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Research Article

Is Tricortical Screw Better than Quadricortical Screw in Syndesmotic Fixation of Ankle Fractures?

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Abstract

Background: Ankle fractures associated with syndesmotic injuries are increasing in number, need early detection and proper treatment. The distal tibiofibular articulation held by ligaments anteriorly and posteriorly in addition to the interosseous ligament, these ligaments resemble the syndesmosis. There are many methods for syndesmotic fixation includes screws or tight rope. Also there are much research about the number of screws and how many cortices should engage.

Objectives: To assess the early functional and radiological outcome in two types of syndesmotic fixation comparing the rigid quadricortical syndesmotic fixation with the more dynamic tricortical syndesmotic fixation.

Subjects and Methods: An analytic prospective comparative study was done in Al-Imamain Al-kadhimain medical city from Jun 2019 to October 2020, comparing the early functional and radiological outcomes of patients treated with tricortical versus quadricortical syndesmotic screw fixation in ankle fractures. The study conducted on 20 patients (13 males, 7 females) ranging in age between 19-56 years old, presented with clinical and radiological evidence of syndesmotic injury concomitant with ankle fracture either Weber B supination external rotation (SER) or Weber C pronation external rotation (PER) and pronation abduction (PA). The two different surgical approaches classified randomly every other case in to two groups, Group 1 (10 patients) treated by open XI reduction and internal fixation (ORIF) of ankle fracture with tricortical screw fixation for their syndesmotic injury, and Group 2 (10 patients) treated by open reduction and internal fixation (ORIF) of ankle fracture with quadricortical screw fixation for their syndesmotic injury. The patients were followed up for a period of 6 months.

Results: The AOFAS ankle hind-foot score was significantly higher for patients treated with tricortical syndesmotic screw (mean = 70.9 ± 5.4) than patients treated with quadricortical syndesmotic screw (mean = 62.6 ± 4.4) ($p = 0.002$) at 3 months. After 6 months the score was not significantly higher for tricortical group (mean = 84.1 ± 9.1) compared to quadricortical group (mean = 80.3 ± 5.9) ($p = 0.286$). There was significant difference for pain which is lower in tricortical group (mean = 31.0 ± 3.1) compared to quadricortical group (mean = 24.0 ± 5.1) ($p = 0.002$).after 6 months there was no significant difference Between the two groups ($p = 0.355$).

Conclusion: Fixation with either tricortical screw or quadricortical screw for syndesmotic injury improve function of the joint in ankle fractures with syndesmotic injuries. There was no significant differences in functional or radiological outcomes between the two groups after six months of treatment.

Keywords: Ankle Fractures; Syndesmosis; Syndesmotic Injuries; Syndesmotic Fixation

Introduction

Ankle fractures are amongst the most common injuries treated by orthopedic surgeons, accounting for 9% of all fractures. Ankle fractures with an associated syndesmotic injury represent a more severe injury pattern with poorer functional outcomes when compared to injuries that required malleolar fixation alone [1]. Ankle fractures where the ankle mortise is stable and there is adequate alignment are usually treated none operatively. Stability and reduction quality can be determined simply in the coronal plane, but syndesmotic instability and posterior malleolar stability are not as easily established and has been the subject of much research and debate [2]. It has been classically described as being much less common than those of the lateral ligament, representing 1% to 18% of ligamentous lesions of the ankle. However, recent studies show that its incidence is much higher, in the range of 17% to 74% of all sports injuries of the ankle, due in part to the improvement in the diagnosis and understanding of the mechanisms of production of these lesions. On the other hand, it is still difficult to understand completely how these injuries actually occur, and as a consequence, their treatment remains controversial in many cases [3,4].

In an estimated 1-11% of all ankle sprains, injury of the distal tibiofibular syndesmosis occurs. Forty percent of patients still have complaints of ankle instability 6 months after an ankle sprain. This could be due to widening of the ankle mortise as a result of increased length of the syndesmotic ligaments after acute ankle sprain. As widening of the ankle mortise by 1mm decreases the contact area of the tibiotalar joint by 42%, this could lead to instability and hence early osteoarthritis of the tibiotalar joint [5]. Within the athletic population, the incidence of injury increases from 12% to 32% [6].

