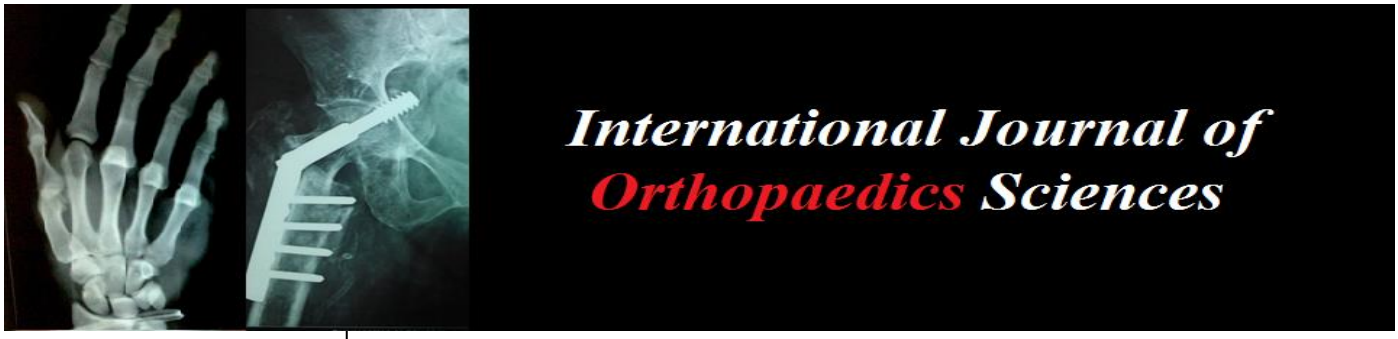

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Functional outcome of ankle fractures with Syndesmotic diastasis managed surgically using AOFAS

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Abstract
Background: Ankle fractures with Syndesmotic injury are common in Orthopaedic practice. Fractures of the ankle are the second most common significant lower extremity fractures. Surgical management for Syndesmotic injuries is indicated to prevent crippling disabilities. Syndesmotic ankle injuries disrupt normal joint functioning, hence need meticulous diagnosis and management.
Objective: To evaluate the functional outcome of surgically managed ankle fractures with Syndesmotic diastasis using AOFAS score.
Materials and methods: In this study, 21 patients diagnosed as ankle fractures with Syndesmotic diastasis, underwent Syndesmotic screw fixation using 3.5mm cortical screws in addition to anatomical fixation of medial and lateral malleolus. Functional outcome was analyzed at 6 months using AOFAS score.
Results: In this study, 33.3% (7 patients) of patients had excellent outcome, 42.9% (9 patients) patients had good outcome, 14.3% (3 patients) had fair outcome, while 9.5% (2 patients) had poor outcome.2 patients developed superficial wound infection, treated with IV antibiotics. One patient developed non union and one patient with delayed union.
Conclusion: For all cases of Ankle fractures with Syndesmotic diastasis, open reduction and internal fixation of ankle fracture with Syndesmotic screw fixation helped to achieve good union of fractures and pain free, stable ankle joint. It also facilitated early mobilization of the patients.

Keywords: Functional outcome, Syndesmotic diastasis, AOFAS

Introduction
Ankle is a complex uniaxial hinge joint consisting of the tibiotalar joint, the subtalar joint and the inferior tibiofibular joint. The bony architecture of the ankle is formed by the distal end of tibia, distal fibula and the talus. Its axis of rotation is dynamic, shifting during dorsiflexion and plantar flexion. The malleoli along with supporting ligaments stabilize the talus underneath the tibia. The ankle joint is bound by strong deltoid ligament which supports the medial side of the joint and the three lateral ligaments: the anterior talofibular ligament and the posterior talofibular ligaments which support the lateral side of joint and the calcaneofibular ligament. Though it does not span across the ankle joint itself, the Syndesmotic ligament makes an important contribution to the stability of the ankle [1]. The syndesmosis is madeup of the anteroinferior tibiofibular ligament, the interosseous ligament and the Postero inferior tibiofibular ligament.
Ankle fractures are among the most common injury treated orthopedic surgeons [2]. Syndesmotic ankle injuries are severe form of ankle injuries which is predominantly caused by external rotation force in a supinated or pronated foot. These Syndesmotic injuries are less common than ankle malleolar fractures. These injuries are difficult to evaluate, have a long recovery period, and may disrupt normal joint functioning if not treated properly. They account for approximately 10% of all the ankle fractures [3]. The tibiofibular syndesmosis are complex of ligaments that provides dynamic stability to the ankle joint [3]. This is essential for the integrity of the ankle mortise and thereby for weight bearing and walking [3].
These injuries require thorough evaluation and optimal treatment to prevent crippling disabilities. These ankle injuries are disastrous if not treated properly especially to athletes and to those engaged in heavy work, particularly on rough or irregular surfaces. Hence treating these ankle injuries are of utmost importance.

Surgeon must be aware of anatomy of both affected and normal ankle, various clinical test to diagnose various types of ankle injuries, limb biomechanics and treatment methods to achieve good results.

Materials and Methods

Prospective study involving 21 patients with syndesmotic diastasis treated surgically with syndesmotic screw fixation. Inclusion criteria includedSER4 and PER4injuries, confirmed intra-operatively by cotton's and modified cotton's test. Ankle fractures associated with ipsilateral distal 3rd tibia fracture, evidence of arthritis of the ankle joint, revision surgery cases were excluded. Syndesmotic diastasis was diagnosed based on both radiological examination and intra-op fluoroscopic evaluation. Stoffel *et al*. (2009) [4] compared two methods of operative assessment of syndesmotic instability and found the lateral stress test to be better than the external rotation stress test. General radiographic criteria for syndesmotic fixation were of low value compared with intraoperative impression of the syndesmotic stability in all operated ankles [5-7].

With regards to treatment, the following protocols were followed for the study:

Surgical technique

Under spinal anesthesia, patient was placed in supine position. The affected limb was prepared and surgical draping was done using the standard aseptic sterile precautions. Standard postero-lateral approach for the fixation of the lateral malleolus was done. After fixing the lateral malleolus syndesmotic integrity was assessed by cotton's test under fluoroscopy and checked for medial tibio-talar clear space (TTCS) and tibio-fibular clear space (TFCS) [8]. The fibula was reduced into the insuraand 3.5mm tricortical syndesmotic screw was put approximately 1-2 cm above the tibial plafond about 30^0 postero-lateral to antero-medial direction. Soft tissue interposition between fracture fragments of the medial malleolus, was observed in all cases. All the patients were operated under tourniquet control and the duration of surgery varied from 45 minutes to 90 minutes. The medial malleolus was fixed with cannulated cancellous screws, or tension band wiring. With the help of radiographs fracture healing status was judged and full weight bearing was started gradually after removal of syndesmotic screw. At the end of 6 months, patients were evaluated for functional outcome using the AOFAS score.

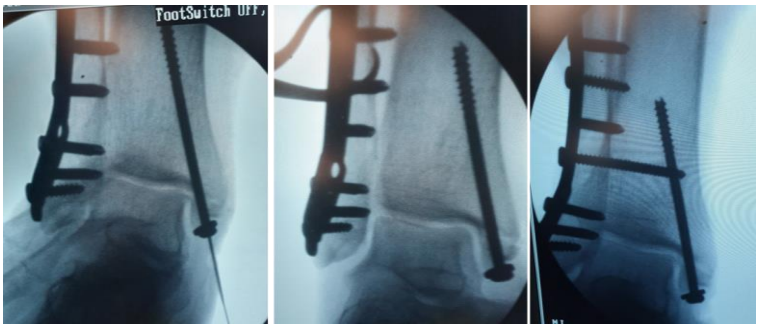

Fig 1: Left (Showing before syndesmotic screw fixation), Middle (Cotton's test being performed intraoperatively. Note the increase in Tibio-fibular clear space) and Right (After syndesmotic screw fixation).

