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## Syndesmotom diastasis and it's relation to the functional outcome in ankle fractures

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### Abstract

Ankle fractures are among the most common injury treated by orthopaedic surgeons. Syndesmotom injuries represent the severity of the ankle injuries. However, they are difficult to evaluate, have a lengthy recovery period, and may disrupt normal joint functioning if not appropriately treated. These ankle injuries are disastrous if not appropriately treated specially to athletes and those engaged in heavy work on irregular surfaces. Hence treating these ankle injuries are of utmost importance. The aim of this study was to assess the functional outcome in ankle fractures with syndesmotom diastasis and without syndesmotom diastasis. To provide guidelines for intra-operative assessment of syndesmotom stability. To find out the complications occurring in each group. This was a prospective observational study conducted in yenepoya medical college hospital from October 2017 to October 2020. In this study 42 patients were treated and each equally were divided into two groups with syndesmotom injury and without syndesmotom injury. Open reduction and internal fixation with locking / one third tubular plate with 3.5 system for lateral malleolus and 4 mm CC screws for medial malleolus for fractures without syndesmotom injury and fracture with syndesmotom injury additional 4mm screw was put, which was evaluated. Diagnosing the syndesmotom instability preoperatively wasn't adequate. However when combined with intraoperative assessment by checking for translational movements and cottons test; it was found to be more reliable. Open reduction and anatomical fixation is required to obtain good results. A simple syndesmotom screw will suffice the job and the screw needs to be removed before weight-bearing in order to avoid screw breakage. To conclude, the functional outcome scores were lower in syndesmotom group. However, we need to assess the functional outcomes in a longer time frame to see if any statistically significant difference actually exists or not.

**Keywords:** syndesmotom injury, open reduction and internal fixation, cotton's test, intraoperative assessment D

### Introduction

The ankle is a complex uniaxial hinge joint consisting of three joints; the tibiotalar joint, the subtalar joint and the inferior tibiofibular joint. Both the malleoli along with the ligaments that span across stabilize the talus underneath the tibia. The deltoid ligament spans the medial aspect of the ankle and stabilizes it. The three lateral ligaments: the anterior talofibular, the posterior talofibular ligament and the calcaneofibular ligament support the lateral side of the ankle joint. The syndesmosis is made up of the anteroinferior tibiofibular ligament, the interosseous ligament and the posteroinferior tibiofibular ligament. The inferior transverse tibiofibular ligament is sometimes considered a fourth ligament <sup>[1]</sup>. Ankle fractures are among the most common injury treated orthopaedic surgeons. Syndesmotom injuries represent the severity of the ankle injuries; which is most commonly caused by external rotation force in a pronated or supinated foot. Syndesmotom ankle injuries are less common than ankle malleolar fractures; however, they are difficult to evaluate, have a lengthy recovery period, and may disrupt normal joint functioning if not appropriately treated. They account for approximately 10% of all the ankle fractures <sup>[2]</sup>. The tibiofibular syndesmosis is a complex of ligaments that provides dynamic stability to the ankle joint <sup>[3]</sup>. The syndesmotom ligaments are essential for the integrity of the ankle mortise and thereby for weight-bearing and walking <sup>[3]</sup>. These injuries require thorough evaluation and optimal treatment to prevent crippling disabilities. These ankle injuries are disastrous if not appropriately treated specially to athletes and those engaged

in heavy work, particularly on rough or irregular surfaces. Hence treating these ankle injuries are of utmost importance. A surgeon must be aware of the anatomy of both affected and sound ankle, various clinical test to diagnose different types of ankle injuries, limb biomechanics and treatment methods to achieve good results.

### Materials and Method

A prospective study was carried which included all consenting patients coming to the Department of Orthopaedics OPD and Casualty of Yenepoya Medical College Hospital between 2017 to 2020 with ankle fractures with or without syndesmotom diastasis.

### Inclusion criteria

1. All consenting patients with open/closed ankle fractures.
2. Weber type C and B fractures
3. Maisonneuve fracture

### Exclusion criteria

1. Paediatric age group
2. Patient's with undisplaced ankle fractures treated conservatively
3. Chronic uncontrolled diabetic patients in whom there is an increased risk of developing charcot arthropathy
4. Ankle fractures associated with ipsilateral distal 3rd tibial fracture
5. Revision surgery
6. Medical conditions-Head Injury, CVA, Cerebral infections, Hypoxia, heatstroke, hypothermia.