The medial rough convex surface of the distal fibula articulate with the lateral triangular fibular notch of the distal tibia to form a fibrous joint, which is linked by strong ligaments. The term syndesmotic injury is used to describe a lesion of the ligaments that connect the distal fibula and the tibial notch surrounded on both sides by the anterior and posterior tibial tubercles, with or without an associated injury of the deltoid ligament. It includes four major ligaments: the anterior inferior tibiofibular ligament (AITFL), the interosseous ligament (IOL), the posterior inferior tibiofibular ligament (PITFL) and the inferior transverse ligament (Figure 1) [7].

The blood supply to the syndesmosis has been well documented. There are three distinct anterior vascular patterns from the anterior tibial and peroneal arteries and two distinct posterior vascular patterns from the peroneal and posterior tibial arteries. The distal tibiofibular joint acts as a spring to spread the mortise to accommodate the wider portion of the talus with dorsiflexion and recoils when the joint returns to a plantarflexed position (Figure 4).

Injury to the syndesmosis occurs through rupture or bony avulsion of the syndesmotic ligament complex [9]. The syndesmosis disruption occurs as the result of relative external rotation and/or dorsiflexion of the talus in the mortise, usually in association with axial loading [10,11].

During external rotation of the foot the fibula is translated posteriorly and rotated externally, resulted in high tensile force acting on the AITFL. Syndesmotic injury was usually associated with ankle fracture, most commonly Weber C type [12].

Surgical treatment

The goals include care of soft tissues, anatomic reductions of fractures, rehabilitation and treatment of complications that may arise [13]. The general principle is to restore the ankle joint congruency and maintain the distal tibiofibular syndesmosis stability, re-establishing the correct tibia-fibula interval, fibula length, and proper alignment of the fibula in the tibial incisura [8].

Surgical technique

Restoring bony anatomy and strength is more reliable than ligament repair and should be the primary consideration when planning surgical reconstruction of ankle fractures. Once the decision has been made to proceed to address the syndesmotic injury surgically, the first step is reduction of the distal tibiofibular joint. When applicable, fibular length must be assessed and corrected appropriately to facilitate anatomic reduction of the syndesmosis [15].

The syndesmosis is most commonly reduced with use of reduction clamps to compress across the tibia and fibula. Reduction of the distal fibula into the tibial incisura is best achieved with a pointed reduction clamp. The clamp should be placed exactly in the axis of the ankle joint to minimize the risk of malreduction [16]. The insertion points should be the lateral malleolar ridge on the fibula and the central part of the medial cortex at the tibia.

Quality of reduction cannot be reliably determined with intraoperative fluoroscopy or standard radiographs. Fixation of the fibula in as much as 30 degree of external rotation may go undetected using intraoperative fluoroscopy and malreduction can occur (10° of internal fibular rotation could be detected reliably with standard fluoroscopy) [14]. The most common malreduction was fibular malpositioning, followed by malreductions of the fracture. The primary fibular malpositions were anterior displacement and internal rotation of the distal end of the fibula [17].

After a Weber C fracture, repair of the medial malleolus alone restored 57% of the original rotational stability; lateral malleolus fixation alone restored 32% of the original stability, and the addition of a syndesmotic screw improved the stability to 51% [18]. Additional techniques to assess for accurate syndesmotic reduction and reduce the rate of malreduction:

- Comparison fluoroscopic imaging of the contralateral ankle to help guide reduction with good radiographic results [19].
- Direct visualization of the syndesmosis is important to minimize the risk of malreduction [20].

Principles of syndesmotic screw fixation

syndesmotic screw fixation entails the placement of screw(s) across the syndesmosis from the lateral aspect of the fibula into the tibia (from posterolateral to anteromedial), inserted at 25° - 30° to the coronal plane of the ankle beginning at least 1 cm above the ankle joint (usually 2 - 4 cm above the tibial plafond) in the proximity of the physeal scar, so that it is directed parallel (perpendicular) to the joint surface to decrease damage to the tibiofibular articulation at the incisura [21].