Fig 2: Intra operative image showing cotton's test being performed.

Fig 3: Case developed superficial wound infection, which later healed by dressings and antibiotics.

Follow up

Regular follow up at the end of 1, 3 and 6months were done. X-rays were taken to monitor the progress of fracture healing, to check the ankle mortise and whether the implant is well in place or not. Patients slab was removed at first follow up, started with ankle mobilization and assisted toe touch walking with walking aid till the removal of syndesmotic screw. AOFAS scoring system was used to assess the functional outcome at 6 months follow up.

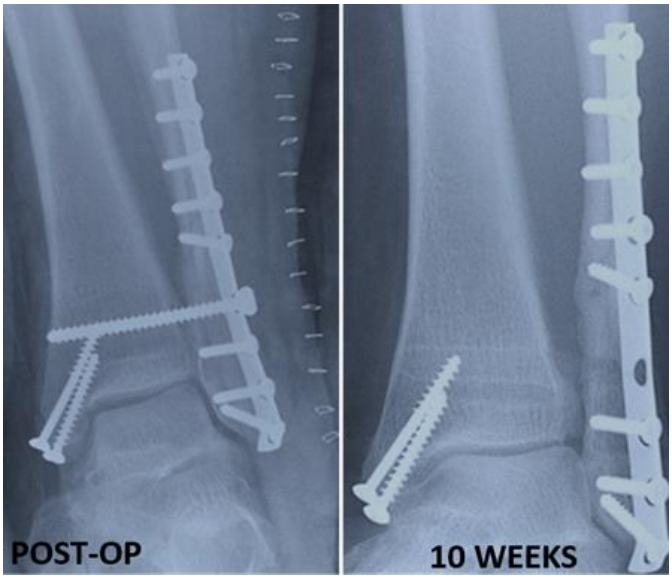

Fig 4: Showing immediate post-op and after removal of syndesmotic screw at 10 weeks

Results

All the 21 cases underwent open reduction and internal fixation and were followed up at 1 month, 3 months and 6 months post op. They were put on a below knee slab for 6 weeks following surgery. Ankle movements were encouraged after removal of the slab. Syndesmotic screw was removed at a mean period of 10 weeks (range 8 to 24 weeks) and then gradual weight bearing was started. At the end of 6 months, the functional outcome was assessed based on the AOFAS score [9].

The mean age was 38 years ranging from 19 years to 60 years. 61.9% (13 patients) of patients were under 40 years of age where as 38.1% (8 patients) of patients were between 41 to 60 years of age. 57.1% (12 patients) of patients were malesand 42.9% (9 patients) were females. There was no statistically significant difference inthe side affected (right-12, left-11). Twisting injury (66.7%) was the most common mode of injury in this study compared to other mode of injuries like RTA, Fall from height.Pronation external rotations accounted for 71.4% (15 patients) while supination external rotation for 28.6% (6 patients) of patients as per Lauge-Hansen classification [10]. Weber C accounted for 66.7% (14 cases) where as Weber B for 33.3% (7 cases).

Table 1: Age Group

	Frequency	Percent
<40	13	61.9
41 - 60	8	38.1
Total	21	100.0

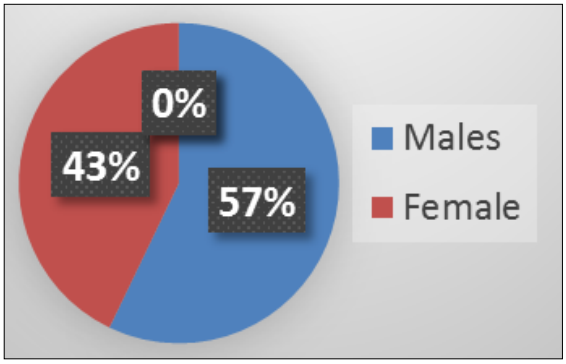

Fig 5: Gender Distribution

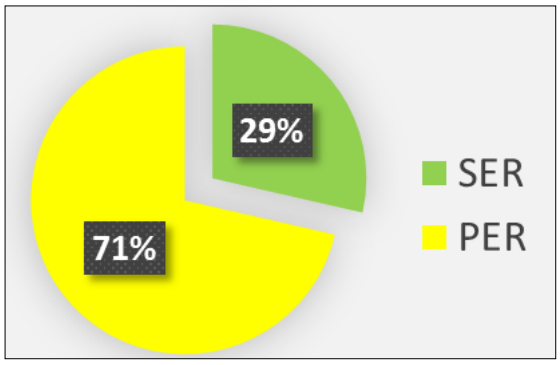

Fig 6: Lauge Hansen's Classification

33.3% (7 patients) of patients had excellent outcome (AOFAS score 90-100), 42.9% (9 patients) patients had goodoutcome (AOFAS score 80-89), 14.3% (3 patients) had fair outcome (AOFAS score 70-79), while 9.5% (2 patients) had poor outcome(AOFAS score <69) according to AOFAS grading criteria.

Table 2: AOFAS Score

	N	Mean	Std. Deviation	F	p
Excellent	7	95.571	3.047		
Good	9	82.778	2.819		
Fair	3	75.000	2.000		
Poor	2	52.500	10.607	74.663	<0.001 VHS

In this study, only 2 patients developed superficial wound infection which subsided with regular dressings and antibiotics. Of the two patients with poor outcomes, one had non union and other with delayed union. The patient with non union had severe uncontrolled diabetes and chronic renal disease.

Fig 5: Post-operative ankle movements (left side operated)

Discussion

The syndesmosis connecting the distal tibial and fibular bony structures normally sustains large three-dimensional loads in daily activity [11-13]. Ankle stability depends greatly on the intact ankle mortise. Once SD occurs, the ankle immediately loses mediolateral restriction provided by the bony contour. Therefore, patients immediately lose walking ability. An ankle with non-anatomically reduced syndesmosis may progress to osteoarthritis and cause lifelong disability [14].

The primary goal of treatment in these cases is to obtain stable, pain free ankle joint and to restore maximum function. Mean age group in this study was 38 years in comparison to 43.7 years in study done by David *et al*. [1] 36.5 years in study by Nimick *et al*. [15]**.** There were 12 males and 9 females with a male: female ratio of 1.3: 1, which is more towards the former which is similar to the results of the study conducted by Nimick *et al*. [15].

Pronation external rotation accounted for syndesmotic injury in 15 patients (71.4%) and 6 patients (28.6%) developed syndesmotic injury due to supination external rotation. This is in accordance with study by Riegels-Nielsen P *et al*. and Heim D *et al*. [16, 17]. Hence it indicates that pronation external rotation injuries are more prone for syndsmotic injury. However the most common type of ankle injury is by supination external rotation, Pronation external rotation injuries are more commonly associated with syndesmotic diastasis [18].

We have employed tricortical screw fixation using 3.5 mm screws. No difference in outcome was reported with the use of tricortical vs quadricortical fixation [19]. None of the patients showed screw breakage on full weight bearing after eight weeks. In our study the mean duration of which patients had secondary procedure of syndesmotic screw removal was 10 weeks. Naqvi *et al*. [20] evaluated clinical outcomes and syndesmotic reduction with CT imaging using two different methods of syndesmotic stabilization using syndesmotic screw fixation versus tight rope; found that there is no statistically significant difference in the outcomes.

