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A prospective study on radiological & functional outcome of syndesmotic screw fixation in distal tibiofibular syndesmotic injuries associated with ankle injuries

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Abstract

Introduction and Purpose: Improper alignment, malreduction and neglecting to foresee syndesmotic injuries in ankle trauma led to persistent post-operative ankle pain, delay in recovery and early arthritic changes of ankle joint. The treatment of distal tibiofibular syndesmotic injuries is a major concern in ankle injuries. The objectives of this study are to have Preoperative suspicious, assessment of mode of injury, stress x-rays and intraoperative test for all ankle injuries to avoid missing syndesmotic injuries and thereby the treatment.

Materials and Methods: This is a prospective study of 28 ankle injuries diagnosed to have a syndesmotic injury. All cases are due to RTA or falls while walking. Mostly of Weber type b and c. Compound grades I, II & III A were also included. After clinical and radiological investigations, the diagnosis was confirmed and intraoperative test was done and bimalleolar fracture was fixed first then syndesmotic injury fixed with either single or double cortical screws and with 3 or 4 cortex purchase. Postoperative check x-rays taken for checking the proper reduction of the syndesmotic joint and level of screw placement. Postoperative outcome were measured using the AOFAS score chart.

Results and Discussion: Results of our study show excellent (AOFAS 90-100) in 17 cases, good (AOFAS 80-89) in 9 cases, fair (AOFAS 70-79) in 1 case and poor (AOFAS less than 70) in 1 case. With this, we come to the conclusion that (1) pronation external rotation injury is the common type. (2) Diagnosis of distal syndesmotic injuries and fixing it is very much important for having a pain-free stable ankle joint, early mobilization and preventing ankle joint arthritis. (3) Three cortical or four cortical purchase of syndesmotic screw is not significant in postoperative maintenance of reduction. (4) There is no definitive disadvantage if the syndesmotic screws were not removed.

Keywords: Prospective, radiological, functional, syndesmotic, fixation

Introduction

The lower extremity is the most common region of injury in road traffic accidents and other sports activities like running, jumping, twisting. One of the most common injuries faced by a practicing orthopaedic surgeon is the injuries of the ankle. We also see many numbers of cases treated by native bone setters and the patients present to our OPD with crippling disabilities. These ankle injuries are life challenging when coming to sports and athletes, for people working on uneven surfaces (our farmers). So, these ankle fractures are of utmost importance for being suspected, early diagnosed, and treated accordingly. For all these, we must be aware of the normal anatomy of the ankle joint, its biomechanics, its bony and ligamentous involvements, its pathology, clinical and radiological methods for diagnosing, and it's potential for healing.

In 1950 Lauge-Hansen gave a classification with a simplified form that associates the fracture pattern, the mechanism of injury. Another classification is the Denis-Weber classification based on the fracture location compared to the distal syndesmotic joint. The AO/OTA classification of malleolar segment fractures is one of the most frequently used systems for classifying malleolar fractures. It takes the Danis-Weber classification into account and can be correlated to the Lauge-Hansen classification.

The management of these fractures are varying with time, and increasing availability of imaging modalities like MRI. Quenu E. Du [25] first published a case of tibiofibular diastasis after ligamentous disruption more than a century ago. This has increased the interest for further research studies on these injuries and controversies in treatment modalities have been raised.

Aim of the study: To evaluate the functional & radiological outcome of syndesmotic injuries associated with various ankle fractures treated with a syndesmotic screw.
Our objective is to evaluate the clinical and radiological measures by assessing the syndesmotic injuries, Anatomical reduction, Biomechanics of syndesmotic ankle injuries.

Epidemiology: Ankle injuries account for 10% of all the fracture (Tim white, Kate bugler) [23] and is the second most common type in lower limb fractures next to hip fractures. In that, syndesmotic injuries occur in 1-18% of all ankle sprains (Angelo Del Buono *et al.*) [26]. The mean age of injury is about 45 years. It's having a bimodal distribution with a peak incidence of ankle fractures in younger men and older women. The evidence for obesity as a risk factor comes from the international GLOW study of 60,393 women. It was found that obese women over the age of 55 years were significantly more likely to sustain an ankle fracture than nonobese women. Open injuries of the ankle are also common in low-velocity injuries. There is also specific epidemiology of specific fracture patterns. The AO/OTA type c fracture is more commonly due to falls from height or road traffic accidents, while the AO/OTA type A or B is more common with simple falls. There is also a change in epidemiology with time. Between 1950–1980 there was an increased incidence in elderly females and younger males. In recent times, the incidence in young males has been static, while there is an increase in incidence among older females. The trabecular pattern of the distal tibia in elderly patients with ankle fracture are abnormal, depleted and the bone quality is much reduced when compared to uninjured controls. So, this fracture can be considered as a true osteoporotic fracture. The highest risk appears to occur in high-velocity contact sports (football, kabaddi, etc) where there is a demand for the intensity of play, twisting, and risk of collision. Jones and Amendola [32] found that time lost from the sport because of these injuries varied with 10 to 14 days and up to 52 days. Boytim *et al.* [18] compared the return to play of high ankle sprains with routine ankle sprains and found that the individuals with high ankle sprains missed on average 1.4 games and 6.3 practices.

Inferior Tibio Fibular Joint

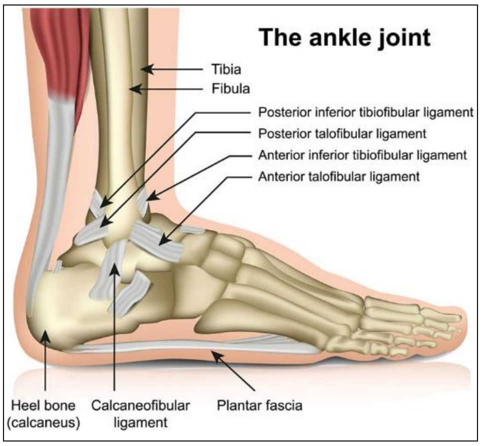


Fig 1: Lateral ankle ligaments

The inferior tibiofibular joint is a syndesmotic joint between the convex surface of the distal fibula and the concave surface of the distal tibia. The distal fibula is firmly attached to the fibular notch of the tibia by syndesmotic ligaments. The stability of this joint is very important for the functioning of the entire limb.