**Radiological Evaluation:** The standard radiographic evaluation of the ankle includes, anteroposterior, lateral and mortise views. In the review of literature radiographic measurements of syndesmotom injury alone is not sufficient to diagnose syndesmotom diastasis. It should be coupled with Dennis Weber classification and intraoperative assessment of syndesmotom integrity.

### Initial Treatment

The extremity was usually splinted and elevated in the emergency room prior to evaluation. With this accomplished, the injured ankle was evaluated, and if the ankle is grossly distorted, as it might be in a severe injury with subluxation, the subluxation was reduced immediately at the initial examination to avoid skin necrosis and eliminate tension on the neurovascular structures and then the radiographic examination is carried out. After radiographs have been obtained, the ankle was splinted and elevated.

### Operative Protocol

Use of a tourniquet will be purely at the surgeon's discretion. With regards to treatment, the following protocols were followed for the study:

1. Lateral malleolus fracture was fixed by ORIF + fibular plating. Postero-lateral approach to expose the fracture. Oblique fractures were stabilized with a lag screw. The fracture was fixed with 3.5mm 1/3rd tubular Neutralizing/ Anatomical/ Recon/ DCP as neutralizing plate. For comminuted fracture 1/3rd tubular/anatomical/ recon/ DCP will be used as a bridge plate.
2. Medial malleolus fracture was fixed by
  - Two parallel or convergent CC screw/Single CC screw/Malleolar screw fixation.
  - Tension band wiring

- K-wires
3. Posterior malleolus fixation if required was fixed through the posterolateral approach or percutaneous fixation with 4 mm CC / Cancellous screws.
  4. Assessment of the syndesmotom integrity was done under fluoroscopic evaluation.
  5. Syndesmotom diastasis: After stable fixation of medial and lateral malleolus; Intra-op modified Cotton test and translation movements was done to assess the syndesmotom integrity. If there was an opening of greater than 5mm of tibio-fibular clear space (TFCS) or 5 mm of medial tibio-talar clear space (TTCS), it was treated with one/two 3.5 mm cortical screw tricortical/quadri-cortical screw fixation inserted 2 cm from the tibiotalar joint approx. 300 posterolateral to anteromedial direction. In the case of two syndesmotom screws following method was followed
    - Transsyndesmotom screw: 2 cm above the ankle joint.
    - Supra syndesmotom screw: 3.5 cm above the ankle joint

Syndesmotom screw removal after 3 months of fixation, after the union and before full weight-bearing to avoid breakage of the screw.

**Post-operative Management:** The ankle was immobilized in well-padded firm dressing incorporated with a posterior plaster splint that will hold the ankle at a right angle and prevent any plantar flexion. Postoperatively limb elevation on BB splint was advocated to reduce postoperative swelling. Strict non-weight-bearing was advocated with walker for the first six weeks and later partial weight was started if the fracture was healing well. Gradual full weight-bearing was started after 12 weeks after removal of the syndesmotom screw.

### Follow up

Regular follow up at the end of 1, 3 and 6 months. The patient was tested for range of movements, compression test etc as mentioned in the proforma. AOFAS scoring was used to assess the pain, function, limitation of range of movements and stability.

### Results

In our study series, we had 42 patients with Ankle fractures admitted in yenepoya medical college hospital, Mangalore. They were divided into two study groups (group A: Ankle fractures without syndesmotom injury and Group B: Ankle fractures with syndesmotom diastasis) and studied. The following observations made from data collected during this study.

**Age distribution:** The mean age of the study population was 39.88 years (Group A was 41.76; Group B was 38 years).

**Table 1:** Distribution of the study population according to age group. The mean age in our study is 39.88 years.

Age group	Frequency	Parent
< 20 Years	21	50.0
20-30 Years	3	7.1
10-40 Years	7	16.7
40-50 Years	5	11.9
50-60 Years	4	9.5
> 60 Years	2	4.8
Total	42	100.0

Table 2 given below represents the association between age group and study groups. Chi-square test confirms that there was an association between age group and study group. We

had 50% of the cases below the age of 20 years suggesting ankle injuries are common in young.