If the screw is placed too far proximally, 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 [22].

Figure Syndesmotic fixation screws should be directed approximately 30 degrees anterior to the coronal plane [23].

Removal of syndesmotic screw

Whether and when syndesmotic screws need to be removed are controversial subjects. Recommendations in the literature range from routine removal of the screw before weight bearing is allowed (in 6 to 8 weeks) to removal after the fracture has healed only if symptoms develop. Advocates of screw removal contend that the syndesmotic fixation disrupts ankle mechanics by restricting the normal external rotation of the fibula that occurs with dorsiflexion [22]. Removing the screw too early may allow recurrent diastasis of the syndesmosis, however. Syndesmosis displacement has been reported when the screw was removed before weight bearing was allowed, and screw breakage has been reported with weight bearing with the screw in place. If tricortical fixation is used, the screw usually loosens rather than breaks and may not disrupt normal ankle mechanics. If fixation through four cortices is used, both ends of the screw can be removed easily if breakage occurs. In general, late diastasis of the syndesmosis creates a much more difficult clinical problem than broken screws; it is advisable to leave the screw in place for at least 12 weeks [24].

Complications

Stiffness, malreduction, recurrent diastasis, loosening of the screw and osteolysis around the implant, anterior impingement syndrome of the talocrural joint, hardware failure, posttraumatic arthritis, Infection.

Aim of the Study

To assess short-term functional and radiological outcomes in two types of syndesmotic fixation, comparing the rigid quadricortical syndesmotic screw fixation with a more dynamic tricortical screw fixation associated with ankle fractures.

Subjects and Methods

An analytic prospective comparative randomized study was done in Al-Imamain Al-kadhimain medical city, department of Trauma and Orthopedics Surgery from June 2019 to October 2020. The study conducted on 20 patients (13 males,7 females) ranging in age (19 - 56) years old, presented with clinical and radiological evidence of syndesmotic injury concomitant with ankle fracture (Weber B "SER " and Weber C "PER and PA"). The study comparing the early (six months) functional and radiological outcomes of patients treated with tricortical versus quadricortical syndesmosis fixation in ankle fractures associated with syndesmotic injury.

The data were collected from patients who attended the orthopedic department of the hospital, the sample collected was 20 patients from both gender, all of them accepted to participate in the study. These patients treated surgically by tricortical and quadricortical syndesmotic screw fixation, the two different surgical approaches classified randomly every other case into two groups. All patients underwent surgery by the same surgical team, and they followed up for a mean period of 6 months.

- **Group 1**: Ten patients were included (6 males, 4 females). Their mean age was 38.2 ± 14.0 (19-56 years), treated by open reduction and internal fixation (ORIF) of ankle fracture with tricortical screw fixation for their syndesmotic injury.
- **Group 2**: Ten patients were included (7 males, 3 female). Their mean age was 36.7 ± 9.9 (26-54years), treated with open reduction and internal fixation (ORIF) of ankle fracture with quadricortical screw fixation for their syndesmotic injury.

The functional outcome of the patients were evaluated with the American Orthopedic Foot and Ankle Society (AOFAS) (appendix) ankle-hindfoot score three months and six months post operatively. The radiological criteria (Tibiofibular clear space, Tibiofibular overlap and Medial clear space) were assessed preoperatively, postoperatively, and 3 months after surgery.

Inclusion criteria

- Patients age between 19 - 56 years old.
- Acute distal tibiofibular syndesmotic injury (within 6 weeks from presentation) with concomitant closed ankle fracture (Weber type B and Weber type C).

Exclusion criteria

- Skeletally immature patients.
- Multiply injured patients.
- Diabetic patients.
- Previous ankle fracture.
- Syndesmotic injury concomitant with proximal fibula fracture (Maisonneuve fracture).
- Patients with pathological fractures.
- Compound ankle fractures.
- Isolated syndesmotic injury.