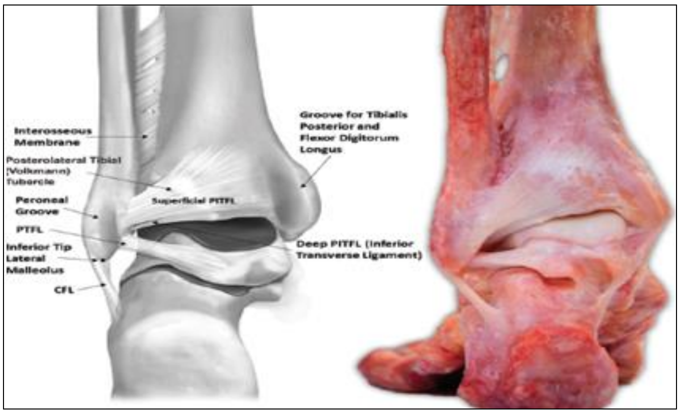


Fig 2: Posterior ankle joint

The ligaments are

- Anterior inferior tibio-fibular ligament
- Posterior inferior tibio-fibular ligament
- The transverse ligament
- The interosseous ligament.

Anterior Inferior Tibio-Fibular Ligament: It is the strongest ligament in this syndesmotic joint. It is attached in the tubercle of Chaput present on the anterior aspect of the tibia and the other end on the tubercle of Wagstaffe on the fibula. Fibers increase in length from proximal to distal. So, the distal Fibers are the longest. The function of this ligament is not only to hold the fibula tight into the incisura but also to prevent excessive fibular movement and external talar rotation.

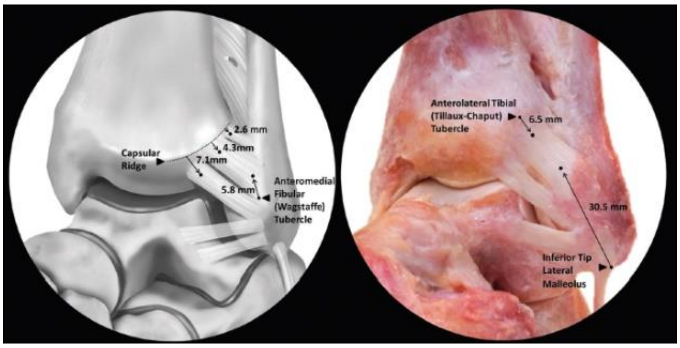


Fig 3: Anterior ankle joint

Posterior Inferior Tibio-Fibular Ligament: The posterior inferior tibiofibular ligament has two components. The superficial and deep components. The superficial fibers originate from the posterior tubercle of tibia and run obliquely, distally and laterally to the posterior aspect of lateral malleolus. This ligament holds the fibula close in the incisura. The deep component is the transverse ligament. It is thick and strong. Its fibres are twisted. It passes from the posterior tibial margin to the osteochondral junction on the posteromedial margin of distal fibula. The location of the transverse ligament below the posterior tibial margin prevents posterior talar translation. The ligament creates a posterior labrum deepening the articular surface of the distal tibia. It fills in the posteromedial aspect of the lateral malleolus, deepening the mortise and increasing joint stability.

Interosseous Ligament: The interosseous ligament originates from the anteroinferior triangular segment of the medial aspect of the distal fibular shaft and then courses to insert on the lateral surface of the distal tibia. It is the thickening of the inferior part of the interosseous membrane. It helps in mild separation between the lateral and medial malleolus during dorsiflexion of the ankle.

Functional Anatomy and Biomechanics

The distal tibiofibular joint is a syndesmotic joint and its main function is to accommodate the talus while in dorsiflexion and plantar flexion. Dorsiflexion can be described as a movement of the dorsum of foot towards anterior aspect of tibial shin. Plantar flexion is the movement of foot away from tibia. The normal range of movement at ankle is between 15 to 20 degrees in dorsiflexion and 45 to 55 degrees in plantar flexion. The trapezoidal-shaped talus requires accessory movements to gap and approximate the mortise during the sagittal plane movement of ankle. The anterior aspect of the superior talar surface is 3-4mm wider than it posterior aspect. The syndesmotic joint acts as a spring to widen the mortise to accommodate the talus while in dorsiflexion and then it recoils itself while in plantar flexion. Ankle stability is more in dorsiflexion and decreased in complete plantar flexion.

In spite of decreased bony stability in plantar flexion the posterior part of talus remains inside the mortise due to talar rotation. Inversion, eversion, supination and pronation are the movement at the subtalar joint. Inversion is called as inward movement of the sole of foot, and eversion is outward movement. Supination is the combination of foot adduction, calcaneal inversion and plantar flexion. Pronation is the combination of foot abduction, calcaneal eversion and dorsiflexion. Normal range of inversion 20 to 30 degrees, eversion 5 to 15 degrees.

Injury to Tibiofibular Syndesmosis

A careful history taking, physical examination and a high degree of suspicion are important in getting a correct diagnosis of the syndesmotic injury.

When the force disrupts the congruency of ankle mortise, the syndesmotic injury occurs. Injury to syndesmosis can occur to any of the following structures. The first and the most common to be injured is the AITFL, followed by PITFL, the transverse ligament and the interosseous ligament.

