



International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2017; 3(4): 758-764
© 2017 IJOS
www.orthopaper.com
Received: 15-08-2017
Accepted: 16-09-2017

Dr. Ajoy SM
Assistant Professor,
Department of Orthopaedics,
Ramaiah Medical College,
Bangalore, India

Dr. Ramneesh Kohli
Junior Resident, Department of
Orthopaedics, Ramaiah Medical
College, Bangalore, India

Dr. Abhilash Palla
Junior Resident, Department of
Orthopaedics, Ramaiah Medical
College, Bangalore, India

Incidence, ultrasound evaluation and outcome of syndesmotic injuries in patients with ankle sprain

Dr. Ajoy SM, Dr. Ramneesh Kohli and Dr. Abhilash Palla

DOI: <https://doi.org/10.22271/ortho.2017.v3.i4k.105>

Abstract

Background and Objectives: Ankle sprain is one of the most common injuries in general population. Lateral ankle sprain make up a majority of these injuries and literature describes a high degree of success with quick return to function. Injury to Syndesmotic ligament occurs in 10-18 percent of all ankle sprains. Its incidence is higher in individuals participating in sports activities like football, downhill skiing and hockey. These injuries are associated with high incidence of chronic pain, significant long term complication as compared to lateral ankle sprain. Recognizing these injuries and intervening at an appropriate time is crucial to prevent long-term morbidity. The workup of these patients involve complete history, weight bearing radiographs, external rotation stress testing and in some cases MRI. In stable injuries non-operative treatment and physiotherapy may work while in unstable injuries tendon repair and other operative interventions may be required. We attempted to study the incidence of Syndesmotic injury in patients of ankle sprain by combining clinical, radiographic and ultrasound examinations. Follow up of all patients was done for 6 months to evaluate their functional outcome.

Materials and Methods: This was a prospective cohort study conducted in the orthopedics department of a tertiary care hospital situated in an urban area to find out the incidence of Syndesmotic injuries in patients with ankle sprain by combining clinical and radiological methods and to know the utility of ultrasound examination in these patients. 66 patients with history of ankle sprain were included in this study after taking into consideration inclusion and exclusion criteria. The patients were assessed on the basis of history, clinical examination, squeeze test, external rotation stress test, anterior drawer test and imaging (X-Ray and Musculoskeletal Ultrasound using high frequency probe). The incidence of Syndesmotic injuries, their mechanism, clinical and imaging evaluation and outcome was studied. The results were studied using various statistical methods. $P < 0.05$ was taken as statistically significant. Data analysis was carried out SPSS 16.0 version software.

Results: 66 patients, 38 male and 28 female were included in the study. Most common mechanism of injury seen in this patient was found to be inversion followed by eversion type injuries which were seen in 39 (59.6%) and 22 (33.3%) patients respectively. During clinical examination Anterior drawer test, external rotation and squeeze test was positive in 15 (22.7%), 8 (12.40%) and 7 (11%) patients. Radiographically 3 patients (4.5%) were positive for disruption and on ultrasonography 8 (12.40%) patients had strain pattern and 4 (6.1%) patients had disruption. On short term follow up, patients with positive signs of Syndesmotic injury had lower functional score as compare to patients with no signs of Syndesmotic injury. However, on long term follow up, all patients had fair to good outcome. Our study shows that grade of ankle sprain does not determine long term outcome

Conclusion: In today's world of competitive sports and vehicular accidents Syndesmotic injuries of ankle are a common occurrence. These injuries may be associated with chronic pain and instability. Ultrasound is a good diagnostic tool to evaluate and grade the Syndesmotic injury. Grade of ankle sprain have a bearing on short term morbidity but it does not seem to be affecting the long term functional outcome.

Keywords: Ankle Syndesmosis, sprain, ligament tear, ultrasonography, outcome

Introduction

Ankle sprain is one of the common injuries in general population^[1]. Lateral ankle sprain make up a majority of these injuries and literature describes a high degree of success with quick return to function. Dorsiflexion (ankle flexion) and plantar flexion (ankle extension) are the primary motions taking place at the ankle joint. Other movements like Inversion, eversion, supination, and pronation occur at subtalar joints. Syndesmotic injuries involve the disruption

Correspondence
Dr. Ramneesh Kohli
Junior Resident,
Department of Orthopaedics,
Ramaiah Medical College,
Bangalore, India

of the ligamentous structures between the distal tibia and fibula [2]. The most common mechanisms of Syndesmotic injuries of ankle joint are external rotation and hyperdorsiflexion. Other less common reported causes include eversion, inversion, plantar flexion, pronation and internal rotation. During external rotation if an undue force is applied this may lead to tears involving the anterior tibiofibular ligament, the superficial posterior inferior tibiofibular ligament, the transverse tibiofibular ligament or a combination of these. The intosseous ligament or intosseous membrane may also get injured in severe cases [3].