Ethical consideration

Written and oral consent was obtained from all the patients before surgery after careful explanation of the procedure and its complications.

Demographics

The following data were collected from each patient of each group: age, gender, injured side and the surgical technique of every patient (Table 1).

Methods

The patients were managed according to advanced trauma life support principles for the patients entered casualty unite. Assessment of the neurovascular status of the limb was evaluated. The patients were examined clinically to evaluate the soft tissue condition, and X-rays were obtained in the anteroposterior, lateral and mortise views. A detailed history and complete physical examination was carried before surgery. Temporary below knee back slab were applied to the affected limb and advise them for leg elevation on one pillow in supine position. All patients sent for routine investigations to assess their general condition and prepare them for surgery.

All patients were followed up preoperatively which include assessment of the soft tissue for correct timing of the surgery.

Operative management

Intravenous antibiotics Prophylactically were administered within 60 minutes prior to skin incision.

Both groups of patients operated on through the same approach and technique for open reduction and internal fixation (ORIF) of the ankle fractures and syndesmotic fixation through the standard

Patient number	Age (years)	Gender	Injured side	Surgical technique
1	28	Male	Left	Tricortical Screw
2	26	Male	Right	Quadricortical Screw
3	53	Male	Right	Tricortical Screw
4	51	Male	Right	Quadricortical Screw
5	25	Male	Right	Tricortical Screw
6	41	Femle	Left	Quadricortical Screw
7	29	Male	Left	Tricortical Screw
8	29	Male	Right	Quadricortical Screw
9	44	Femle	Right	Tricortical Screw
10	36	Male	Right	Quadricortical Screw
11	48	Femle	Right	Tricortical Screw
12	54	Femle	Right	Quadricortical Screw
13	20	Male	Left	Tricortical Screw
14	31	Male	Left	Quadricortical Screw
15	56	Femle	Right	Tricortical Screw
16	42	Femle	Left	Quadricortical Screw
17	39	Femle	Right	Tricortical Screw
18	27	Male	Right	Quadricortical Screw
19	50	Male	Right	Tricortical Screw
20	30	Male	Left	Quadricortical Screw

Table 1: Demographic distribution of the patients and their surgical technique.

lateral approach and some cases medial approach for medial malleolus fracture by the same surgical team. The patients are positioned supine with a sandbag underneath the buttock of the affected side after marking of the limb. This allowed the foot to lie in neutral position and prevents external rotation of the leg. Sometimes the knee flexed to 30 degrees to allow access to both the medial and lateral sides.

General or spinal anesthesia used according to anesthetist decision and condition of the patients.

Pneumatic tourniquet applied to mid-thigh region and inflated to (100-150) mmHg above the systolic pressure after exsanguination of the limb.

The foot and ankle were prepared with povidone-iodine 10% solution from below tourniquet level to the tip of the toes then draping of the limb in an appropriate manner.

The surgeon stand or sits on the side of injury. The assistant stands at the foot of the table. The image intensifier is brought in from the foot of the operating table.

A straight surgical incision was made over the distal fibula (Figure 1), Careful dissection and protection of superficial Peroneal and Sural nerves. The fracture site in the distal fibula directly visualized, anatomically reduced and fixated by four or six holes one-third semi tubular plates applied at the lateral surface of the distal fibula in neutralizing mode.

Figure 1: Standard lateral skin incision.

In cases with medial ankle injury, the standard medial incision runs either posterior or anterior to the malleolus. Fracture fixed by either by malleolar screw or tension band according to the size of the distal fragment identified.

The anatomical site of the syndesmotic screw determined under fluoroscopic guidance. Stability of the syndesmosis assessed by "Hook test"; performed by applying bone hook, pulling the fibula laterally in the coronal plane to assess the integrity of the syndesmosis after reduction under fluoroscopic guidance.

Large reduction clamp applied from the lateral surface of the distal fibula to the medial border of the distal tibia, tensioned and position checked under image intensifier.

Figure 2: Assess the site of syndesmotic screw.