External rotation is greatly increased by incising both anterior aspects of the deltoid ligament, the anterior tibiofibular ligament or the posterior talofibular ligament. Hence the rupture of the distal tibiofibular structures occurs only with external rotation injuries. ATFL injury alone is a rare and complete rupture of the distal TF structures are mostly combined along with it.

The main function of the distal ankle ligaments is primarily to prevent the lateral displacement of fibula from incisura fibularis. When the diastasis occurs, there will be a separation of the syndesmosis, rupture of TF ligaments, the deltoid ligament and the lateral malleolus fracture above the ankle.

Diastasis without fibular fracture can be classified into two categories.

- The latent diastasis
- The frank diastasis

In latent diastasis the mortise will not widened in a normal x-ray, but when a stress view is taken the widening will be visualised.

In frank diastase is the widening of the mortise can be visualised in a routine x-ray.

Injuries to the syndesmosis ligaments are mostly incomplete and occurs in association with other bony or ligamental injuries. Depending on the mechanism of force involved, the ATFL can be sprained or even avulsed from the tibia or fibula. Continuous application of external rotation force can rupture the Tibiofibular ligaments and the interosseus membrane and possibly cause an oblique or spiral fracture of the fibula.

Mechanism of Injury

The most common type of injury-causing syndesmotic disruption external rotation injury and hyperdorxiflexion injuries. In pronation external rotation injuries, the talus is unable to rotate within the mortise and tends to displace the lateral malleolus and thereby disrupting the ATFL and superficial PITFL, the transverse ligament, or a combination of all these. The twisting injury may also tear the interosseous membrane or even fracture the proximal fibula.

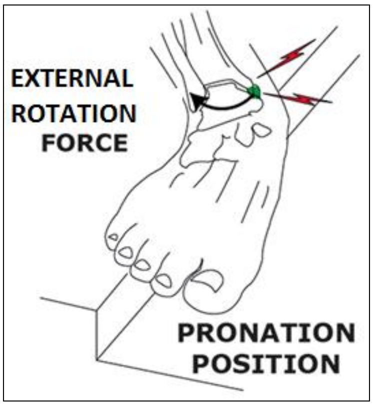


Fig 4: Pronation external rotation

Isolated syndesmotic injuries, without bony injury, are thought to occur mainly from forced dorsiflexion and external rotation in combination with axial load.

The syndesmotic ligaments are in a fully taut position when the ankle is either in maximum dorsiflexion or plantar flexion. And when the external rotation force occurs at the ankle causes the talus to press against the lateral malleolus. This rotational movement first ruptures the AITFL and. if the rotational movement continues, then it injures the Interosseous membrane and then the PITFL. In skirting and skiing the boot does not allow any sagittal plane movement and this results in excessive external rotation and injury to the syndesmosis. Ankle mortise is widened due to excessive dorsiflexion also. Normally dorsiflexion causes the interosseous ligament to become taut. Since the anterior aspect of talus is wider than the posterior part, the wider portion of the talus pushed the malleoli apart during the full dorsiflexion. This excessive force can rupture the syndesmosis ligaments. Hyper dorsiflexion type of injuries is seen in jumping and running sports activities where the foot is planted in the ground and the person falls forward. In skirting the person falls forward and the ankle is hyper dorsiflexed on his board resulting in syndesmotic injury. The chance of hyper dorsiflexion type injury is low when the knee is in an extended position due to the increased tightness of gastrocnemius muscle. Syndesmotic injuries can also occur in severe inversion/eversion of ankle sprains. Maximum eversion of the subtalar joint can rupture the deltoid ligament, and the force of the talus pushed the fibula laterally, there by damaging the syndesmotic ligaments. Severe inversion injuries cause the lateral ankle ligaments to strain and can also disrupt the ankle mortise and stability of fibula. In the mechanism of inversion/eversion, the distal fibula the medial malleolus or the lateral malleolus usually get fractures before the rupture of the syndesmotic ligaments. Bony injury does not always reliably reveal the underlying ligamentous injury - *stress tests* including external rotation of the foot and stressing the fibula with a bone hook.

Clinical features will be

- Swelling of ankle and foot
- Tenderness over the swelling
- Ankle deformity
- Most of the cases have high soft tissue swelling, but open injuries are comparatively low.

Usually, there will be the adequacy of distal neuro vascularity. But have to be checked and documented.