The mean AOFAS score in our study was 83.04 which is in par with study by Littenta *et al*. [18]. In contrast, Egol *et al*. demonstared poor functional outcomes at one year follow up patients with syndesmotic injury [21]. Sagi *et al*. [22] in their study on functional outcomes of malreduced syndesmosis at the end of two years concluded that malreduced syndesmotic injuries had significantly worse functional outcomes. However many studies indicate that anatomical reduction is the most important factor which affects the functional outcome in ankle fractures [23-25].

The limitations in our study being the small study group and a shorter follow up time.

Conclusion

In conclusion, treatment of ankle fracture with syndesmotic injury with open reduction and syndesmotic screw fixation gives good results provided we achieve good anatomical reduction. Literature says there is no benefit of tight rope over syndesmotic screw, no difference between tricortical vs quadricortical fixation. We achieved good results with tricortical syndesmotic screw fixation. No breakage of syndesmotic screw was observed, that may be primarily due to weight bearing after screw removal.

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The efficacy of platelet rich plasma in the treatment of resistant plantar Fasciitis-follow up of 12 months

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Abstract
Background: Platelet-rich plasma (PRP) has been used as an alternative therapy for plantar fasciitis (PF) to reduce heel pain and improve functional restoration. PRP has a role in the inflammatory, coagulation processes as well as immunity modulation. During the degranulation of platelets they release cytokines and other growth factors. These promote angiogenesis, help in tissue remodelling and wound healing. They may have a pain relieving effect depending on the release of proteases with analgesic properties. This is a study of 26 patients treated with PRP for the treatment of resistant PF.
Objective: To compare the efficacy of local injection of PRP at different time intervals for the treatment of resistant PF
Materials and methods: In this study, 26 patients diagnosed with resistant Plantar Fasciitis, underwent local injection of PRP and were followed up at 3, 6, 9 and 12 months and VAS recorded.
Results: In this study, the VAS showed significant improvement from the pre injection VAS to the VAS at 3 months, 6 months, 9 months and 12 months after injection. The difference in the VAS from 3 months to 6, 9 and 12 months post was statistically significant. The difference in VAS from 6 months to 9 months and 12 months post injection was statistically highly significant and very highly significant respectively. In between 9 months to 12 months post injection, there was no statistical significance.
Conclusion: Platelet Rich Plasma provides good symptomatic relief in the treatment of Plantar Fasciitis with sustained gradual relief of pain and improving daily function and activity level. Platelet Rich Plasma proved to be effective modality in providing continuous and sustained relief of pain over a period of 12 months.

Keywords: Platelet rich plasma, Fasciitis-follow

Introduction
Plantar Fasciitis (PF) presents with severe pain in the heel after a period of rest or with the first few steps of the day which alleviates with movement of the foot [1]. The exact etiology of PF is not known but it is postulated that it is mainly caused due to overloading of the plantar foot muscles. The risk factors for the development of PF include; obesity, flat feet, limb length discrepancy and overuse. Tightness of the Achilles tendon and inappropriate foot wear has also been proven to cause plantar fasciitis [2].
The various modalities for the treatment of PF include activity and lifestyle modifications, night splints, orthotics and special foot wears, extracorporeal shockwave therapy and casting. Corticosteroid injection and Platelet Rich Plasma (PRP) injection over the medial tuberosity of the Calcaneum is an effective treatment modality once conservative management doesn't provide relief to the patient. Of late PRP, which is bioactive with a platelet concentration 2-5 times the baseline platelet count of the patient is been used in the treatment [2].
PRP has a role in the inflammatory, coagulation processes as well as immunity modulation. During the degranulation of platelets they release cytokines and other growth factors. These promote angiogenesis, help in tissue remodelling and wound healing. They may have a pain relieving effect depending on the release of proteases with analgesic properties.
Research is being done on PRP and its beneficial effects in chronic tendinopathies as well as treatment in cosmetic, dental and wound healing therapies.

Materials and Methods
This is cohort of 26 patients with resistant PF treated with PRP. The inclusion criteria includes

all Patients with chronic heel pain and with confirmed diagnosis of Idiopathic PF from 30 to 60 years of age and exclusion criteria include Patients with Diabetes Mellitus, Rheumatoid Arthritis, Gout, Patients with history of trauma to foot or congenital foot deformity, Patients who have had previous foot surgery, BMI > 40, Anaemia (Hb<7)and Pregnant women. Patient demographics were recorded. Through history taken and complete clinical examination of foot performed and lateral and antero-posterior x-rays of the foot were done to confirm the diagnosis and rule out other causes of heel pain. In bilateral cases, only the more painful side was recruited into our study.

Patients were asked to report the pain they experience using the Visual Analogue Score (VAS) and were recorded on the scale of 0-10 where 0 was pain free and 10 was pain imaginable.

Injections were given on the basis of direct palpation of the most tender area by using the Pitthing technique (20 times).

PRP Preparation Technique

A 20 ml sample of venous blood was drawn from the patient's Cubital vein and transferred equally into 4 Vacutainers containing buffered sodium citrate (BD Vacutainer, manufactured at Becton, Dickinson and Company, 1 Becton Drive, Franklin Lakes, NJ, USA).

Fig 1: 20CC Syringe

Fig 2: Autologous Blood being drawn from patient's Cubital vein

Fig 3: Buffered sodium citrate and Plain Vacutainers used to prepare PRP

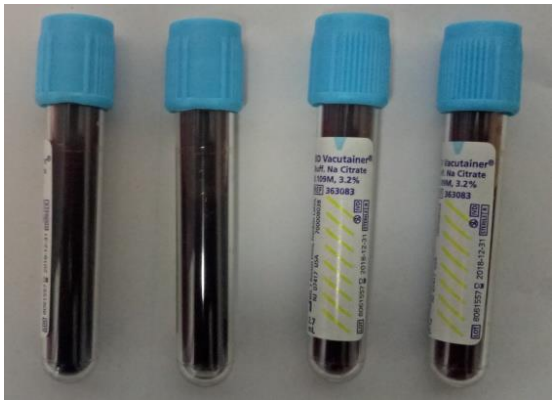


Fig 4: Vacutainers with blood

The sample were then placed in a centrifugation machine (REMI R-8CBL, REMI ELEKTROTECHNIK LTD, VASAI INDIA) and centrifuged at 2400rpm for 10 minutes. Using a 18G spinal needle (BD Spinal Needle) the buffy coat and supernatant platelet poor plasma layer was aspirated, and transferred to 2 plain vacutainers in equal volumes.

Fig 5: Centrifuge first spin: 2400RPM x10 minutes

The collected sample were again centrifuged at 3600rpm for another 15 minutes. The supernatant platelet poor plasma was then aspirated using a 10 ml syringe and an 18G spinal needle and discarded. The sediment PRP was aspirated and was then transported to the Procedure room of the Orthopaedic outpatient department under aseptic precautions.

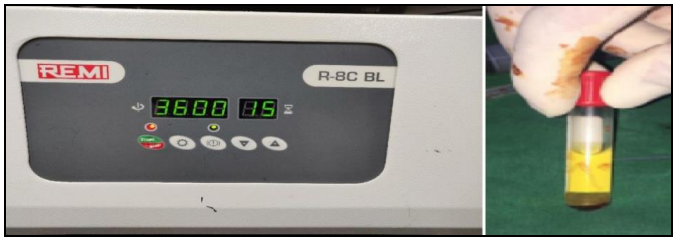


Fig 6: Centrifuge second spin: 3600RPM x 15 minutes

3 ml PRP was aspirated from the syringe that was transported to the OPD using a 18G needle and 5cc syringe and injected into the medial calcaneal tubercle at the point of maximum tenderness under aseptic precautions.