With foot in neutral position or slight dorsiflexion, drill bit over electrical drill 3.2mm directed 30 degree anteriorly from poster-lateral to Anteromedial direction, about 3cm above the ankle joint line with position checked under fluoroscopy.

Figure 3: The use of reduction clamp before insertion of the screw.

Cortical fully threaded 4.5 mm stainless steel screw of appropriate length after measuring the track by depth gauge and taping by tapering device:

- **For group 1 (tricortical screw):** Engaged 3 cortices (two fibular cortices and lateral tibial cortex).
- **For group 2 (quadricortical screw):** Four cortices (2 fibular and 2 tibial).

Tourniquet deflated and good hemostasis. Skin closed with non-absorbable sutures, sterile dressing and back slab applied.

Figure 4: Insertion of syndesmotic screw three cortices.

Post-operative care

During day zero, monitoring of the limb status and the patient condition as a whole with special attention paid to assess capillary refilling and any signs of compartment syndrome. Parenteral antibiotics and analgesia was given to all patients.

The patients encouraged to perform active movement of the toes with continued elevation of the limb.

patients discharged home after 24 or 48 hours, continued on parenteral antibiotics for 3 days and oral antibiotics for another 5 days with analgesics as required, instructed on non-weight bearing, continued elevation with active movement of the toes. All patients sent for plain radiograph in the first post-operative visit, and assessed for radiographic finding.

The phone number and personal data of all patients recorded to facilitate the scheduled follow up.

Statistical analysis

Data were presented in tables and figure for summarization, categorical variables were analyzed using chi square and Fischer exact test. Two sample t test was applied to investigate the difference in means between the two groups and paired t test was used to explore difference in mean score over follow up time period of the two groups. Statistical Package of Social Sciences (SPSS) version 18.0.0 (Chicago, IL) Software was used to compute the statistical analysis, p value equal or less than 0.05 were considered significant.

Results

Demographic and patient characteristics

The current study included 20 patients; the average age of all participants was 37.4 ± 11.9 years ranging between 19-56 years of age. Two thirds of the participants were males (13; 65%). Half of the participants were assigned for tricortical screw (10; 50%) and the remaining had quadricortical screw procedure.

Variables		Tricortical Screw (n = 10)	Quadricortical screw (n = 10)	P value
Age (years), mean ± SD		38.2 ± 14.0	36.7 ± 9.9	0.787
Gender	Male	6(46.2%)	7(53.8%)	1.0
	Female	4(57.1%)	3(42.9%)	
Injured side	Right	6(46.2%)	7(53.8%)	1.0
	Left	4(57.1%)	3(42.9%)	
Type of Ankle fracture	Weber B	4(57.1%)	3(42.9%)	1.0
	Weber C	6(46.2%)	7(53.8%)	
Breakage	Yes	1(33.3%)	2(66.7%)	1.0
	No	9(52.9%)	8(47.1%)	
Superficial infection	Yes	0	1(100%)	1.0
	No	10(52.6%)	9(47.4%)	
SD: standard deviation, n: number				

Table 2: Distribution of demographic and patient characteristics by type of screw; n = 20.

The study showed no significant difference in the age, gender, and injured side, type of ankle fracture, broken screw, and superficial infection in relation to the surgical procedure.

First follow up - three months post operation

In first Group (tricortical screw), the mean AOFAS ankle-hind foot score (At 3 months after surgery) was 70.9 ± 5.4 points (range, 63-81) were: four patients had a score ranged (60-69), five patients scored between (70-79) points and only one patient had a score of 81 points.