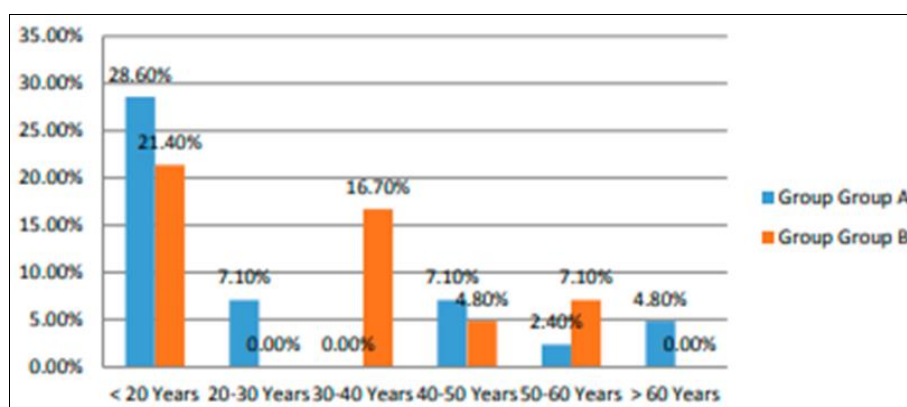
**Table 2:** Association between age group and study group.

Age group	Group		Total
	Group A	Group B	
< 20 Years	12	9	21
	28.6%	21.4%	50.0%
20-30 Years	3	0	3
	7.1%	0.0%	7.1%
30-40 Years	0	7	7
	0.0%	16.7%	16.7%
40-50 Years	3	2	5
	7.1%	4.8%	11.9%
50-60 Years	1	3	4
	2.4%	7.1%	9.5%
> 60 Years	2	0	2
	4.8%	0.0%	4.8%
Total	21	21	42
	50.0%	50.0%	100.0%

Chi-square value = 13.629, DF = 5, P = value = 0.018 (Statistical Significance at 5% level of Significance).

**Group A:** Ankle fractures without syndesmotom injury

**Group B:** Ankle fractures with syndesmotom diastasis



**Fig 1:** Age distribution

## Mode of injury

**Table 3:** Distribution of study population according to mode of injury.

Mode of injury	Frequency	Percent
RTA	13	31.0
Twisting Injury	29	69.0
Total	42	100.0

Table given below represents the association between the mode of injury and study groups. There was no association between the mode of injury and study group as confirmed by

chi-square test. Twisting injury was the most common mode of injury in our study.

**Table 4:** Association between mode of injury and study group.

Mode of injury	Group		Total
	Group A	Group B	
RTA	6	7	13
	14.3%	16.7%	31.0%
Twisting Injury	15	14	29
	35.7%	33.3%	69.0%
Total	21	21	42
	50.0%	50.0%	100.0%

Chi-square value = 0.111, DF = 1, P = value = 0.739 (Not Statistical Significance).

**Group A:** Ankle fractures without syndesmotom injury

**Group B:** Ankle fractures with syndesmotom diastasis

## Open fracture

**Table 5:** Open fracture.

Open fracture	Frequency	Percent
Yes	7	16.7
No	35	83.3
Total	42	100.0

Table given below gives percent of open fractures in each study group. We had a total of 7 cases of open fracture; 3 in group A and 4 in group B. From the chi-square test, we confirmed that there was no association between open fractures and study group.

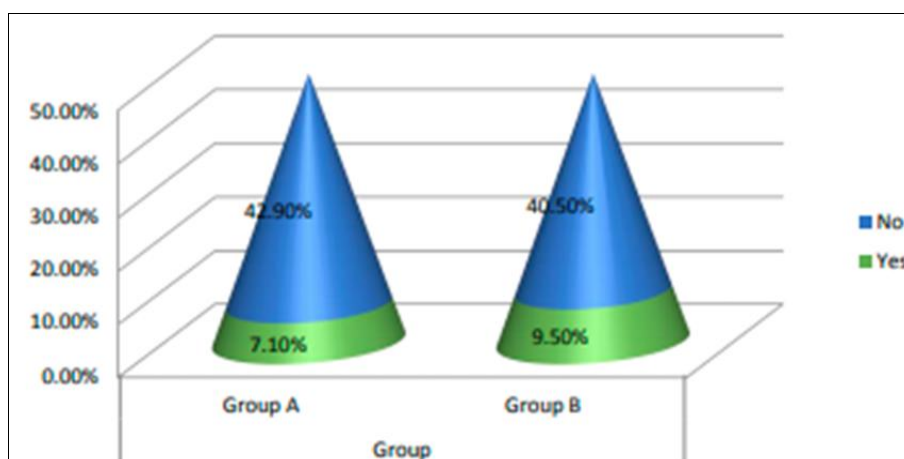
**Table 6:** % of open fractures in each study group.