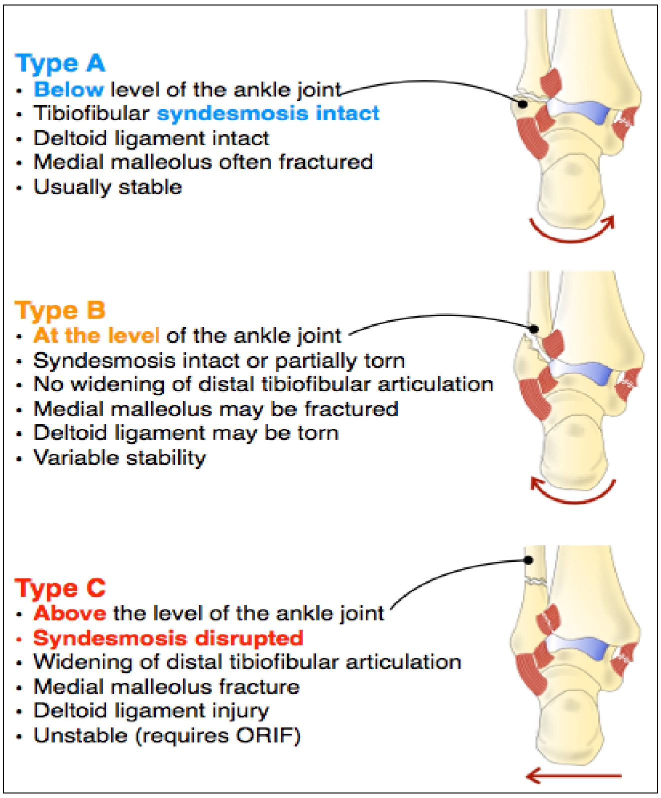


Fig 5: Danis –weber classification

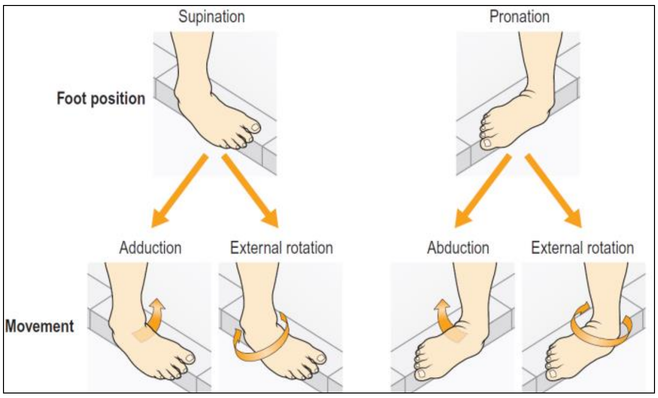
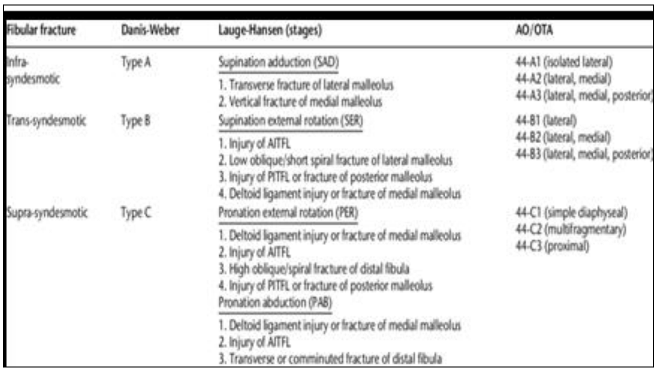


Fig 6: Lauge-Hansen classification



Fibular fracture	Danis-Weber	Lauge-Hansen (stages)	AO/OTA
Infra-syndesmotic	Type A	Supination adduction (SAD) 1. Transverse fracture of lateral malleolus 2. Vertical fracture of medial malleolus	44-A1 (isolated lateral) 44-A2 (lateral, medial) 44-A3 (lateral, medial, posterior)
Trans-syndesmotic	Type B	Supination external rotation (SER) 1. Injury of AITFL 2. Low oblique/short spiral fracture of lateral malleolus 3. Injury of PITFL or fracture of posterior malleolus 4. Deltoid ligament injury or fracture of medial malleolus	44-B1 (lateral) 44-B2 (lateral, medial) 44-B3 (lateral, medial, posterior)
Supra-syndesmotic	Type C	Pronation external rotation (PER) 1. Deltoid ligament injury or fracture of medial malleolus 2. Injury of AITFL 3. High oblique/spiral fracture of distal fibula 4. Injury of PITFL or fracture of posterior malleolus Pronation abduction (PAB) 1. Deltoid ligament injury or fracture of medial malleolus 2. Injury of AITFL 3. Transverse or comminuted fracture of distal fibula	44-C1 (simple diaphyseal) 44-C2 (multifragmentary) 44-C3 (proximal)

Fig 7: Comparison of classification

Ankle fracture classification

Weber A = Lauge Hansen Supination adduction
Weber B = Lauge Hansen Supination external rotation
Weber C = Lauge Hansen Pronation external rotation

Investigations

Clinical tests

External rotation stress test (Kleiger test): First, stabilise the distal part of leg with knee in 90-degree flexion and then externally rotate the foot. This will lead to widening of tibio-fibular syndesmotic joint and if injured, will be painful.

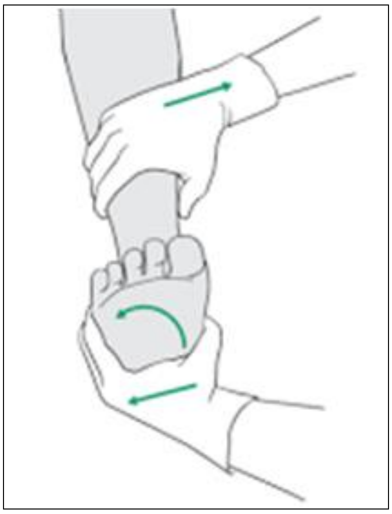


Fig 8: External rotation stress test

Squeeze test: This test is done by compressing the proximal part of the fibula to the tibia, this will separate the two bones distally and will cause pain if there is a syndesmotic injury.

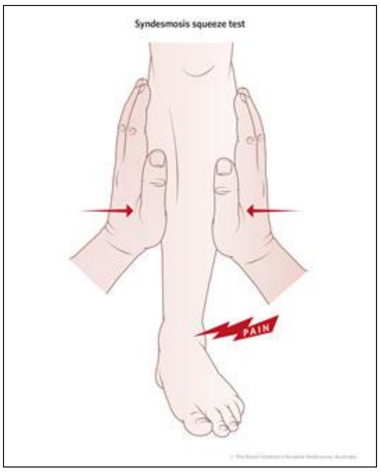


Fig 9: Squeeze test

Forced dorsiflexion test: The ankle is dorsiflexed forcefully either manually or with an athletic tape, there will be pain and this pain will decrease when the manoeuvre is repeated while compressing the distal end of the tibia and fibula. This suggests the presence of syndesmotic injury.

Crossed-leg test: It is done by crossing the injured leg over the uninjured leg while the patient is seated. A gentle downward pressure to the knee of the injured leg will cause pain suggesting syndesmotic injury.