These injuries occur in 10-18 percent of all ankle sprain and are not easy to diagnose when frank diastasis is absent. The incidence of high ankle sprain has been increasing because of improved understanding of diagnosis, biomechanics and cause of Syndesmotic injury [4]. Recent reports suggest the incidence of Syndesmotic injury 17-74 percent in young population [5]. These injuries require a recovery time almost twice as long as that of a severe (third degree) lateral ankle sprain, with a mean time to return to normal activity of 45 days. There is still paucity of information on optimum conservative and operative management [6]. These injuries have rapid resolution of external ecchymosis and edema and patient can start walking immediately with little pain. Stretching of the injured syndesmosis leads to prolonged recovery, chronic pain and instability [7].

It is important to analyze the mechanism of injury and the prior history of instability. It can be classified into acute (<3 weeks), subacute (3 weeks -3 months and chronic (>3 months). Severity of injury can be correlated with ability to bear weight. Patients complain of generalized pain with weight-bearing or push off during gait if they are able to bear weight [8]. A heel-raise gait pattern may be observed to avoid excessive ankle dorsiflexion and to avoid pain during push off. In chronic situations, the patients may complain of stiffness and feelings of instability, especially on rough or uneven terrain. Patients with chronic injuries may show prolonged recovery as compared to those with ordinary lateral ankle sprains [9].

Inspections reveal edema and ecchymosis about the lateral aspect of the ankle. The patient will often have well-localized anterolateral pain located over the anterior syndesmosis of the ankle. The pain and swelling in acute syndesmotic injuries are often more precisely localized than in patients with the common inversion lateral ankle sprain. Careful palpation over the anterior talofibular and calcaneofibular ligaments should reveal minimal if any tenderness. The degree of swelling tends not to be as substantial as with lateral inversion injuries [10].

The clinical tests used for diagnosis and knowing severity of ankle syndesmosis include squeeze test, external rotation stress test, shuck test, cross legged test and heel thump test. The diagnosis can be reliably confirmed by imaging studies which may include weight bearing radiographs, and in some cases 3D Computed tomography and MRI. In stable injuries non-operative treatment and physiotherapy may work while in unstable injuries tendon repair and other operative interventions may be required.

The purpose of this study was to study the incidence of Syndesmotic injury in patients of ankle sprain by combining clinical, radiographic and ultrasound examinations and to know the functional outcome of the patients during a follow up period of 6 months.

Materials and Methods

The study was conducted at department of orthopaedics of a

medical college situated in a metropolitan city with an objective to evaluate the incidence of Syndesmotic injury in patients with ankle sprain by combining clinical and radiological methods and to know the utility of ultrasonography in patients with ankle syndesmosis. The study was duly approved by institutional ethical committee. All patients in the age of 18 -65 years with history of ankle sprain were included in this study depending upon the inclusion and exclusion criteria. A detailed history was taken and thorough clinical examination was done in all the cases. Clinical evaluation in all the patients was done by squeeze test, external rotation stress test and anterior drawer test. Plain radiographs (Anteroposterior view, lateral view and anteroposterior mortise view) were taken in all the patients. The radiographs were evaluated for overlap and clear space. Point of care ultrasound (POCUS) was one of the important parts of this study. Ultrasound of the ankle joint was done in all the cases. The patients were examined in the supine with the knee extended and the foot flush to the examination table. The ultrasound assessment of the anterior compartment was done for the presence of joint fluid, synovitis, and tibial or talar osteophytes. The syndesmosis was then imaged in all cases in the transverse plane via the anterior approach. The syndesmosis was visualized for continuity and contour, and the distance between the tibia and fibula was measured (clear space); the presence of fluid and/or hematoma around the ligament was documented. Finally, a dynamic ultrasound examination was performed using external and internal rotations of the foot in 5° to 10° of ankle dorsiflexion.

