various Ankle joint pathology, however MRI remains gold standard investigation for imaging of ankle joint pathology.

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