Fig 10: Crossed-leg test

Intraoperative tests: The hook test is done intraoperatively after fixation of fibula. The fibula is distracted using a bone hook separating from tibia, under fluoroscopy. If there is no displacement then the syndesmosis is intact if there is more than 3-4mm displacement, then it suggests syndesmotic injury.

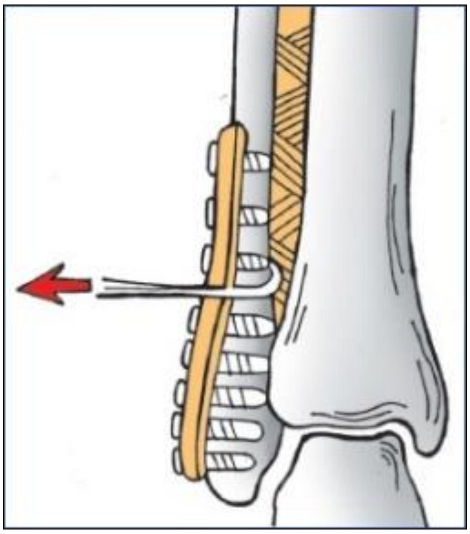


Fig 11: Hook test

Cotton test: It is done by stabilising the distal tibia and fibula with one hand and a thrust is applied from the medial to lateral side on the hindfoot. The test is said to be positive with syndesmotic injury if a lateral translation of more than 3-5mm.

Radiological Findings in Normal Ankle Joint

The common radiological investigation is an x-ray of the ankle anteroposterior view, lateral view and mortise view.

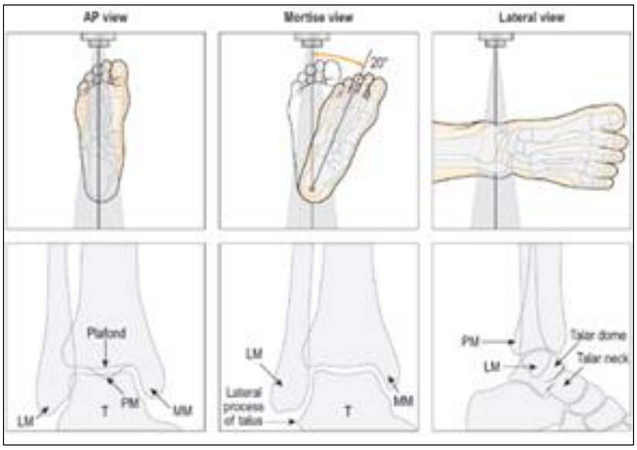


Fig 12: Radiological position

The normal findings are

- Tibio fibular overlap of more than 5mm on AP view
- Tibio fibular clear space less than 5mm
- Medial and superior clear space should be equal

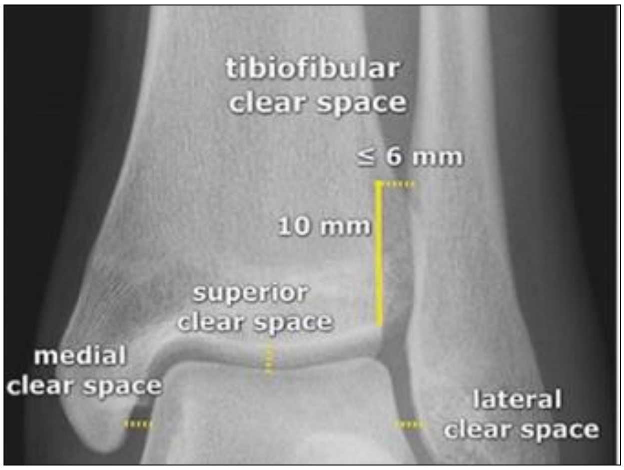


Fig 13: Normal values of ankle joint x-ray

1. External rotation stress radiographs can differentiate between frank diastasis (That's evident on static radiographs) and latent diastasis (which is evident only on stress radiographs).
2. Diastasis occurs primarily with posterior displacement of the fibula and is best seen inlateral radiograph.
3. Comparisons with radiographs of the contralateral limb will be helpful if there is doubt about the presence of diastasis.
4. Ct scan of ankle gives an accurate position on the tibio fibular displacement in cross-section views and also in the post-surgery assessment of the syndesmosis reductions
5. MRI has been shown to have a more accurate assessment of syndesmotic injuries that corresponds to the arthroscopic views. In chronic injuries and instabilies, it is more helpful.

Preoperative planning: Radiolucent operating table, Supine positioning of the patient with a bolster under the ipsilateral buttock, Fluoroscopy located on the contralateral side.

Materials and Methods

Our study is a Prospective study over a period of One and a

Half years (June 2020 to November 2021). 28 patients were included in our study. All the cases were from our RMMCH Emergency ward and Orthopaedic OPD. Proper history was recorded to find out the mode of injury. Clinical examination done with all stress tests. All required laboratory investigations are done and covid protocols are followed strictly to get anaesthesia fitness for surgery. Consent was obtained meticulously for performing surgery, Anaesthesia, And For inclusion in our study.

Inclusion criteria

1. Skeletally matured patients
2. 18 to 65 years old
3. Closed simple injuries
4. Grade I, Grade II, and Grade III A compound injuries
5. Those who give consent for surgery.

Exclusion criteria

1. Patients below 18 years
2. Compound grade III C.
3. Unacceptable High risk for surgery and anaesthesia
4. Severe comminutions and bone loss
5. Non-complaint patients.

Pre-operative assessment is done for all patients. All haematological and radiological investigations were done.

Radiological Investigation

X-ray of the ankle: Antero-posterior view, Lateral view, Mortise view. Ct scan of the ankle for a few cases with severe comminutions. Emergency stabilisation done with below knee pop slab with adequate padding.
The time interval between injury and surgery1 to 10 days. Mostly done under regional anaesthesia.