On ultrasound, Syndesmotic tears were graded as:

Grade 1: Strain Pattern

Grade 2: Partial Tear

Grade 3: Complete Tear

All patients were followed up at 2 weeks, 6 weeks and 6 months and functional outcome was evaluated by modified Karlsson and Peterson scoring system. The results were studied using appropriate statistical methods. $P < 0.05$ was taken as statistically significant. Data analysis was carried out using SPSS16.0 version software. Microsoft word and excel were used for generating charts and graphs

Inclusion criteria

- All patients in the age of 18 -65 years with history of ankle sprain.

Exclusion criteria

- Patients with ankle fracture.
- Patients with neurovascular deficits.
- Patient with history of ankle arthritis.

Results

Our study consisted of 66 patients out of which 38 were males and 28 were females with an M: F ratio being 1: 0.76.

Table 1: Gender Distribution of the studied cases.

Gender	Frequency	Percent
Male	38	57.5%
Female	28	42.5%
Total	66	100%

The most common age group affected was found to be between 30-39 years with a mean age of 33.8 years with standard deviation of 8.175 years. Median age was found to be 32.0 years.

Table 2: Age distribution of the studied cases

Age	Frequency	Percent
20-29 yrs.	17	25.8
30-39 yrs.	32	48.5
40-49 yrs.	12	18.2
50-59 yrs.	5	7.6
Total	66	100.0

The analysis of mechanism of injury revealed that the most common type of injury was inversion type of injury (59.6%)

followed by eversion (33.3%), plantar flexion (6.1%) and dorsiflexion (1.5%).

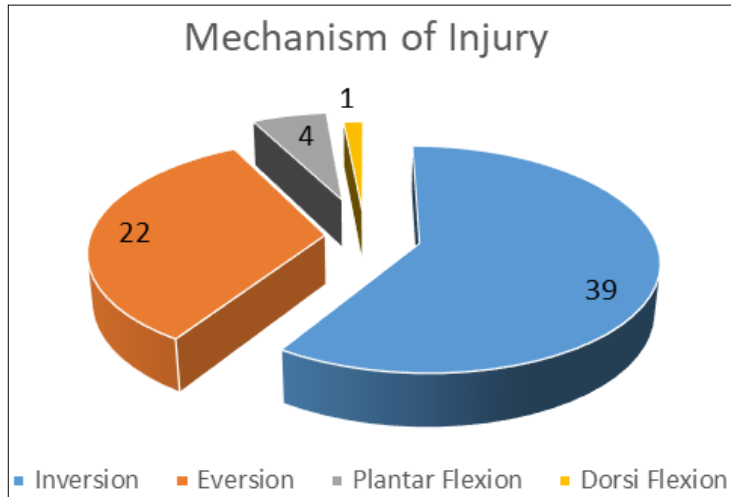


Fig 1: Mechanism of injury in the studied cases.

The clinical examination revealed that External rotation test was most common test to be found positive (89%) followed

by squeeze test (87.60%) and anterior drawer test (77.3%).

Table 3: Clinical Examination of the studied cases.

		No Of Patients	Percentage
Squeeze Test	Positive	58	87.60%
	Negative	8	12.40%
External Rotation Test	Positive	59	89%
	Negative	7	11%
Anterior Drawer Test	Positive	51	77.3
	Negative	15	22.7

The analysis of Ankle score and squeeze test and external rotation was done respectively. The relationship was evaluated at presentation, at 2 weeks, 6 weeks and at 6

months follow up visits. P value less than 0.01 was taken as statistically significant.

Table 4: Relationship between Squeeze test and external rotation with Ankle scoring.

Ankle score		Mean	Std. Deviation	P value
Squeeze Test				
At present	Negative	30.34	4.575	0.01
	Positive	27.62	6.567	
At 2wk	Negative	37.93	5.184	0.035
	Positive	36.12	8.967	
At 6wk	Negative	43.90	5.534	0.02
	Positive	41.88	11.319	
At 6months	Negative	54.55	1.366	0.131
	Positive	53.88	1.553	
External Rotation				
At presentation	negative	30.33	4.754	0.949
	Positive	26.83	5.419	
At 2wk	Negative	38.03	5.418	0.372
	Positive	34.50	7.969	
At 6wk	Negative	44.10	5.991	0.077
	Positive	39.17	9.174	
At 6months	Negative	54.52	1.384	0.290
	Positive	54.00	1.549	

The relationship between squeeze test and external rotation was also studied squeeze test was positive in 8 patients while external rotation was positive in 6 patients. Out of 8 patients having positive squeeze test 5 patients had a positive external rotation test and out of 6 patients with positive external rotation 3 patients had positive squeeze test.