Open fracture	Group		Total
	Group A	Group B	
Yes	3	4	7
	7.1%	9.3%	16.7%
No	18	17	35
	42.9%	40.3%	83.3%
Total	21	21	42
	50.0%	50.0%	100.0%

Chi-square value = 0.171, DF = 1, P = value = 0.679 (Not Statistical Significance).

**Group A:** Ankle fractures without syndesmotom injury

**Group B:** Ankle fractures with syndesmotom diastasis



**Fig 2:** Open fracture among study group

## Denis weber classification

**Table 7:** According to Denis weber classification

Denis weber	Frequency	Percent
Type-A	4	9.5
Type-B	24	57.1
Type-C	14	33.3
Total	42	100.0

**Table 8:** Association between Denis weber and study group.

Denis weber	Group		Total
	Group A	Group B	
Type-A	4	0	4
	9.3%	0.0%	9.5%
Type-B	17	7	24
	40.5%	16.7%	57.1%
Type-C	0	14	14
	0.0%	33.3%	33.3%
Total	21	21	42
	50.0%	50.0%	100.0%

Chi-square value = 22.167, DF = 5, P = value = 0.000 (Statistical Significance at 5% level of Significance).

**Group A:** Ankle fractures without syndesmotom injury

**Group B:** Ankle fractures with syndesmotom diastasis

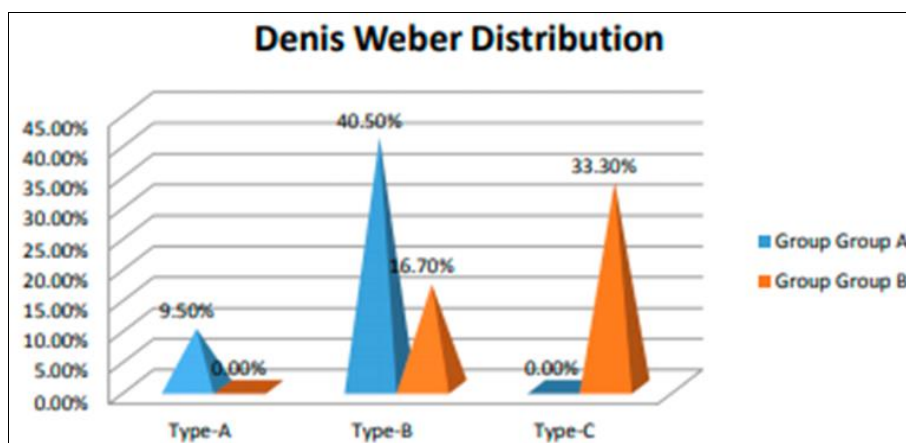


Fig 3: Denis weber distribution

## Functional outcome

Table 9: Mean score comparison of study parameters between normal and affected limb of study population.

For Group A				
Study Parameters	Side	Mean	SM. Deviation	Mean DIFF. / Sign.
Movements	Affected Limb	21.667	3.2914	-4.0476
Dorsiflexion	Normal Limb	25.714	1.7928	0.000 (Sign.)
Plantar	Affected Limb	30.000	4.1833	4.2857
Flexion	Normal Limb	34.286	1.7928	0.000 (Sign.)
Inversion	Affected Limb	17.381	3.3982	-1.9048
l	Normal Limb	19.286	1.7928	0.017 (Sign.)
Eversion	Affected Limb	13.333	2.4152	-1.6667
	Normal Limb	15.000	.0000	0.005 (Sign.)
For group b				
Movements	Affected Limb	16.905	5.3563	-6.6667
Dorsiflexion	Normal Limb	23.571	2.3146	0.000 (Sign.)
Plantar	Affected Limb	28.333	5.3229	43238
Flexion	Normal Limb	32.857	2.5355	0.002 (Sign.)
Inversion	Affected Limb	16.905	3.7001	-1.4286
	Normal Limb	18.333	2.4152	0.083 (Sign)
Eversion	Affected Limb	11.429	2.3146	-33714
	Normal Limb	15.000	.0000	0.0 ign.)