Implants and Instrumentations: K – wires, Ss – wires, $1/3^{rd}$ tubular plates, Recon plates, Anatomical locking plates, Malleolar screws, Cortical screws 3.5mm, 4.5mm, Cannulated cancellous screws 4.0mm.

Procedure Done

Fixation of lateral malleolus: The patient is placed supine. The bolster is placed under the ipsilateral hip to allow the foot to lie vertically. Under tourniquet control, the lateral malleolus is addressed first. An incision of 5 to 8cm is placed directly over the fibula and centered on the fracture. Blunt dissection is performed through subcutaneous tissue for avoiding injury to the superficial peroneal nerve. The fracture is identified. Periosteum and ligamentous interventions are cleared from the fracture edges. Reduction is achieved and held by the "lobster claw" clamp. If more force is necessary, inversion and distraction of foot and ankle is done. This will help in regaining the length of fibula. A one-third tubular plate or anatomical locking plate of sufficient length is selected so as to allow the placement of three screws below and above the fracture.

Fixation of fracture medial malleolus: Incision of about 5 to 8cm placed over the medial malleolus, skin and subcutaneous tissue incised. Soft tissue interposing between the fracture sites is removed. Fracture reduced and fixed using 4.5 mm malleolar screws. If the fractured fragment is small then either K wire stabilization or a Tension Band is applied for transverse fracture. The syndesmotic injury is reduced first with a reduction clamp. During the reduction, the ankle is kept in the neutral position or in slight dorsiflexion. Then the reduction is checked under fluoroscopy. After satisfactory reduction is achieved drilling is done. Screws are positioned at 2 – 3 cm proximal to the ankle joint line (tibial plafond), parallel to it and angled at 30 degrees from the posterolateral surface of fibula to the anteromedial surface of tibia.

Use of reduction clamps: Variations in the direction of reduction clamps and syndesmotic screw placement can cause iatrogenic syndesmotic mal-reduction.

- An angulation of 15 and 30 in the axial plane can displace the fibula in external rotation and cause over compression at the syndesmosis.
- Clamp placed in neutral anatomical axis reduces the syndesmosis most accurately.
- Fixing of the fibula in as much as 30° of external rotation may go undetected even with the use intraoperative fluoroscopy.

The most common malreduction was fibular malpositioning, followed by malreduction of the fracture.
It was recommended to keep the ankle in maximal dorsiflexion, during syndesmotic fixation to prevent postoperative limitation of motion; however, there are dataagainst this finding and the maximal dorsiflexion may induce an external rotation moment, risk ingmalreduction.
However, while the strength of fixation, stabilizes the joint, it also eliminates normal motion between the tibia and fibula.

Placement of syndesmotic screw

- If the screw is placed too proximally, then it may deform the fibula and cause the mortise to widen.
- If the screw is not parallel to the joint, the fibula may shift proximally.
- If the screw is not perpendicular to the tibiofibular joint, the fibula may remain laterally displaced.

The AO group also recommend a fully threaded syndesmotic screw in a neutralization mode.

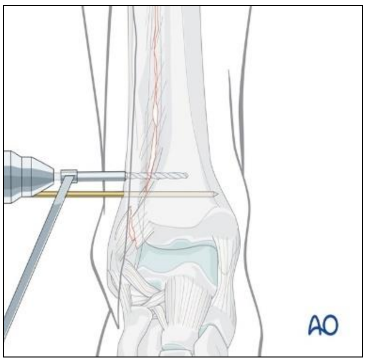


Fig 14: Placement of screw

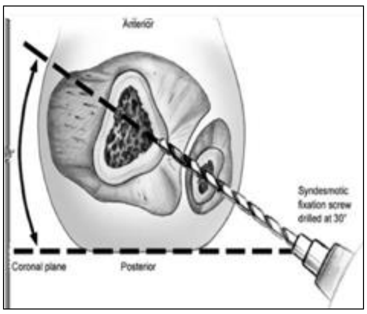


Fig 15: Placement of screw cross-section view

Post Operative Follow-Up

Dressing done on 3rd, 6th, 9th, and 12th pod. Suture removal on 12th POD after a healthy wound. Below knee, pop cast was given after that for 6 to 8 weeks with non-weight bearing walking. Check x-ray for assessing the callous formation and union done every one-month interval. Follow-up and evaluation for the joint made at 4th week, 8th week, and 6th month end. Active physiotherapy given for getting ankle mobility till a full range of movement is achieved. Weight bearing is allowed at 8 – 12 weeks. Postoperative scoring system given below.

Pain (40 points)
- None..40
- Mild, occasional.......................................30
- Moderate, daily...20
- Severe, almost always present..................0

Function (50 points)

Activity limitations, support requirement
- No limitations, no support........................10
- No limitation of daily activities, limitation of recreational activities, no support...7
- Limited daily and recreational activities, cane.....4
- Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace......0

Maximum walking distance, blocks
- Greater than 6.....................................5
- 4-6..4
- 1-3..2
- Less than 1..0

Walking surfaces
- No difficulty on any surface.......................5
- Some difficulty on uneven terrain, stairs, inclines, ladders................................ 3
- Severe difficulty on uneven terrain, stairs, inclines, ladders................................ 0

Gait abnormality
- None, slight.......................................8
- Obvious..4
- Marked...0

Sagittal motion (flexion plus extension)
- Normal or mild restriction (30° or more)...........8
- Moderate restriction (15°-29°).....................4
- Severe restriction (less than 150).................0

Hindfoot motion (inversion plus eversion)
- Normal or mild restriction (75%-100% normal)........6
- Moderate restriction (25%-74% normal)..............3
- Marked restriction (less than 25% normal)..........0