Fig 7: PRP Injection Technique

After injection, All the patients were prescribed analgesics (Aceclofenac 100mg + Paracetamol 325mg) twice daily for one week with local heat fomentation and analgesic gel after 48 hours post injection and were advised restriction of moderate to severe activities for a period of 2 weeks. All the patients were followed up at 3 and 6 months but at 9 months, 1 patient did not report for follow up at 9 months and at 12 months respectively. The drop out rate being 3.85% at 9 months 3.85% at 12 months. These patients were interviewed over telephone and VAS was recorded for the particular follow up interval.

Statistical analysis was carried out using SPSS version 17.0. Students unpaired t test, Chisquare test, ANOVA-Fishers F test and Bonfernni t test were carried out. $p< 0.05$ was considered to be significant.

Results

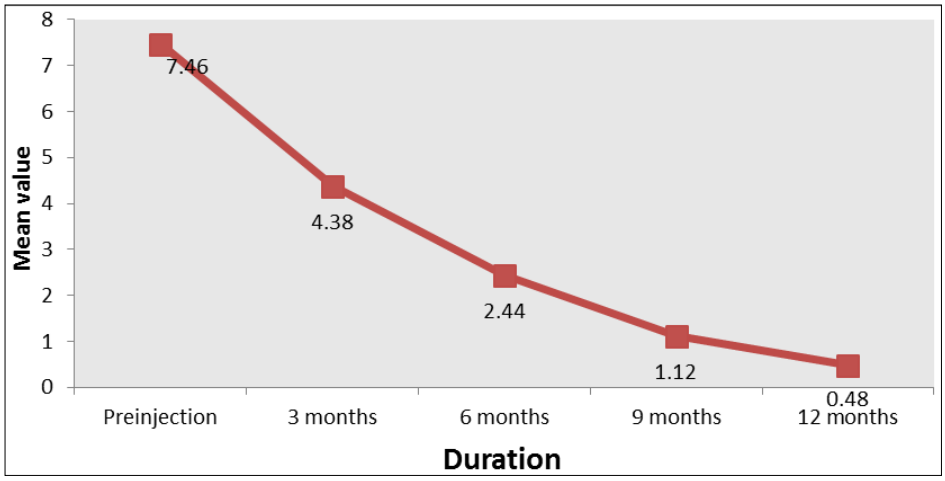
In Our study, 26 patients with Idiopathic PF received PRP injection. We compared the efficacy of PRP using the VAS at 3 months, 6 months, 9 months and 12 months post injection.

Table 1: Patient Demographics

	Mean	SD
Age (years)	43.15	9.649
Gender	10	38.5%
Male	16	61.5%
Female		
Side	19	73.1%
Right	7	26.9%
Left		
Duration of pain (months)	6.42	5.818
BMI	27.54	3.373
Pre injection VAS	7.46	1.174

Table 2: Comparison of VAS at different time intervals

	Duration					F	P
	Pre Injection VAS	3 months VAS	6 months VAS	9 months VAS	12 months VAS		
	7.46+ 1.174	4.38 +1.134	2.44 +1.083	1.12+ 1.505	0.48 + 1.295	131.72	<0.001 vhs
t	1.601	6.036	0.567	7.113	11.91		
p	0.116 ns	<0.001 vhs	0.573 ns	<0.001 vhs	<0.001 vhs		



Graph 1: Comparison between Mean VAS and duration at different time intervals.

Table 3: Multiple Comparisons at different time intervals (Bon Feronni t test)

group	(I) VAS at time	(J) VAS at time	Mean Difference (I-J)	P
PRP	Pre injection	3 months	3.077	<0.001 vhs
		6 months	5.022	<0.001 vhs
		9 months	6.346	<0.001 vhs
		12 months	6.982	. <0.001 vhs
	3 months	6 months	1.945	<0.001 vhs
		9 months	3.269	<0.001 vhs
		12 months	3.905	<0.001 vhs
	6 months	9 months	1.325	.002 hs
		12 months	1.960	<0.001 vhs
	9 months	12 months	.635	.716 ns

Vhs: very highly significant hs: highly significant ns: non significant

The VAS in this study showed significant improvement from the pre injection VAS to the VAS at 3 months, 6 months, 9 months and 12 months after injection with p values <0.001.The difference in the VAS from 3 months to 6, 9 and 12 months post was statistically significant (p = <0.001). The difference in VAS from 6 months to 9 months and 12 months post injection was statistically highly significant and very highly significant respectively (p = <0.002 and p = < 0.001). In between 9 months to 12 months post injection, there was no statistical significance with mean difference of VAS being 0.635 with p values being 0.716.This shows that maximum benefit of PRP injection was there till 9 months. If the patient is not symptomatically better this can be considered as an indication for another injection of PRP at 9 months.

Discussion

This study was designed to compare the efficacy of local injection of PRP at different time intervals for the treatment of resistant PF. PRP contains a more concentrated amount of platelets than does whole blood. Within the platelets, there are

powerful growth factors, including platelet-derived growth factor, transforming growth factor beta and epidermal growth factor. The injection of PRP into the affected tissue initiates the healing stages necessary to reverse the degenerative process at the base of the plantar fascia. The individual cytokines present in the platelet alpha granules have been shown to enhance fibroblast migration and proliferation, up-regulate vascularisation and increase collagen deposition in a variety of *in vitro* and *in vivo* settings [3]. Additionally, many of these cytokines have been seen to work in a dose dependent manner. The concentrated growth factors work in a synergetic manner to initiate a tendon healing response. Transforming growth factor beta 1 is shown to significantly increase type I collagen production by tendon sheath fibroblasts. This same mechanism is likely to be active in chronic PF.

The age range of the patients in our study being 30 years to 60 years with mean age of 43.15 years. There were 10 male patients (38.5%) and 16 female patients (61.5%). BMI of the patients in our study with 5 patients in the BMI less than 25 group and 21 patients in the BMI greater than or equal to 25 group with a mean BMI of 27.54.The mean Pre injection VAS of the patients in our study was 7.46. The duration of pain (symptom) of the patients in our study ranging from 2 months to 2 years with mean duration of 5.818 months.

In this study, we found that there was a significant decrease in the pain as time progressed from the first visit to their last visit at 12 months. This was observed by the decreasing VAS which was statistically significant ($p< 0.001$). At 3 months post injection, the mean VAS was 4.38. At 6 months post injection, the VAS being 2.44 and at 9 and 12 months, the VAS being 1.12 and 0.48 respectively. The difference in the VAS from 3 months to 6, 9 and 12 months post injection was statistically significant ($p = <0.001$). The difference in VAS from 6 months to 9 months and 12 months post injection was statistically highly significant and very highly significant respectively ($p = <0.002$ and $p = < 0.001$). In between 9 months to 12 months post injection, there was no statistical significance with mean difference of VAS being 0.635 with *p* values being 0.716.

This shows that maximum benefit of PRP injection was there till 9 months. If the patient is not symptomatically better this is an indication for another injection of PRP at 9 months.

Rahim A, Tiwari M in a comparative study from June 2013 to December 2014 evaluated the outcomes of PF treated with PRP against steroid injections. 163 patients received PRP injections and 158 patients received steroid injections into the plantar fascia and were assessed using the VAS at 4, 8, 12, 26 and 52 weeks after the procedure. Their results were similar to the results of our study with regard to progressive pain relief with single PRP injection over a period of 1 year [4].

Martinelli N *et al*. in 2008-2009 studied the use of PRP in chronic PF in 14 consecutive patients. They were injected with PRP and subjective scores taken, they were followed up after 12 months. 11 patients had a decrease in the VAS. There was significant decrease in VAS from 7.1 ± 1.1 before treatment to 1.9 ± 1.5 at the last follow-up ($p< 0.01$). This further substantiates the fact that PRP was a safe alternative and had a potential to decrease the pain due to this condition [5].