\*Sign - Statistical Significance difference, NS- Not Significant

**Group A:** Ankle fractures without syndesmotic injury

**Group B:** Ankle fractures with syndesmotic diastasis

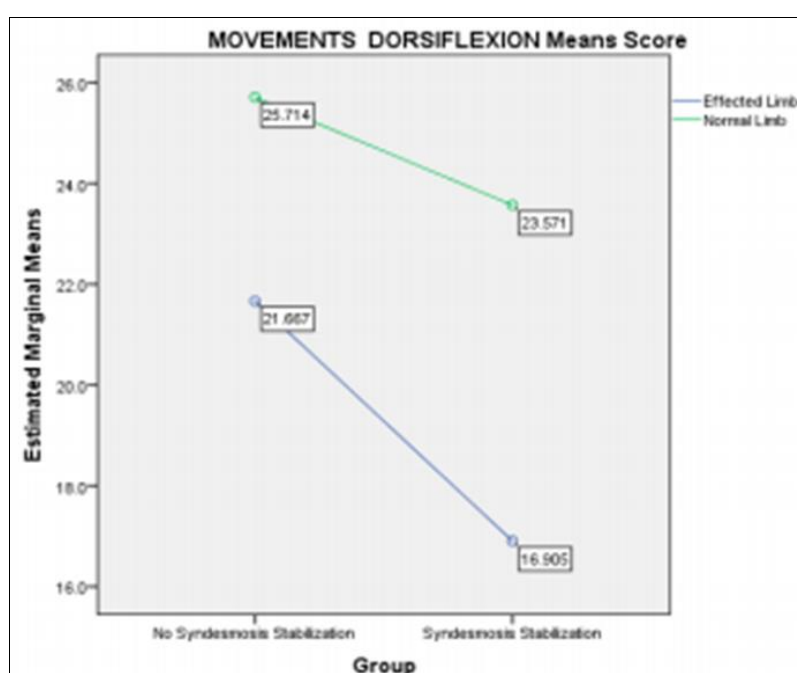
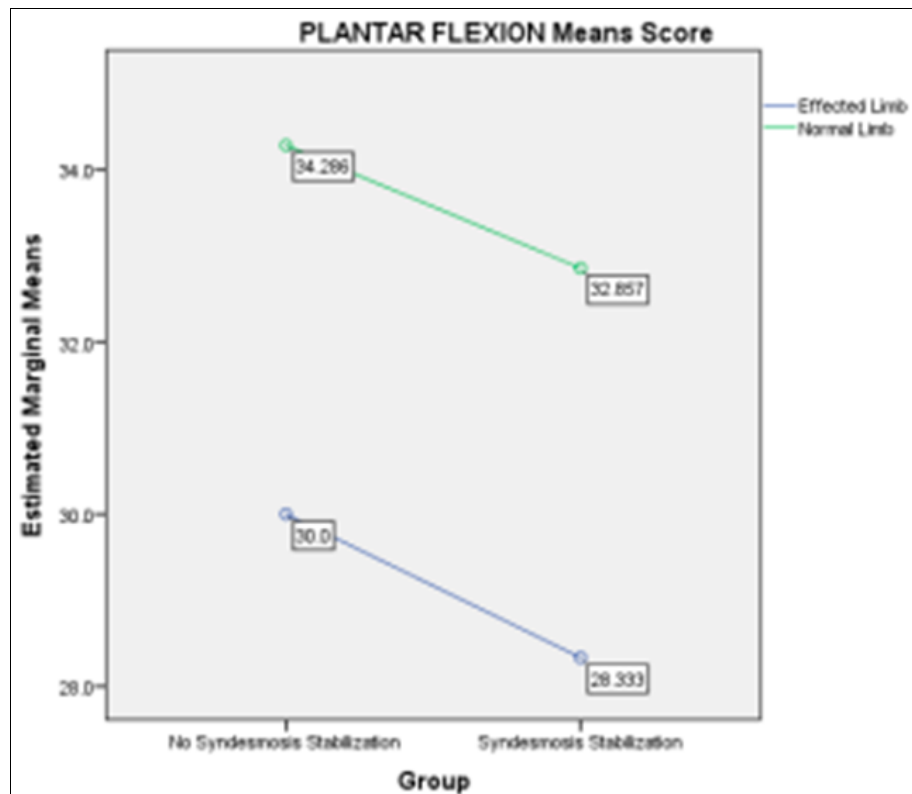


Fig 4: Moments dorsiflexion means score



**Fig 5:** Plantar flexion means score

## Complications

**Table 10:**Complications in the study population.

Complications	Frequency	Percent
No Complication	31	73.8
Wound Healing	4	9.5
Infection	2	4.8
Delayed Union	1	2.4
Non-Union	1	2.4
Delayed Wound Healing	3	7.1
Total	42	100.0