Table 5: Relationship between External rotation and Squeeze test.

Squeeze	External Rotation		Total
	Negative	Positive	
Negative	55	3	58
Positive	5	3	8
Total	60	6	66

Chisquare test, Ficher exact value=0.03

The analysis of the radiological features of the cases revealed that on X-Ray overlap in mortise was present in 2 (3%) patients while clear space in AP and clear space in mortise was present in 1 (1.5%) patient each. Overlap in AP was not found in any patients.

Table 6: X-Ray findings in the studied cases

X RAY Findings	Normal/Abnormal	Number	Percentage
Clear Space in AP	Normal	65	98.5%
	Abnormal	1	1.5%
	Total	66	100%
Overlap in AP	Normal	66	100%
	Abnormal	0	0
	Total	66	100%
Clear Space In Mortise	Normal	65	98.5%
	Abnormal	1	1.5%
	Total	66	100%
Overlap in Mortise	Normal	64	97%
	Abnormal	2	3%
	Total	66	100%

On ultrasound the most common abnormality seen was clear space in internal rotation which was seen in 18 (26.3%) patients followed by clear space in ER (19.7%) and clear space in neutral position (14.7%). Analysis of Syndesmotic integrity on ultrasound revealed strain pattern in 8 (12.1%) and tears in 4 (6.1%) patients.

Table 7: Sonographic analysis of Syndesmotic integrity

Syndesmotic Integrity	Syndesmotic Integrity		Clear Space Neutral		Clear Space ER		Clear Space IR	
	N	Percent	N	Percent	N	Percent	N	Percent
Normal	54	81.8%	57	86.3%	53	80.3	48	72.7
Abnormal	8(Strain)	12.1%	9	14.7%	13	19.7	18	26.3
	4 (Tear)	6.1						
Total	66	100%	66	100%	66	100	66	100

Analysis of relationship between X-Ray and Ultrasound examination revealed that USG was normal (Continuity maintained) in 54 (81.80%) patients while strain pattern and tears were found in 8 (12.10) and 4 (6.10%) patients

respectively. Out of 63 patients having normal X-Ray Abnormal USG was normal in 85.7% patient while some abnormality (Either Strain pattern or tear was found in 14.3% patients.

Table 8: relationship between X-Ray and Ultrasound examination

X-ray	USG Continuity			Total
	Normal	Strain Pattern	Tear	
-ve (N=63)	85.7%	10.7%	3.6%	100.00%
+ve (N=3)	95.4%	1.5%	3%	100.00%
	54	8	4	66
Total	81.80%	12.10%	6.10%	100.00%

Analysis of ankle sprain and radiographic changes showed that X-ray was abnormal in 9.9% (2/22) patients with eversion injuries while it was abnormal in 1 patient with inversion

injury. X-ray was normal in dorsiflexion and plantar flexion sprains.

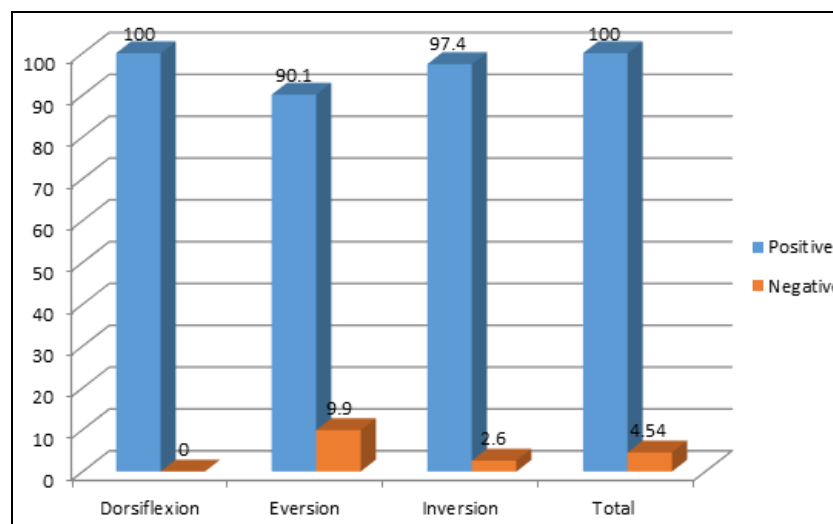


Fig 2: Type of Injury and Radiographic Changes

Study of Syndesmotic disruption on USG and type of injury revealed that Syndesmotic disruption was present in 12