Ankle-hindfoot stability (anteroposterior,varus-valgus)
- Stable...8
- Definitely unstable................................0

Alignment (10 points)
- Good, plantigrade foot, midfoot well aligned..............10
- Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms......8
- Poor, nonplantigrade foot, severe malalignment, symptoms...0

Fig 16: AOFAS Ankle-Hindfoot Scale (100 Points Total)

AOFAS score grading (Scott J. Mubarak, MD *et al*. [37])

Excellent	90 – 100
Good	80 – 89
Fair	70 – 79
Poor	less than 69

Case illustration

Case -1: A 35-year-old male patient sustained injury to his left ankle due to a history of RTA and was diagnosed as Lateral malleolar fracture left ankle –with syndesmotic injury – Weber Type C

Preoperative x-ray

Fig 17: Intra operative images

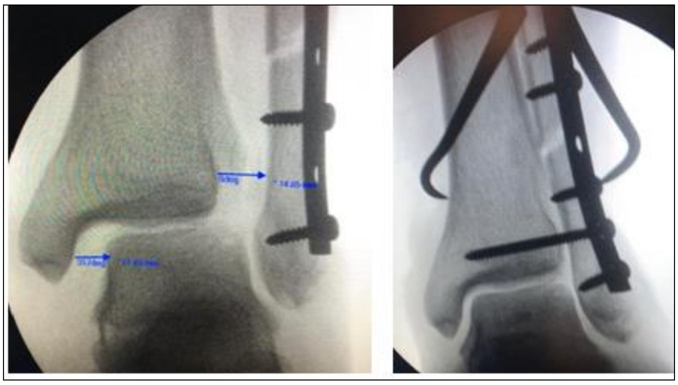


Fig 18: Post-operative images

Fig 19: 6 months clinical photos – plantar and dorsiflexion

Case 1: A 38-year-old female patient with a history of RTA sustained an injury to her left ankle and was diagnosed to have Bimalleolar fracture left ankle – compound grade III B with ankle dislocation and syndesmotic injury – Weber B

Fig 20: Pre-operative x-ray

Fig 21: Immediate-post operative x-ray

Fig 22: Clinical photos – 2 months follow up – plantar flexion

Fig 23: Clinical photos – 2 months follow up – dorsiflexion

Fig 24: Post-op 6 months follow up x ray

Fig 25: Clinical photos 6 months follow up - dorsiflexion

Fig 26: Clinical photos 6 months follow up – plantar flexion

Results

We had 28 patients in our study having ankle fractures associated with syndesmotic injury. All were operated within a range of 0 to 10 days from the date of injury. The longest follow-up period was 16 months. Follow-up analysis was made using the AOFAS score and AOFAS grading criteria.

In our study, we had 42% of patients with less than 40 years of age. In which, 53% of patients were male and there was no difference in the side affected.

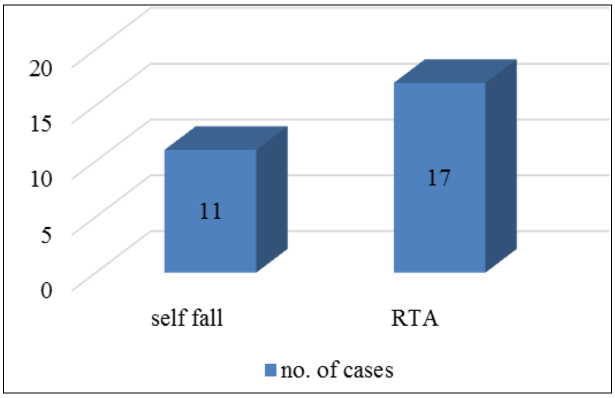
Table 1: Age Distribution

Age	Number of cases	Percentage
< 40	12	42.85
41 – 65	16	57.15
Total	28	100

Table 2: Sex Distribution

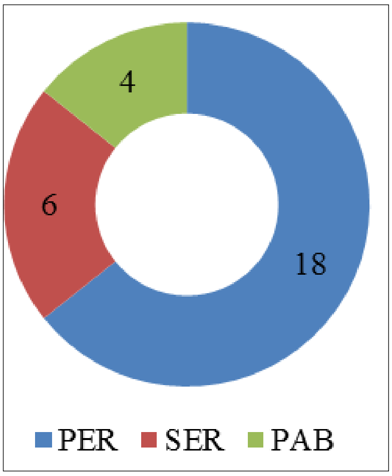
Sex	Number of cases	Percentage
Male	15	53.57
Female	13	46.43
Total	28	100

We had 17(61%) patients who sustained injury due to RTA, and the remaining were by self-fall while walking in home.



Graph 1: Mode of Injury

We had 18 cases of pronation external rotation-type injuries. 6 supination external rotation and 4 pronation abduction.



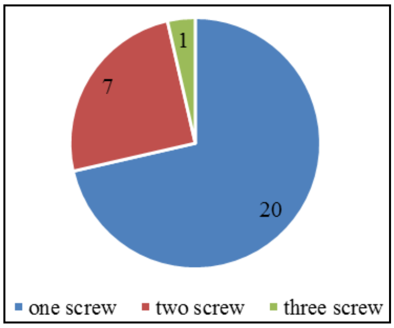
Graph 2: Lauge-Hansen classification

There were 9 cases of compound injuries and 19 cases of closed ankle injuries.