As for the second group (quadricortical screw), the mean AOFAS ankle-hind foot score (At 3 months after surgery) was 62.6 ± 4.4 points (range, 56-71) were: two patients had a score ranged (56-59), seven patients ranged (60-69), and only one patient scored 71 points. Table 3 Illustrates the distribution of patients according to AOFAS score by type of screw three months post-surgery

AOFAS score	Tricortical screw (n = 10)	Quadricortical screw(n = 10)	p-value
Pain	31.0 ± 3.1	24.0 ± 5.1	0.002
Activity limitation	4.6 ± 1.2	4.6 ± 1.2	1.0
Maximum walking distance	3.0 ± 1.0	3.2 ± 1.0	0.673
Walking surface	3.0 ± 0.0	2.7 ± 0.9	0.331
Gait abnormality	3.6 ± 1.2	3.6 ± 2.2	1.0
Sagittal motion	5.6 ± 2.0	3.6 ± 2.2	0.054
Hindfoot motion	3.6 ± 1.2	3.9 ± 1.4	0.628
Ankle-hindfoot stability	8.0 ± 0.0	8.0 ± 0.0	1.0
Alignment	8.5 ± 2.4	9.0 ± 2.1	0.628
Total	70.9 ± 5.4	62.6 ± 4.4	0.002

Table 3: Assessment of the AOFAS score after 3 months follow up post operatively.

Pain had significantly higher score in "Tricortical screw" group compared to "quadricortical screw" treated patients, at three months after surgery. Total score of AOFAS also showed a significant difference between the two groups in favor of "Tricortical screw" treated group. While the rest of components of the AOFAS score system were not significantly different between the two surgical procedures.

Second follow up - six months post operation

After six months follow up after surgery; for the tricortical group, the mean AOFAS ankle-hind foot score was 84.1 ± 9.1 point (range, 73 - 94). Four patients had a score ranging between (70-79), two patients scored between (80-89) and four patients scored 94 points. While for the quadricortical screw group, the mean AOFAS ankle-hind foot score was 80.3 ± 5.9 point (range, 72-94). Three patients had a total score of (70-79) and six patients scored between (80-89) and only one patient scored 94 points. Table 4 demonstrate the difference of AOFAS score between the two groups six months postoperatively.

AOFAS score	Tricortical screw (n = 10)	Quadricortical screw (n = 10)	p-value
Pain	34.0 ± 5.1	32.0 ± 4.2	0.355
Activity limitation	6.7 ± 0.9	7.0 ± 1.4	0.584
Maximum walking distance	4.2 ± 0.4	4.0 ± 0.0	0.151
Walking surface	3.4 ± 0.8	3.5 ± 1.0	0.820
Gait abnormality	6.8 ± 1.9	5.2 ± 1.9	0.081
Sagittal motion	6.8 ± 1.9	6.0 ± 2.1	0.388
Hindfoot motion	4.2 ± 1.5	5.1 ± 1.4	0.196
Ankle-hindfoot stability	8.0 ± 0.0	8.0 ± 0.0	1.0
Alignment	10.0 ± 0.0	9.5 ± 1.5	0.331
Total	84.1 ± 9.1	80.3 ± 5.9	0.286

Table 4: Assessment of the AOFAS score after 6 months post operatively.

The current study showed no significant difference in the AOFAS total score and its components between the two surgical procedures, six months after surgery.

Difference in AOFAS total mean scores between the two groups by time of follow up.

There was a highly significant difference (paired t = -6.203; d.f. = 9; P < 0.001) in the total mean score of tricortical screw group from 70.9 ± 5.4 to 84.1 ± 9.1 for the period from 3 to 6 months respectively. As for the second group (the quadricortical screw group) there was a significant increment (Paired t = -10.0; d.f. = 9; p < 0.001) in total mean score from 62.6 ± 4.4 to 80.3 ± 5.9 for the period between three to six months follow up. Figure 5 shows the increase in total scores for each group by follow up time.

Radiological changes between the two groups

Medial clear space

There was no significant difference in "Medial clear space" measurement between the two surgical procedures. Table 5 shows the

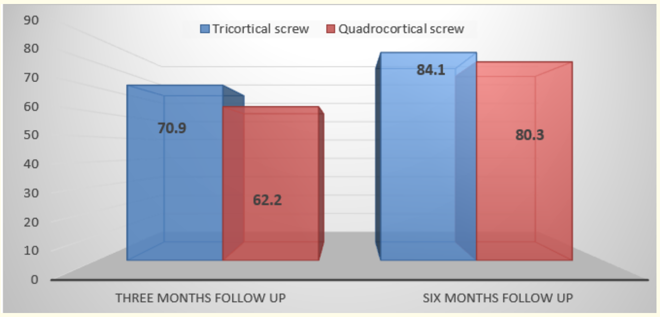

Figure 5: The distribution of AOFAS total mean score for tricortical and quadricortical groups according to follow up time.