Ragab EM *et al*. between February 2010 and June 2011, studied on 25 patients with PF who underwent treatment with PRP injections. They noted that 22 patients showed subjective improvement and 15 patients had better functional outcome. The average pre-injection VAS was 9.1 (range 8–10). Post-injection, using the same VAS scale the pain decreased to average of 1.6 (range 0–6) ($p< 0.001$).USG showed significant changes in the thickness of the plantar fascia as well as signal intensity in the region of injection of the PRP [6].

Peerbooms *et al*. in their study concluded that the concentrated growth factors work in a synergetic manner to initiate a tendon healing response. This hypothesis is supported by *in vitro* research in the literature. Transforming growth factor β1 is shown to significantly increase type I collagen production by tendon sheath fibroblasts. This same mechanism is likely to be active in chronic plantar fasciitis [7].

Wilson *et al*. in their prospective case series on patient reported pain and disability following PRP injection in patients with chronic plantar fasciitis. They concluded that PRP is a safe therapeutic option with the ability to decrease heel pain in patients with chronic plantar fasciitis not responding to conservative management [8].

Previous studies described PRP injection as an effective treatment option for chronic PF. PRP is beneficial in its own way, with fewer complications, but the need for a centrifuge machine that is expensive and is the mainstay for anyone who wants to give PRP in an outpatient facility and thus increases the cost of it by at least 6-8 times more than that of corticosteroids.

The limitations of our study being less number of patients. When compared to the study done by Mahindra P, Yamin M, Sehi H.S *et al*. [9] in 2016, the lack of objective and quantifying diagnostic tool such as a USG-scan or an MRI to confirm the diagnosis and changes in the plantar fascia thickness after injection which allows better insight and therefore a quantification of the efficacy of injection and also the post-injection changes in the fascia. The absence of ultrasound guidance for accurate needle placement and delivery of PRP injections was also a limitation of our study. We accept that this may arguably allow for more accurate placement of the injection, and could be considered, but a randomized control trial done by Tsai *et al*. [10] showed no advantage of ultrasound guidance over direct palpation of the most tender area, when steroid was injected for PF.

Conclusion

In this study, we conclude that Platelet Rich Plasma provides good symptomatic relief in the treatment of Plantar Fasciitis with sustained gradual relief of pain and improving daily function and activity level. Platelet Rich Plasma proved to be effective modality in providing continuous and sustained relief of pain over a period of 12 months. The maximum benefit of PRP injection was there till 9 months and hence can be considered as an indication for another PRP injection. There were no complications related to the technique of injection.

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Clinical, Radiological, And Histopathological Analysis of Osteosarcoma and Ewing's Sarcoma: A Multicenter Retrospective Analysis.

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Abstract

Background: Osteosarcoma and Ewing's sarcoma are the two most common primary malignant bone tumors in children and young adults. Despite overlapping clinical presentations, these entities differ in age of onset, radiological features, and histopathology. This study aims to compare the clinical, radiological, and histopathological profiles of osteosarcoma and Ewing's sarcoma to enhance early diagnosis and differentiation. ***Material and Methods:*** This multicenter retrospective study was conducted over 10 year data of 80 patients diagnosed with primary bone tumors—45 with osteosarcoma and 35 with Ewing's sarcoma at a tertiary care center. Clinical data, imaging findings, and histopathological slides were analyzed and compared using appropriate statistical tests. A p-value < 0.05 was considered statistically significant. ***Results:*** The mean age of patients with osteosarcoma (17.9 ± 5.3 years) was significantly higher than those with Ewing's sarcoma (14.2 ± 4.7 years; $p = 0.003$). Male predominance was observed in both groups. Constitutional symptoms like fever and weight loss were more frequent in Ewing's sarcoma patients ($p < 0.001$ and $p = 0.042$, respectively). Radiologically, sunburst pattern and Codman's triangle were more common in osteosarcoma, whereas onion-skin appearance and soft tissue mass were more typical of Ewing's sarcoma ($p < 0.001$). Histologically, osteoid production was exclusive to osteosarcoma, while small round blue cells were hallmark of Ewing's sarcoma ($p < 0.001$).***Conclusion:*** Significant differences in clinical symptoms, radiographic findings, and histopathological features exist between osteosarcoma and Ewing's sarcoma. Recognizing these differences facilitates accurate and timely diagnosis, which is essential for effective management.

Keywords: Osteosarcoma, Ewing's Sarcoma, Radiology, Histopathology, Bone Tumors, Clinical Comparison

INTRODUCTION

Primary malignant bone tumors, although relatively rare, represent a significant concern due to their aggressive nature and tendency to affect adolescents and young adults. Among them, osteosarcoma and Ewing's sarcoma are the two most common types, accounting for the majority of bone sarcomas in the pediatric and adolescent population [1]. Osteosarcoma is characterized by the production of osteoid matrix by malignant cells and typically affects the metaphyseal regions of long bones, particularly around the knee joint [2]. Ewing's sarcoma, on the other hand, is a small round blue cell tumor often arising in the diaphysis of long bones and pelvis, with hallmark features including chromosomal translocations, most notably t(11;22)(q24;q12) [3].

Clinical differentiation between these two entities is critical yet challenging due to overlapping symptoms such as localized pain, swelling, and occasionally systemic features like fever and weight loss [4]. Radiological imaging plays a pivotal role in narrowing the differential diagnosis, with osteosarcoma typically showing aggressive periosteal reactions like sunburst appearance and Codman's triangle, whereas Ewing's sarcoma often demonstrates onion-skin layering and soft tissue involvement [5]. Histopathology remains the

definitive diagnostic modality, enabling distinction based on matrix production, cell morphology, and immunohistochemical markers [6].

Despite advances in diagnostic tools and multimodal therapy, the prognosis and treatment strategies differ significantly between these two sarcomas. A better understanding of their distinguishing clinical, radiographic, and pathological features can enhance early diagnosis and improve outcomes through tailored treatment [7].

This study aims to provide a comparative evaluation of the clinical presentation, imaging findings, and histopathological characteristics of osteosarcoma and Ewing's sarcoma, thereby contributing to improved diagnostic clarity and therapeutic planning.

MATERIALS AND METHODS

This multicenter, retrospective, comparative study was conducted at tertiary care academic hospitals in India. The study included patients diagnosed histopathologically with either osteosarcoma or Ewing's sarcoma over a period of 10 years data records.

Study Population: A total of 80 patients with primary malignant bone tumors were included, of which 45 were diagnosed with osteosarcoma and 35 with Ewing's sarcoma. Inclusion criteria comprised patients aged between 5 and 40 years with radiologically and histologically confirmed diagnosis of either osteosarcoma or Ewing's sarcoma, with no prior treatment history. Patients with metastatic disease at presentation or incomplete records were excluded.

Data Collection: Demographic parameters (age, sex), clinical presentation (pain, swelling, systemic symptoms), radiological features (location, type of bone involvement, periosteal reaction), and histopathological characteristics (tumor subtype, cellular morphology, necrosis percentage) were recorded from hospital records and pathology archives.

Radiological assessment included plain radiographs and MRI of the affected limb. Findings were evaluated for bone destruction patterns, soft tissue extension, periosteal reactions (e.g., Codman's triangle, sunburst appearance), and medullary involvement.

Histopathological slides were reviewed by two independent pathologists, blinded to clinical diagnosis. Parameters assessed included tumor architecture, presence of small round blue cells (for Ewing's sarcoma), osteoid production (for osteosarcoma), mitotic activity, and necrosis.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Categorical variables were compared using Chi-square or Fisher's exact test, and continuous variables using Student's t-test or Mann–Whitney U test, depending on distribution. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 80 patients were included in the study, with 45 cases diagnosed as osteosarcoma and 35 as Ewing's sarcoma. The demographic profile is summarized in Table 1. The mean age of presentation was significantly higher in patients with osteosarcoma (17.9 ± 5.3 years) compared to those with Ewing's sarcoma (14.2 ± 4.7 years) ($p = 0.003$). While both tumors showed male predominance, the gender distribution was not statistically significant.