**Table 11:** Association of complications between study population.

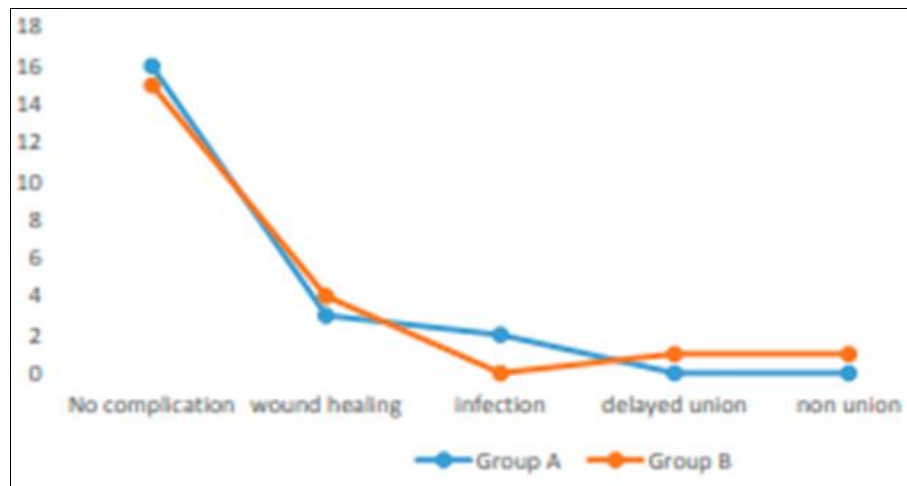
Complications	Group		Total
	Group A	Group B	
No Complication	16	15	31
	38.1%	35.7%	73.8%
Wound Healing	3	4	7
	7.1%	9.5%	16.6%
Infection	2	0	2
	4.8%	0.0%	4.8%
Delayed Union	0	1	1
	0.0%	2.4%	2.4%
Non-Union	0	1	1
	0.0%	2.4%	2.4%
Total	21	21	42
	50.0%	50.0%	100.0%

Chi-square value = 8.032, DF = 5, P = value = 0.154 (Not Statistical Significance).

**Group A:** Ankle fractures without syndesmotomic injury

**Group B:** Ankle fractures with syndesmotomic diastasis



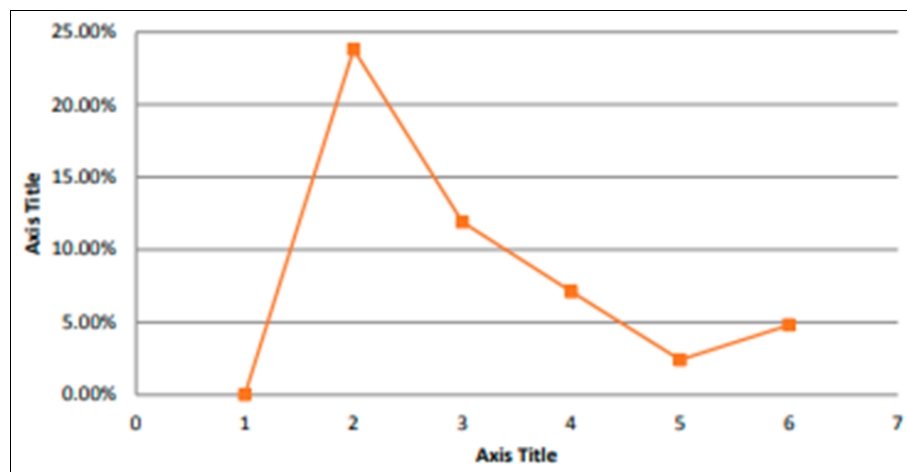
**Fig 6:** Complication

### Syndesmotic screw removal

**Table 12:** Interval between syndesmotic screw removal in the syndesmotic group.

Screw removal	Group B
Control	0
	0.0%
< 10 Weeks	10
	23.8%
10-12 Weeks	5
	11.9%
12-16 Weeks	3
	7.1%
> 16 Weeks	1
	2.4%
Not Removed	2
	4.8%
Total	21
	50.0%

Chi-square value = 42.000, DF = 5, P = value = 0.000 (Statistical Significance at 5% level of Significance).

**Fig 7:** Syndesmotic screw removal in group B

### AOFAS score

**Table 13:** AOFAS score outcome in the study population.

Outcome	Frequency	Percent
Poor	3	7.1
Fair	5	11.9
Good	15	35.7
Excellent	19	45.2
Total	42	100.0

The table given below represents the association between functional outcome (AOFAS) and study groups. Chi-square test conforms that there was no association between the

functional outcomes as measured by AOFAS score between the study groups.