patients out of which 8 patients (12.10%) had strain pattern while tears were seen in 4 (6.10%) Patients.

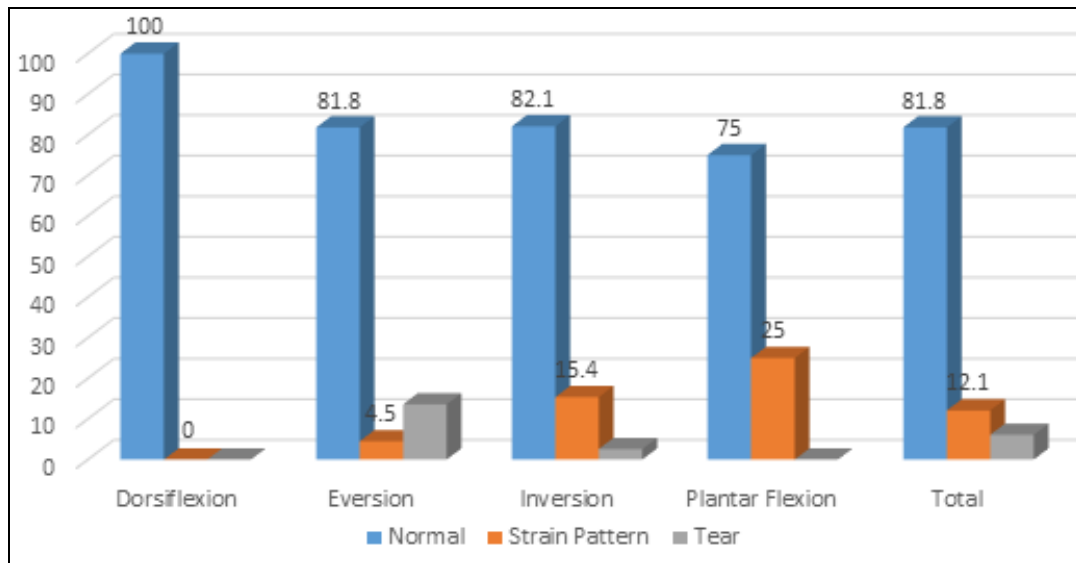


Fig 3: Type of injury and Syndesmotic disruption on ultrasound (%).

Relationship between Clear space in neutral and external rotation was analysed and it was found that in neutral position Clear space was abnormal in 9 (13.70%) patients while clear

space in external rotation was abnormal in 13 (19.60%) patients.

Table 9: Clear space in neutral and external rotation

	Clear Space Neutral		Clear Space ER	
	Normal	Abnormal	Normal	Abnormal
Dorsiflexion (N=1)	100.0%	0.0%	100.0%	0.0%
Eversion (N=22)	76.4%	23.6%	67.3%	32.7%
Inversion (N=39)	62.2%	37.8%	72.3%	28.7%
Plantar flexion (N=4)	80%	20%	50.0%	50.0%
Total (N)	57	9	53	13
Total (%)	86.30%	13.70%	80.30%	19.60%

Relationship between Clear space on Ultrasound and clear space on AP radiograph was analyzed and it was found that Clear space on Ultrasound was abnormal in 18 (27.30%)

patients while clear space on AP radiograph was abnormal in 1 (1.50%) patient.

Table 10: Clear space on Ultrasound and clear space on AP radiograph

	Clear Space USG		Clear Space AP Radiograph	
	Normal	Abnormal	Normal	Abnormal
Dorsiflexion (N=1)	100.0%	0.0%	100.0%	0.0%
Eversion (N=22)	77.3%	22.7%	95.5%	4.5%
Inversion (N=39)	74.4%	25.6%	100.0%	0.0%
Plantar flexion (N=4)	50.0%	50.0%	100.0%	0.0%
Total (N)	48	18	65	1
Total (%)	72.70%	27.30%	98.50%	1.50%

Clear space in mortise view was abnormal plantar flexion, eversion and inversion in 25%, 9.1% and 2.6% patients

respectively while Overlap in mortise was found only in eversion and was found in 4.5% patients.