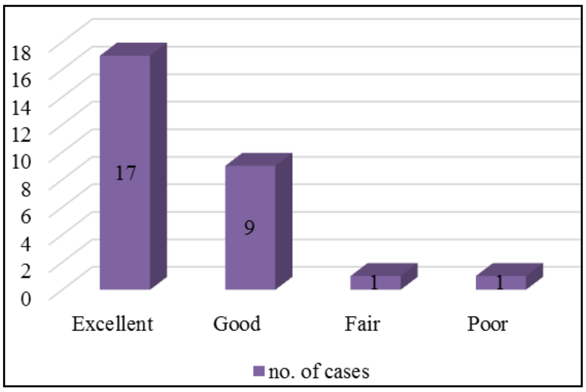
Table 3: Grade of Injury

	Number of cases	Percentage
Simple	19	67.86
Compound	9	32.14
Total	28	100

We had used single syndesmotic screws in 20 patients, double syndesmotic screws in 7 patients and triple syndesmotic screws in 1 patient. We had 29 screws with the tricortical purchase and 8 screws with 4 cortex purchase.



Graph 3: Number of Screws



Graph 4: Outcome

In our study, we had 17 of patients with excellent outcomes, 9 with a good outcome, 1 with a fair outcome and 1 with a poor outcome. We had 3 patients who developed wound infection postoperatively. All 3 were compound injuries. They were treated with higher IV antibiotics and recovered.

Discussion

Fractures around the ankle joint are not uncommon in our orthopaedic practice. The primary goal of our treatment is to obtain a pain-free, stable ankle joint with preservation of maximum function. The mean age of our study is agreeable with other studies of Davis *et al.* [4], Hasselman *et al.* [6]. Though the inclination is towards older age, our study shows a wider range between 20 to 65 years. Our study shows the ratio of male vs female of 15:13. We have a little higher incidence in male patients. A higher incidence of young male patients shows mostly due to RTA while in female, it's due to slip and fall in the home in their older age, similar to Davis *et al.* [4]. Bridgman *et al.* [33] showed a higher incidence rate for an ankle injury in males between 15-39 and in females over forty years old compared with their opposite-sex counterparts. In our study also we have 8 males out of 12 cases, with the age of less than 40 years. In more than 40 years patients, there were 9 females and 7 males, which corresponds to the above study.

Out of 28 patients, 18 patients developed syndesmotic injury due to pronation external rotation injury, 6 patients due to supination external rotation injury, and the remaining 4 patients due to pronation abduction injury. Hence in our study also it is proved that pronation external rotation injury is the most common type of ankle injury leading to syndesmotic injury as also stated by Mark J. Boytim *et al.* [18]. Regarding the number of cortices purchased by syndesmotic screws, we had 3 cortex purchase in 29 syndesmotic screws placed. And 4 cortex purchase in 8 syndesmotic screws None of them experienced screw pull-out. There was also no screw breakage in our patients during our follow-up. We have not done any secondary procedure of syndesmotic screw removal. In a prospective study, Hoiness and stromsoe [34] compared fixation of the syndesmosis with two 3.5 mm screws with tricortical fixation, with one 4.5mm screw with quadricortical purchase. There was no difference in pain, ankle dorsiflexion, and other movements at the end of 1 year. The advantage is, 4.5 mm screws will be easy to remove as an outpatient procedure under local anaesthesia rather than in 3.5mm screws. Regarding screw composition, Thordarson *et al.* [3] compared a 4.5mm polylactide bioabsorbable screw with a stainless steel screw of the same size in a cadaveric model of syndesmotic injury, there was no difference in load to failure and stiffness noted between these groups. But we have used only stainless steel screws in all of our patients.

In surgical technique the syndesmotic screw insertion should be done after the syndesmosis held together with reduction clamp to avoid shifting of the drill holes and all screws should be fully threaded. We don't want a lag effect in our syndesmotic screws. The drill should be centered on the fibula to avoid fracture. And is directed at 25 to 30° oblique direction from posterolateral to anteromedial. Browner BD *et al.* Gaurav Kumar Sharma *et al.* [29] in his article says that RTA is the most common mode of injury followed by fall and industrial accidents with a significant majority of fracture heing open. The outcomes of severe injuries were similar to simple foot injuries. In our study also 60% of cases have RTA as a mode of injury. One of our patients developed early ankle arthritis at the 16th month of our follow-up. The most probable reason may be due to improper reduction of the syndesmotic joint during insertion of the syndesmotic screw. But longer follow-up is needed for evaluating arthritis.

We have achieved an AOFAS score of

- More than 90 in 17 cases (60%)
- Between 80 to 90 in 9 cases (33%)
- Between 70 to 80 in 1case (3.5%)
- Less than 70 in 1 case (3.5%)

In our follow up, we have not encountered any heterotopic ossification in the interosseous membrane of the affected ankles, or synostosis, in our study. It is recommended that posterior fragments greater than 25% of the size should be fixed, by Christain Bergman *et al*. [31]. In our study also we have fixed 5 cases of posterior malleolus fracture which has more than 25% of its articular size. Because of the low complication rate and much difficulty in treatment of late syndesmotic diastasis, a syndesmotic screw should be placed when in doubt of the indication. (Michel P.J. van den Bekerom) [30]. In our study also few cases of Weber type B fractures were in doubt of stability and syndesmotic injury but we fixed the syndesmotic joint with a syndesmotic screw. Syndesmotic screw fixation with one or two screws need not compulsorily be removed for the fear of screw breakage on weight-bearing walking (Michel P.J. van den Bekerom) [30].

Conclusion

Based on the results of our study, the following conclusions are made.

For all ankle fractures cases associated with syndesmotic diastasis, open reduction and internal fixation of the malleoli and diastasis should be fixed with syndesmotic screw, to achieve a fracture union, pain-free and stable ankle joint.

A syndesmotic screw can be placed whenever there is a doubtabout stability of inferior tibiofibular joint, intraoperatively.

In conclusion, treating the ankle fractures with syndesmotic injury with open reduction and screw fixation facilitated early mobilisation of the patient and helped in achieving stable, pain-free ankle joint and also prevent ankle arthritis.

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