**Table 14:** Association between functional outcome (AOFAS) and study group.

Outcome	Group		Total
	Group A	Group B	
Poor	1	2	3
	2.4%	4.8%	7.1%
Fair	2	3	5
	4.8%	7.1%	11.9%
Good	6	9	15
	14.3%	21.4%	35.7%
Excellent	12	7	19
	28.6%	16.7%	45.2%
Total	21	21	42
	50.0%	50.0%	100.0%

Chi-square value = 8.032, DF = 5, P = value = 0.154 (Not Statistical Significance).

**Group A:** Ankle fractures without syndesmotic injury

**Group B:** Ankle fractures with syndesmotic diastasis

## Discussion

**AGE** In a study conducted by Thur *et al.* that the mean age of patients presenting with ankle fractures was 45yr for men and 58 yrs for women [4]. In a study done by Nitin Bither *et al.* on Indian population found that the average age of ankle fractures in 37.7 years which is in par with our study as compared to western studies where the average age of ankle fractures is variable [5]. **Mechanism of injury** The study conducted by Salai *et al.* [6] noted that the most common mechanism of injury is a fall from standing position which was is similar to other studies conducted by Jensen *et al.* [7] and Thur *et al.* [4]. In the present study, 69% of the population suffered ankle fractures as a result of twisting injuries which is a common mode of injury as described above. 31% of the injuries were as a result of road traffic accidents. In the present study, 83.3% of the population had closed fractures. Overall we noticed that 57.1% had Weber type B fractures with 33.3% having Weber type C fractures.

**Syndesmotic screw 3.5 mm Vs 4.5mm screw:** Both 3.5 and 4.5 mm screws were used for trans syndesmotic fixation, although in recent years there seems to be a tendency to favour 3.5mm screws[58,59,60]. Studies which have compared 3.5 mm and 4.5 mm screws biomechanically and found that there was no advantage of a 4.5 mm screw over a 3.5 mm screw [8]. In our present study, we used 3.5 mm screws for Transsyndesmotic screw fixation.

**Tricortical vs Quadricortical fixation:** Hoiness and Stromsoe in their randomized trial comparing two tricortical screw fixation versus single quadricortical fixation concluded that two tricortical screw fixation yielded better functional results at the end of 3 months, but no significant differences were found at the end of 1 year [9]. In biomechanical research, no difference was found between fixation of the syndesmosis through three or four cortices [10, 11, 12]. We had employed tricortical single screw fixation for majority of the cases in our study. Removal of syndesmotic screw was difficult in 3 cases.

**Position of the screw:** The purpose of optimal positioning of the screw was to restore the normal anatomy of the syndesmosis. Since the anatomic position of the fibula was posterior relative to the tibia, a 30° anteromedial placement was advised to achieve proper fixation in the tibia if the fibula was restored in the tibiofibular notch. McBryde *et al.* found less syndesmotic widening in external rotation with the screw placed at 2 cm proximal to the tibial plafond and recommend

the same [13]. Based on a cadaver study, Olerud reported a decreased dorsiflexion of 0.1 degrees for every degree of plantar flexion at implantation [66]. We put the syndesmotic screw approx. 2cm above the tibial plafond facing 30-degree anteromedial direction with the ankle in neutral or slight dorsiflexion. In one case we had used two screws; the second screw about 3.5cm above the tibial plafond.

In the present study, 19 of 21 patients underwent syndesmotic screw removal, and the mean interval for screw removal was 10 weeks (6 to 16weeks). We did not have any case with screw breakage.

## Outcomes

In the present study, the average AOFAS score was 85.19. Group A mean score was 87.33 and Group B it was 83.04. Patients with syndesmotic injury had lower functional scores at the end of 6 months. Both groups had decreased ankle movements when compared with the unaffected side. However, statistical analysis reveals there was no significant difference in the functional outcome parameters as well as the final score between the groups at the end of 6 months.

Weaning and Bhandari evaluated 51 patients found that the single most important predictor in functional outcomes was accurate syndesmotic fixation.

## Photographs

### Case 1



Trimalleolar fracture left ankle.



Follow-up x ray at 6<sup>th</sup> month.**Case 2**

Preop x ray showing Complete syndesmotomous injury and Postop xray showing tricortical syndesmotomous screw fixation.



Picture showing open fracture and marginal necrosis of the wound postoperatively.



Superficial infection following fixation.



6 months clinical follow-up clinical picture.