Table 11: Clear space and overlap in mortise view in studied cases.

	Clear Space In Mortise		Overlap In Mortise	
	Normal	Abnormal	Normal	Tear
Dorsiflexion (N=1)	100.0%	0.0%	100.0%	0.0%
Eversion (N=22)	90.9%	9.1%	95.5%	4.5%
Inversion (N=39)	97.4%	2.6%	100.0%	0.0%
Plantar flexion (N=4)	75.0%	25.0%	100.0%	0.0%

Finally Ankle scoring at presentation, 2 weeks, 6 weeks and at 6 months was done. The findings of ankle scoring are given in

tabulated form below. P value < 0.01 was taken as statistically significant.

Table 12: Ankle scoring at presentation, 2weeks, 6 weeks and 6 months in the studied cases.

		N	Mean	SD	Min.	Max.	F value*	P value
Normal	At Presentation	54	30.2	4.787	20	40	79.694	<0.001
	Week 2	54	37.67	5.978	22	47		
	Week 6	54	44.09	6.289	25	55		
	Months	54	54	3.216	45	55		
Strain Pattern	At Presentation	8	30.13	6.058	22	40	6.88	0.005
	Week 2	8	38.75	5.175	30	45		
	Week 6	8	41.25	7.44	30	50		
	Month 6	6	47.5	6.3	45	50		
Tear	At Presentation	4	27.25	3.775	22	30	11.345	0.003
	Week 2	4	36.25	2.5	35	40		
	Week 6	4	42.5	6.455	35	50		
	Months 6	6	45	6.33	45	50b		

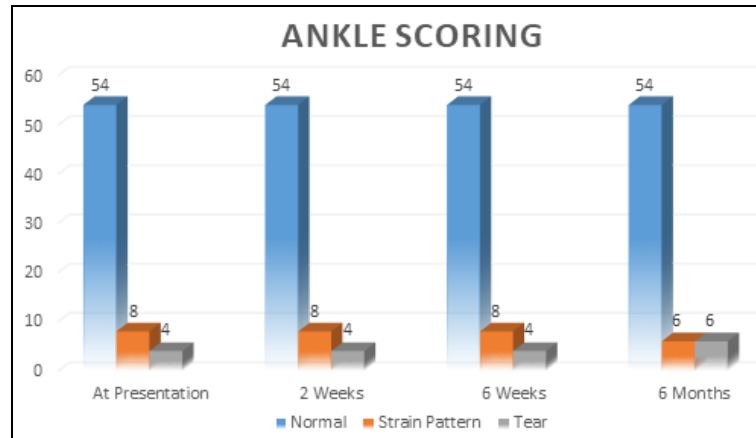


Fig 4: Ankle scoring at presentation, 2weeks, 6 weeks and 6 months in the studied cases.

Discussion

Injury to Syndesmotoc ligaments occurs in 10-18 percent of all patients with ankle sprain. These injuries are difficult to diagnose without the presence of fracture or frank diastasis and the diagnosis is frequently missed. As compared to lateral ankle sprain, these patients have rapid resolution of ecchymosis and edema and patients starts walking early stressing the injured ligament which leads to chronic pain and instability [11]. As there are no obvious symptoms and normal radiography, these injuries are generally missed. According to recent literature, ankle Syndesmotoc sprain requires a recovery time almost twice as long as that of a severe (third degree) lateral ankle sprain, with a mean time to return to normal activity of 45 days [12]. The mechanism of Syndesmotoc injury has been ascribed to ankle being subjected to external rotation moment with the foot in dorsiflexed position [13]. In view of being an underdiagnosed and undertreated condition leading to long term complication, we planned to assess the patients of ankle sprain for Syndesmotoc ligament injury. We have combined the clinical, radiographic and sonographic methods to assess the incidence of Syndesmotoc injury. All the patients were treated by standard treatment protocols and evaluated by functional ankle scoring system.