Medial Clear Space (mortise view) (mm)	Tricortical screw (n = 10)	Quadricortical screw(n = 10)	p-value
Preoperative	7.7 ± 0.61	7.4 ± 0.35	0.248
Immediately post operation	3.8 ± 0.14	3.8 ± 0.17	0.890
Three months post operation	3.9 ± 0.13	3.8 ± 0.20	0.802

Table 5: Assessment of radiological changes in Medial clear space.

medial clear space change between the two groups by follow up timing.

Tibiofibular overlap

There was no significant difference in “Tibiofibular overlap” between the two surgical procedures. Table 6 shows the tibiofibular overlap change between the two groups by follow up timing.

Tibiofibular overlap (AP view) (mm)	Tricortical screw (n = 10)	Quadricortical screw(n = 10)	p-value
Preoperative	3.2 ± 0.59	3.4 ± 0.51	0.388
Immediately post operation	8.7 ± 0.36	8.9 ± 0.40	0.181
Three months post operation	8.6 ± 0.35	8.8 ± 0.43	0.407

Table 6: Assessment of radiological changes in tibiofibular overlap.

Tibiofibular clear space

There was no significant difference in “Tibiofibular clear space” between the two surgical procedures. Table 7 shows the change of tibiofibular clear space between the two groups by follow up timing.

Tibiofibular overlap (AP view) (mm)	Tricortical screw (n = 10)	Quadricortical screw(n = 10)	p-value
Preoperative	3.2 ± 0.59	3.4 ± 0.51	0.388
Immediately post operation	8.7 ± 0.36	8.9 ± 0.40	0.181
Three months post operation	8.6 ± 0.35	8.8 ± 0.43	0.407

Table 7: Assessment of radiological changes in tibiofibular clear space.

Discussion

The main purpose of this study was to investigate any possible difference in early joint movement and function after syndesmosis fixation with 2 different methods. The most important consideration in treating syndesmosis injuries associated with ankle fracture is need for anatomical reduction and restoration of the distal tibiofibular relationship and ankle mortise, as this is the only significant prediction of functional outcome. In the fact of an associated fibula fracture, restoring the fibular length is critical to syndesmosis fixation, as malreduction of the syndesmosis most commonly occurs due to inadequate restoration of the fibular length [25].

In the present study, 20 patients were included, the average age was 37.4 ± 11.9 years ranging between 19-56 years of age. Two thirds of the participants were males (13; 65%), and this is similar to study done by Majed., *et al.* 2012 [26]. Half of the participants were assigned for tricortical screw (10; 50%) and the remaining had quadricortical screw procedure.

Regarding the mean of total AOFAS ankle-hind foot score, this study show significant difference between group one (tricortical) and group two (quadricortical) at 3 months. The mean in tricortical group was (70.9 ± 5.4) while quadricortical group was (62.6 ±

4.4). This means that patients treated with tricortical screw have better outcome than patients treated with quadricortical screw within 3 months, and this similar to study done by Hoiness., *et al*. 2004 [27] and Majid A., *et al*. 2012 [26].

After six months the mean of total score for tricortical group was (84.1 ± 9.1) and for quadricortical group (80.3 ± 5.9). This means there is no significant difference between patients treated with tricortical syndesmotic screw and patients treated with quadricortical syndesmotic screw at six months, which is similar to study done by Jain., *et al*. 2015 [28], Monga P., *et al*. 2008 [29], T. Schepers., *et al* [30].

Regarding the pain, there is significant difference between group 1 and group 2 (p = 0.002) with in three months of follow-up, patients treated with tricortical syndesmotic screw had less pain than patients treated with quadricortical syndesmotic screw within three months of surgery. This is similar to study done by Hoiness., *et al*. 2004 [27] and Majid. A., *et al*. 2012 [26] this difference proposed to be because the more dynamic fixation in the tricortical group.