Clinical features of the two malignancies varied in frequency and type, as shown in Table 2. Localized pain and swelling were common in both groups. However, constitutional symptoms such as fever and weight loss were significantly more frequent in patients with Ewing's sarcoma ($p < 0.001$ and $p = 0.042$, respectively), indicating a more systemic presentation.

Radiological differences between the groups were clearly evident (Table 3, Image 1). Classic findings like the "sunburst" periosteal reaction and Codman's triangle were predominantly observed in osteosarcoma, whereas "onion-skin" appearance, characteristic of Ewing's sarcoma, was significantly more frequent in that

group ($p < 0.001$). Soft tissue mass was observed in both groups, with a higher prevalence in Ewing's sarcoma patients ($p = 0.018$).

Histopathological evaluation (Table 4) revealed distinct features in both tumors. Osteoid production was universally present in osteosarcoma cases, while small round blue cell morphology was characteristic of Ewing's sarcoma, seen in 97.1% of cases ($p < 0.001$). Other histological parameters, such as tumor necrosis and mitotic activity, did not differ significantly between the two groups.

Table 1: Demographic Profile of Patients (N = 80)

Variable	Osteosarcoma (n = 45)	Ewing's Sarcoma (n = 35)	Total (n = 80)	p-value
Mean Age (years)	17.9 ± 5.3	14.2 ± 4.7	16.3 ± 5.2	0.003
Age Group				
≤ 10 years	6 (13.3%)	9 (25.7%)	15 (18.8%)	0.121
11–20 years	26 (57.8%)	21 (60.0%)	47 (58.8%)	
> 20 years	13 (28.9%)	5 (14.3%)	18 (22.5%)	
Gender (M/F)	28 / 17	21 / 14	49 / 31	0.872

Table 2: Clinical Presentation

Symptom	Osteosarcoma (n = 45)	Ewing's Sarcoma (n = 35)	p-value
Localized pain	42 (93.3%)	32 (91.4%)	0.752
Swelling	37 (82.2%)	28 (80.0%)	0.801
Fever	5 (11.1%)	16 (45.7%)	<0.001
Weight loss	4 (8.9%)	9 (25.7%)	0.042

Table 3: Radiological Findings (X-ray + MRI)

Radiologic Feature	Osteosarcoma (n = 45)	Ewing's Sarcoma (n = 35)	p-value
Sunburst periosteal reaction	33 (73.3%)	5 (14.3%)	<0.001
Onion-skin appearance	2 (4.4%)	21 (60.0%)	<0.001
Codman's triangle	20 (44.4%)	7 (20.0%)	0.018
Soft tissue mass	28 (62.2%)	30 (85.7%)	0.018

Table 4: Histopathological Features

Histological Feature	Osteosarcoma (n = 45)	Ewing's Sarcoma (n = 35)	p-value
Osteoid production	45 (100%)	0 (0.0%)	<0.001
Small round blue cells	2 (4.4%)	34 (97.1%)	<0.001
Tumor necrosis >50%	17 (37.8%)	13 (37.1%)	0.941
Mitoses >10/HPF	19 (42.2%)	21 (60.0%)	0.106

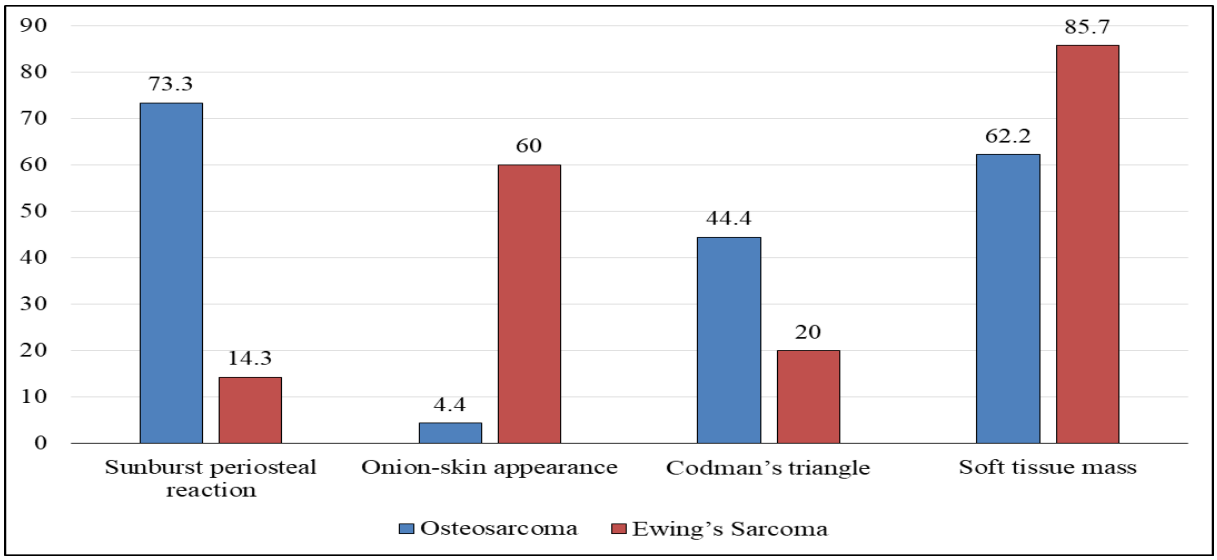

Image 1: Radiological Findings (%) in study cases

DISCUSSION

This comparative analysis demonstrates distinct clinical, radiological, and histopathological profiles between osteosarcoma and Ewing's sarcoma.

Patients with osteosarcoma presented at an older mean age, consistent with the bimodal age distribution described by Kim C et al., who reported peak incidence during adolescence and a smaller peak in older adults [8]. In contrast, Ewing's sarcoma affected a younger cohort and more frequently manifested with systemic symptoms such as fever and weight loss, in line with recent epidemiological data highlighting its aggressive systemic presentation [9].

Radiologically, osteosarcoma exhibited classic aggressive periosteal reactions—sunburst appearance and Codman's triangle—whereas Ewing's sarcoma more often showed onion-skin layering and extensive soft-tissue masses. These findings corroborate those of Jalali P et al., who emphasized the diagnostic value of periosteal reaction patterns in differentiating pediatric bone sarcomas [10], and that soft-tissue extension on MRI is a hallmark of Ewing's sarcoma [11].

Histopathologically, osteosarcoma was defined by abundant osteoid production, whereas Ewing's sarcoma nearly universally displayed small round blue cell morphology with high mitotic activity. These distinctions mirror the molecular underpinnings described by Dupuy M et al., in which EWS-FLI1 fusion–driven proliferation underlies the small round cell phenotype of Ewing's sarcoma [12], and by Miwa S et al., who characterized osteoid matrix as pathognomonic of osteosarcoma [13].

Despite these clear differences, both tumors exhibited similar rates of extensive necrosis (>50%) and high mitotic index (>10/HPF), suggesting comparable biological aggressiveness once established. This aligns with Kim C et al.'s observation that aggressive histological features predict poorer outcomes across both tumor types [8].

Overall, the combination of demographic, imaging, and histological criteria enhances diagnostic accuracy and informs tailored management strategies. Early recognition of these patterns is critical for initiating appropriate multimodal therapy, which remains the cornerstone for improving long-term survival in these patients.