In our study of 66 patients, 38 patients were male and 28 are female. This is in contrast to the other studies as Indian women wear more flat heel footwear in contrast to western population. The other reason is that Indian women are less commonly involved in outdoor sporting activities. The mean age of the study population is 33.2 which is expected as ankle sprain are more common in active population. In our study, the most common mechanism of injury was inversion type of injury (59.6%) followed by eversion (33.3%) which is similar to the study by Anandacoomarasamy *et al.* [14].

In our study of 66 patients, 8 patients were positive for

squeeze and 7 patients were positive for external rotation stress test. The diagnostic sensitivity, specificity and inter-rater reliability of these clinical tests is variable in the literature. Patients with positive squeeze test had lower functional outcome at 6 weeks. This indicates that positive squeeze test is a bad prognostic indicator and patients with positive squeeze require a longer rehabilitation. A weak but significant correlation existed between squeeze test and external rotation stress test.

In a study by Amy D Sman [15], comparison was done between clinical tests and MRI and sensitivity and specificity of squeeze test was 65 percent and 88 percent respectively whereas sensitivity and specificity of external rotation stress test was found to be 58 percent and 81 percent. In our study, the sensitivity and specificity of squeeze test is 68 percent and 81 percent respectively. The sensitivity and specificity of external rotation stress test is 62 percent and 81 percent respectively. Similar results were seen in studies by Gerber [16] *et al.* and Hopkins *et al.* [17].

The ability of clinical tests to diagnose ankle Syndesmotoc injury accurately without the necessity of imaging investigations would enable early start of appropriate management and potentially decrease the risk of persistence of problems. Importantly it would limit costs for the patients and healthcare system.

X-ray are widely used, especially to rule out bony injury, but the reliability of x-ray to rule out Syndesmotoc injury is questionable. There is variable data on the diagnostic criteria for Syndesmotoc injury on X-rays. In our study, one patient had abnormal clear space on AP view, no patient had abnormal overlap on AP view. On mortise view, 1 patient had abnormal clear space and 2 patients had abnormal overlap. These patients had abnormal ultrasonographic pattern. The reason for lower incidence of Syndesmotoc injury on

radiography is because strain pattern and partial tear will not lead to diastasis on X-ray. Our results are similar to study by Takao *et al.* ^[18] which had 44 percent sensitivity and 100 percent sensitivity for AP view and 58 percent sensitivity and 100 percent specificity for Mortise view.

In our study, we have used dynamic ultrasonography to diagnose injury to inferior tibio-fibular ligament. According to study by Omer Mei Dan, it is 100 percent sensitivity and specificity as compare to MRI for latent Syndesmotic injury ^[19]. Additional advantage of dynamic USG is that tear can be graded and treatment can be decided accordingly. The merit of the study is that all ultrasound scans were done by single experienced musculoskeletal radiologist. In our series, 8 patients had Syndesmotic strain pattern and 4 patients had partial tear of syndesmosis. No patient had complete disruption on ultrasonography as such injuries are seen in high energy contact sports. All patients presenting with Syndesmotic injury were immobilized for 2 weeks in a posterior splint and then rehabilitation program was started.

Out of 66 patients, 61 had grade 1 or 2 ankle sprain which is similar to that reported by Jackson *et al.* ^[20]. The assumption that grade 1 sprain are minor injuries is not true. These patients might return to full activity early as compare to grade 2 however when comparing two groups at 6 months, few differences were seen. It may be because either patients with grade 1 sprain do not follow rehabilitation protocol or grade 1 injuries are underestimated.

In our study, all patients were treated by standard protocol according to grade of sprain. Patients presenting with Syndesmotic injury were immobilized for a relatively longer time (2 weeks). On short term follow up (6 weeks) patients having Syndesmotic injury had lower functional scores but at 6 months of follow up all patients had acceptable functional outcome.

Conclusion

Syndesmotic injury after ankle sprain is an under-diagnosed condition which leads to chronic pain and instability. Ultrasound is a good diagnostic tool to evaluate and grade the Syndesmotic injury. Treatment plan can be decided based upon the grade of injury. Clinical tests are useful to detect the ligament injury and they have prognostic value. Grade of ankle sprain have a bearing on short term morbidity but it does not seem to be affecting the long term functional outcome. We recommend that ultrasound should be considered as a diagnostic modality in all patients of ankle sprain to diagnose ligament injury as it is affordable and easily available in comparison to MRI. Moreover it can also be done in patients who may have a contraindication for MRI (cochlear implants, aneurysmal clips or individuals with claustrophobia).