After six months of surgery there is no significant difference in pain between the two groups (p = 0.355). This is means that the patients with dynamic tricortical screw had less pain than the patients with quadricortical screw until the time of removal of quadricortical screw were the pain will approximate in the two groups.

The current study show that sagittal motion of the ankle is better in tricortical screw than quadricortical screw (with mean 5.6 ± 2.0, 3.6 ± 2.2 respectively) within three months of surgery, although this difference don't reach the significance (p = 0.054), similar to study done by Zalavras., *et al*. 2007 [11]. This difference may due to, three cortices is less rigid than four cortices in syndesmotic fixation.

After six months, the range of motion between the two groups approximate with no significant difference between them, similar to study done by Jain., *et al*. 2015 [28].

The study show there is no significant difference between other parameters of function of the AOFAS score for the two surgical procedure within three or six months of surgery and this is similar to study done by A.C. Peek., *et al*. 2014 [31].

In the present study, the age of the patients had no significant impact on the outcome of patients with different surgical procedures (P. =0.787) which was not consistent with the findings of Vlijmen., *et al*. (2015) [32].

I n the current study, the male patients were more than the female patients which had no significant impact on the outcome (p. = 1.0), similar to study done by M.J. Boyle., *et al*. (2014) [33].

Regarding the type of ankle fracture, there was no significant difference in the functional outcome between ankle fracture weber B or ankle fracture weber C, which share similar results to study done by T. Schepers., *et al*. (2014) [30].

The radiographic parameters:

Regarding medial clear space for tricortical group immediately post operatively (mean = 3.8 ± 0.14) while for quadricortical group (mean = 3.8 ± 0.17) and was the (p = 0.890), which is not significant.

After three months for tricortical group (mean = 3.9 ± 0.13) and for quadricortical group (mean = 3.8 ± 0.20), the p value was (0.802). There was no significant difference between two groups either immediate post operatively or three months later.

The tibiofibular space for tricortical group immediately post operatively (mean = 4.4 ± 0.37) while for quadricortical group (mean = 4.5 ± 0.38) and was the (p = 0.773), which is not significant.

After three months for tricortical group (mean = 4.4 ± 0.42) and for quadricortical group (mean = 4.5 ± 0.42), the p value was (0.755). There was no significant difference between two groups either immediate post operatively or three months later, also there was no increase in diastasis after removal of the syndesmotic screw for both groups.

The tibiofibular overlap for tricortical group immediately post operatively (mean = 8.7 ± 0.36) while for quadricortical group (mean = 8.9 ± 0.40) and was the (p = 0.181), which is not significant.

After three months for tricortical group (mean = 8.6 ± 0.35) and for quadricortical group (mean = 8.8 ± 0.43), the p value was (0.407). There was no significant difference between two groups either immediate post operatively or three months later. This is similar to study done by Jasqui Remba., *et al*. (2015) [34] this study evaluate changes in radiological indexes (TFCS decreased, TFO increased, and MCS was decreased post operatively and still reduced till time of screw removal. Also, Gennis., *et al*. (2015) study show Radiological measures (TFCS, TFO and MCS) were assessed on 3 occasions: pre and immediate postoperative, and at follow up when weight bearing started and syndesmosis screw removed. Slightly increased tibiofibular clear space and decreased tibiofibular overlap after elective screw removal ≥3months after surgery, assessed on mortise view were statistically not significant. Pre and postoperative changes in changes in medial clear space were not significant.

This reflect that anatomical reduction of the syndesmosis with either three or four cortices improve function and radiographic parameters.

Limitation of the Study

Small sample size and short time for follow up because of COVID-19 pandemic.

Conclusion

According to the results of this study, there was significant difference between the two involved populations in the functional outcome, but there was no significant difference in radiographic outcome after three months.

After six months the results was Converge with no significant difference between either functional or radiological outcomes.

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