CONCLUSION

This comparative study highlights key distinctions between osteosarcoma and Ewing's sarcoma in terms of clinical presentation, imaging characteristics, and histopathological features. Osteosarcoma was found to occur at a slightly older age and was more often associated with classic radiologic signs such as sunburst appearance and Codman's triangle. In contrast, Ewing's sarcoma commonly presented with constitutional symptoms and distinctive onion-skin periosteal reaction on imaging. Histologically, osteoid matrix production was exclusive to osteosarcoma, while Ewing's sarcoma consistently exhibited sheets of small round blue cells. Awareness of these patterns can improve diagnostic accuracy and guide appropriate treatment planning in suspected bone malignancies.

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Comparison of MRI and Ultrasound in the Diagnosis of Rotator Cuff Tears in Orthopedic Shoulder Injuries

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Abstract

Background: Rotator cuff tears are a frequent cause of shoulder morbidity, especially in middle-aged and elderly individuals. While MRI is considered the gold standard for diagnosis, ultrasound has gained popularity due to its availability and cost-effectiveness. This study compares the diagnostic performance of MRI and ultrasound in detecting rotator cuff tears. ***Materials and Methods:*** A cross-sectional study was conducted at a tertiary care center involving 234 patients with clinically suspected rotator cuff injuries. All patients underwent both MRI and ultrasound imaging. Demographic and clinical profiles were documented. MRI findings served as the reference standard for calculating the diagnostic efficacy of ultrasound. ***Results:*** The mean age group affected was 46–60 years, with males comprising 58.55% of the sample. The most common clinical symptom was shoulder pain (93.59%). MRI identified full-thickness tears in 47.86% and partial-thickness tears in 32.48% of patients. Ultrasound detected full-thickness and partial-thickness tears in 43.16% and 29.49% of patients, respectively. When compared to MRI, ultrasound demonstrated a sensitivity of 90.64%, specificity of 71.43%, positive predictive value of 89.61%, and diagnostic accuracy of 85.47%. ***Conclusion:*** Ultrasound shows high sensitivity and diagnostic accuracy in the evaluation of rotator cuff tears and may be a useful first-line imaging modality, especially in resource-limited settings. However, MRI remains superior for comprehensive assessment and surgical planning.

Keywords: Rotator cuff tear, Ultrasound, MRI, Shoulder injury, Diagnostic accuracy

INTRODUCTION

Rotator cuff tears are a leading source of shoulder pain and functional limitation, particularly affecting middle-aged and older adults, with global prevalence estimates ranging from 20% to 54% in symptomatic individuals [1]. Accurate diagnosis is critical for guiding management decisions and predicting outcomes; while Magnetic Resonance Imaging (MRI) is considered the reference standard for comprehensive tendon evaluation, it is relatively expensive and not universally accessible [2].

In recent years, high-resolution musculoskeletal ultrasound (US) has emerged as a viable, cost-effective alternative. It offers comparable accuracy to MRI in both full- and partial-thickness tears of the supraspinatus tendon, with meta-analyses reporting no significant difference in sensitivity or specificity between the two modalities [3]. Multiple studies have demonstrated that US sensitivity in detecting full-thickness tears ranges from 90% to 100% and specificity from 85% to 94% when performed by well-trained operators and compared against MRI or surgical findings [4][5]. Such findings underline the potential value of US as a first-line imaging modality in rotator cuff pathology.

The advantages of ultrasound include its wide availability, absence of ionizing radiation, and capacity for real-time dynamic assessment, making it particularly helpful in outpatient and resource-limited settings [6]. However, ultrasound remains operator-dependent and may offer less comprehensive evaluation than MRI in complex or concomitant shoulder pathologies, such as labral tears or muscular atrophy [2][3].

Despite growing evidence supporting US, there is a need for larger, direct comparison studies in diverse populations to determine its diagnostic performance relative to MRI. This study addresses that gap by evaluating the accuracy of ultrasound compared with MRI in detecting rotator cuff tears, aiming to inform imaging strategies for shoulder injuries.

MATERIALS AND METHODS

This hospital-based cross-sectional study was conducted over a period of 18 months in the Department of Orthopaedics and Radiodiagnosis at a tertiary care center in India. A total of 234 patients aged ≥18 years, presenting with shoulder pain and clinical suspicion of rotator cuff injury, were included after obtaining written informed consent.

Inclusion criteria were: (1) patients with clinically suspected rotator cuff pathology based on symptoms such as shoulder pain, restricted range of motion, or weakness; and (2) those who underwent both ultrasound (US) and magnetic resonance imaging (MRI) for diagnostic evaluation. Exclusion criteria included: history of prior shoulder surgery, recent fracture or dislocation, generalized inflammatory joint diseases, and incomplete imaging data.

All included patients first underwent a standardized ultrasound examination using a high-frequency linear transducer (7–12 MHz). Dynamic real-time scanning in multiple planes was performed, evaluating the supraspinatus, infraspinatus, subscapularis, and teres minor tendons, as well as the biceps tendon and subacromial-subdeltoid bursa. Findings were categorized as full-thickness tear, partial-thickness tear, tendinosis, or no tear.

Subsequently, all patients underwent MRI of the shoulder, performed using a 1.5 Tesla scanner. Standard axial, coronal, and sagittal T1- and T2-weighted sequences were obtained. MRI findings were interpreted by another blinded radiologist, with categorization similar to that of ultrasound. MRI served as the reference standard for diagnostic comparison.

Data on patient demographics, clinical symptoms, imaging findings, and side of involvement were recorded and analyzed. Statistical analysis was carried out using SPSS software version 26.0. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy of ultrasound in detecting rotator cuff tears were calculated with MRI findings as the gold standard.

RESULTS

The present study analyzed a total of 234 patients with clinically suspected rotator cuff injuries to compare the diagnostic utility of MRI and ultrasound. The demographic characteristics of the study population are presented in Table 1. The most commonly affected age group was 46–60 years (35.04%), followed by 31–45 years (28.21%). Males comprised a higher proportion of the study population (58.55%) than females. Right-sided shoulder involvement was more prevalent (64.96%) compared to the left.

The clinical presentation of patients is detailed in Table 2. Shoulder pain was the most frequently reported symptom (93.59%), followed by restricted range of motion (75.21%) and weakness in abduction (52.99%). Night pain was noted in 44.02% of cases. A history of trauma was documented in nearly one-third of the patients, while signs of chronic degenerative changes were observed in 38.03%.

The MRI findings, considered the reference standard in this study, are summarized in Table 3. Nearly half of the patients (47.86%) were diagnosed with full-thickness rotator cuff tears, and another 32.48% had partial-thickness tears. Tendinosis was identified in 13.25%, whereas 6.41% showed no evidence of a tear.

In comparison, ultrasound findings (Table 4) showed a slightly lower detection rate for full-thickness tears (43.16%) and partial-thickness tears (29.49%). However, ultrasound detected tendinosis in a greater number of cases (17.52%) and failed to detect any abnormality in 9.83% of patients.