Conflict of Interest: None

References

1. Polzer H, Kanz KG, Prall WC *et al.* Diagnosis and treatment of acute ankle injuries: development of an evidence-based algorithm. *Orthopedic Reviews.* 2012; 4(1):e5.
2. Del Buono A, Florio A, Boccanera MS, Maffulli N. Syndesmosis injuries of the ankle. *Current Reviews in Musculoskeletal Medicine.* 2013; 6(4):313-319.
3. Jones M, Amendola A. Syndesmosis sprains of the ankle: a systematic review. *Clin Orthop Relat Res.* 2007; 455:173-175.

4. Molinari A, Stolley M, Amendola A. high ankle sprains syndesmotic in athletes: diagnostic challenges and review of the literature. *The iowa orthopaedic journal,* 2009; 29:130-138.
5. Kramer DE, Cleary MX, Miller PE, Yen Y-M, Shore BJ. Syndesmosis injuries in the pediatric and adolescent athlete: an analysis of risk factors related to operative intervention. *Journal of Children's Orthopaedics.* 2017; 11(1):57-63.
6. Porter DA, Jagers RR, Barnes AF, Rund AM. Optimal management of ankle syndesmosis injuries. *Open Access Journal of Sports Medicine.* 2014; 5:173-182.
7. Schnetzke M, Vetter SY, Beisemann N, Swartman B, Grütznier PA, Franke J. Management of syndesmotic injuries: What is the evidence? *World Journal of Orthopedics.* 2016; 7(11):718-725.
8. Hunt KJ. Syndesmosis injuries. *Current Reviews in Musculoskeletal Medicine.* 2013; 6(4):304-312.
9. Pick TD, Howden R, editors. *Grays Anatomy, Descriptive and Surgical.* New York, NY: Bounty Books; 1977, 283-286.
10. Kellett JJ. The clinical features of ankle syndesmosis injuries: a general review. *Clin J Sport Med.* 2011; 21(6):524-9.
11. Wagener ML, Beumer A, Swierstra BA. Chronic instability of the anterior tibiofibular syndesmosis of the ankle. *Arthroscopic findings and results of anatomical reconstruction.* *BMC Musculoskeletal Disorders.* 2011; 12:212.
12. Press CM, Gupta A, Hutchinson MR. Management of ankle syndesmosis injuries in the athlete. *Curr Sports Med Rep.* 2009; 8(5):228-33.
13. Lin CF, Gross ML, Weinhold P. Ankle syndesmosis injuries: anatomy, biomechanics, mechanism of injury, and clinical guidelines for diagnosis and intervention. *J Orthop Sports Phys Ther.* 2006; 36(6):372-84.
14. Anandacoomarasamy A, Barnsley L. Long term outcomes of inversion ankle injuries *Br J Sports Med,* 2005; 39:e14.
15. Amy D Sman, Claire E Hiller, Kathryn M Refshauge. diagnosis of ankle syndesmosis injury: a Diagnostic accuracy of clinical tests for syndesmotic injuries. originally published online *Br J Sports Med,* 620-628.
16. Gerber JP, Williams GN, Scoville CR, Arciero RA, Taylor DC. Persistent disability associated with ankle sprains: a prospective examination of an athletic population. *Foot Ankle Int,* 1998; 19:653-660.
17. Hopkinson WJ, St Pierre P, Ryan JB, Wheeler JH. Syndesmosis sprains of the ankle. *Foot Ankle.* 1990; 10:325-330.
18. Takao M, Ochi M, Oae K. Diagnosis of a tear of the tibiofibular syndesmosis. The role of arthroscopy of the ankle. *J Bone Joint Surg Br,* 2003; 85:324.
19. Mie-Dan O, Carmont M, Laver L, Nyska M, Kammar H, Mann G, Clarck B, Kots E. Standardisation of functional syndesmotic widening by usg. *BMC Sports Sci Med Rehabil,* 2013; 2;5:9.
20. Jackson DW, Ashley RL, Powell JW. Ankle sprains in young athletes. *Clin. Orthop.,* 1974; 101:201-215.