**Conclusion**

Ankle fractures are common injuries seen in routine practice with a mean age around 40 years, however in our study 50 percent of injury were around the age of 20 years with twisting injury being the most common mode. Diagnosing the syndesmotomous instability preoperatively wasn't adequate. However when combined with intraoperative assessment by checking for translational movements and cottons test; it was found to be more reliable. Open reduction and anatomical fixation was required to obtain good results. Syndesmotomous injuries represent a severe form of ankle injuries and if not treated, can lead to poorer outcomes. Even though the functional outcomes in syndesmotomous groups were lower than the non syndesmotomous group, there wasn't any statistically

significant difference at the end of 6 months as assessed by the AOFAS score. Knowledge of the syndesmosis and anatomy is crucial in understanding the fracture patterns and treatment. Treatment technique and methodology for syndesmotomous injuries is still highly debatable. However, we feel that a simple syndesmotomous screw will suffice and the screw needs to be removed before weight-bearing in order to avoid screw breakage. To conclude, the functional outcome scores were lower in syndesmotomous group. However, we need a longer follow up period to accurately assess the functional outcomes to see if any statistically significant difference actually exists or not.

## References

1. Van Den Bekerom MPJ, Haverkamp D, Kerkhoffs GMMJ, Van Dijk CN. Syndesmotic Stabilization in Pronation External Rotation Ankle Fractures. *Clin Orthop Relat Res* 2010;468(4):991-5.
2. Van Zuuren WJ, Schepers T, Beumer A, Sierevelt I, Van Noort A, Van Den Bekerom MPJ. Acute syndesmotic instability in ankle fractures: A review. *Foot and Ankle Surgery* 2017;23(3):135-41.
3. Geissler WB, Tsao AK, Hughes JL. Fractures and injuries of ankle. In: Rockwood and Green's fractures in adults. Chapter-31, 4th edn ed. Rockwood CA, Green DP, Bucholz RW, Heckman JD. Philadelphia: Lippincott Raven 1996;2:2201-2266.
4. Thur CK, Edgren G, Jansson K-Å, Wretenberg P. Epidemiology of adult ankle fractures in Sweden between 1987 and 2004. *Acta Orthopaedica* 2012;83(3):276-81.
5. Bithar N, Bhatti S, Paul R, Sadiq S. Outcome following operative treatment of ankle fractures in Indian population.
6. Salai M, Dudkiewicz I, Novikov I, Amit Y, Chechick A. The epidemic of ankle fractures in the elderly – is surgical treatment warranted? *Arch Orth Traumat Surg* 2000;120(9):511-3.
7. Jensen SL, Andresen BK, Mencke S, Nielsen PT. Epidemiology of ankle fractures: A prospective population-based study of 212 cases in Aalborg, Denmark. *Acta Orthopaedica Scandinavica* 1998;69(1):48-50.
8. Thompson MC, Gesink DS. Biomechanical Comparison of Syndesmosis Fixation with 3.5- and 4.5-millimeter Stainless Steel Screws. *Foot Ankle Int* 2000;21(9):736-41.
9. Høiness P, Strømsøe K. Tricortical versus Quadricortical Syndesmosis Fixation in Ankle Fractures: A Prospective, Randomized Study Comparing Two Methods of Syndesmosis Fixation. *Journal of Orthopaedic Trauma* 2004;18(6):331.
10. Markolf KL, Jackson SR, McAllister DR. Syndesmosis Fixation Using Dual 3.5mm and 4.5 mm Screws With Tricortical and Quadricortical Purchase: A Biomechanical Study. *Foot Ankle Int* 2013;34(5):734-9.
11. Beumer A, Campo MM, Niesing R, Day J, Kleinrensink G-J, Swierstra BA. Screw fixation of the syndesmosis: a cadaver model comparing stainless steel and titanium screws and three and four cortical fixation. *Injury* 2005;36(1):60-4.
12. Nousiainen MT, McConnell AJ, Zdero R, McKee MD, Bhandari M, Schemitsch EH. The Influence of the Number of Cortices of Screw Purchase and Ankle Position in Weber C Ankle Fracture Fixation. *Journal of Orthopaedic Trauma* 2008;22(7):473.
13. McBryde A, Chiasson B, Wilhelm A, Donovan F, Ray T, Bacilla P. Syndesmotic Screw Placement: A Biomechanical Analysis. *Foot Ankle Int* 1997;18(5):262-6.
14. Weening B, Bhandari M. Predictors of Functional Outcome Following Transsyndesmotic Screw Fixation of Ankle Fractures. *Journal of Orthopaedic Trauma* 2005;19(2):102.