The diagnostic performance of ultrasound was evaluated against MRI as the gold standard (Table 5 and Figure 1). The sensitivity and specificity of ultrasound were 90.64% and 71.43%, respectively. The positive predictive value (PPV) was 89.61%, while the negative predictive value (NPV) was 73.77%. The overall diagnostic accuracy of ultrasound in detecting rotator cuff pathology was found to be

Table 1: Demographic Profile of Study Participants (N = 234)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
18–30	28	11.97%
31–45	66	28.21%
46–60	82	35.04%
>60	58	24.79%
Gender		
Male	137	58.55%
Female	97	41.45%
Side of Involvement		
Right	152	64.96%
Left	82	35.04%

Table 2: Clinical Presentation of Shoulder Injuries (N = 234)

Symptom	Number of Patients	Percentage (%)
Shoulder Pain	219	93.59%
Restricted Range of Motion	176	75.21%
Weakness in Abduction	124	52.99%
Night Pain	103	44.02%
History of Trauma	71	30.34%
Chronic Degeneration	89	38.03%

Table 3: MRI Findings in Suspected Rotator Cuff Tear Patients (N = 234)

Finding	Frequency (n)	Percentage (%)
Full Thickness Tear	112	47.86%
Partial Thickness Tear	76	32.48%
Tendinosis	31	13.25%
No Tear Detected	15	6.41%

Table 4: Ultrasound Findings in the Same Patients (N = 234)

Finding	Frequency (n)	Percentage (%)
Full Thickness Tear	101	43.16%
Partial Thickness Tear	69	29.49%
Tendinosis	41	17.52%
No Tear Detected	23	9.83%

Table 5: Diagnostic Comparison between MRI and Ultrasound (Gold Standard: MRI)

Parameter	Value
True Positives (TP)	155
False Positives (FP)	18
True Negatives (TN)	45
False Negatives (FN)	16
Sensitivity (%)	90.64%
Specificity (%)	71.43%
Positive Predictive Value	89.61%
Negative Predictive Value	73.77%
Accuracy (%)	85.47%

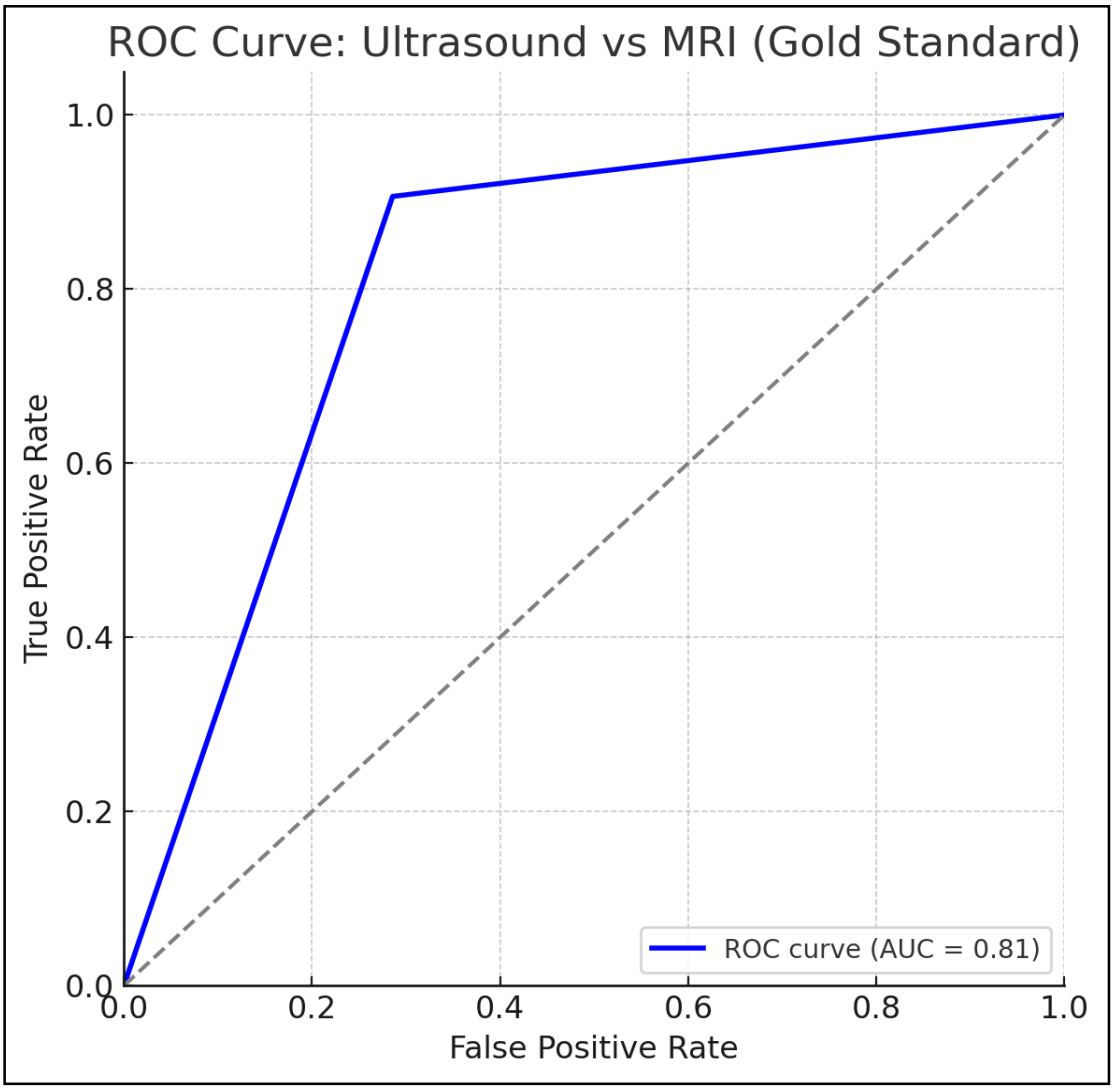

Figure 1: ROC Curve for US vs MRI (Gold Standard)

DISCUSSION

This study evaluated the diagnostic performance of ultrasound compared to MRI in a cohort of 234 patients with clinically suspected rotator cuff tears. Our ultrasound sensitivity (90.64%) and specificity (71.43%) in detecting rotator cuff pathology align closely with prior meta-analyses indicating no significant difference between MRI and ultrasound in diagnosing full- or partial-thickness tears [7]. The overall diagnostic accuracy of ultrasound in our cohort (85.47%) also supports its role as a reliable initial screening tool, particularly for full-thickness tears.

A study from North India, though smaller in sample size, reported sensitivities around 86.7% for full-thickness and 89.7% for partial-thickness tears, with near-perfect agreement (kappa ~0.9) between ultrasound and MRI [8]. Similarly, another study found excellent correlation—sensitivity of 91.2%, specificity of 81.8%, and overall accuracy of 88.6% between ultrasound and MRI findings in rotator cuff injuries [9]. These results confirm the high reliability of ultrasound when performed by skilled operators.

Despite its advantages, ultrasound's lower specificity (71.4% in our study) relative to MRI points to potential false positives and limitations in evaluating complex or subtle pathologies [8]. MRI remains superior in mapping tear extent, detecting associated intra-articular conditions, and guiding surgical planning [10]. In resource-limited settings, however, ultrasound's availability, cost-effectiveness, and dynamic real-time imaging make it a practical first-line imaging modality.

The demographic trends observed—predominance of patients aged 46–60 and right-sided involvement—mirror established epidemiological patterns for degenerative rotator cuff disease [11]. Clinically, more than 90% reported shoulder pain, with most cases showing restricted motion and functional impairment, consistent with other epidemiological studies in similar populations [11-15].

Limitations include the single-center design and lack of arthroscopic or surgical confirmation in all cases, which precludes definitive gold-standard comparison. Furthermore, ultrasound is operator-dependent, and results may vary by examiner expertise.

CONCLUSION

This study demonstrates that ultrasound has high sensitivity and diagnostic accuracy in detecting rotator cuff tears, making it a valuable screening tool, particularly for full-thickness tears. Despite MRI being the gold standard, ultrasound offers a cost-effective, readily available, and non-invasive alternative, especially in resource-constrained settings. MRI remains superior in evaluating complex tear patterns and associated intra-articular pathologies. The findings support the integration of musculoskeletal ultrasound in routine orthopedic diagnostic pathways. Further studies with surgical correlation are recommended to validate diagnostic accuracy across varying clinical scenarios.

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