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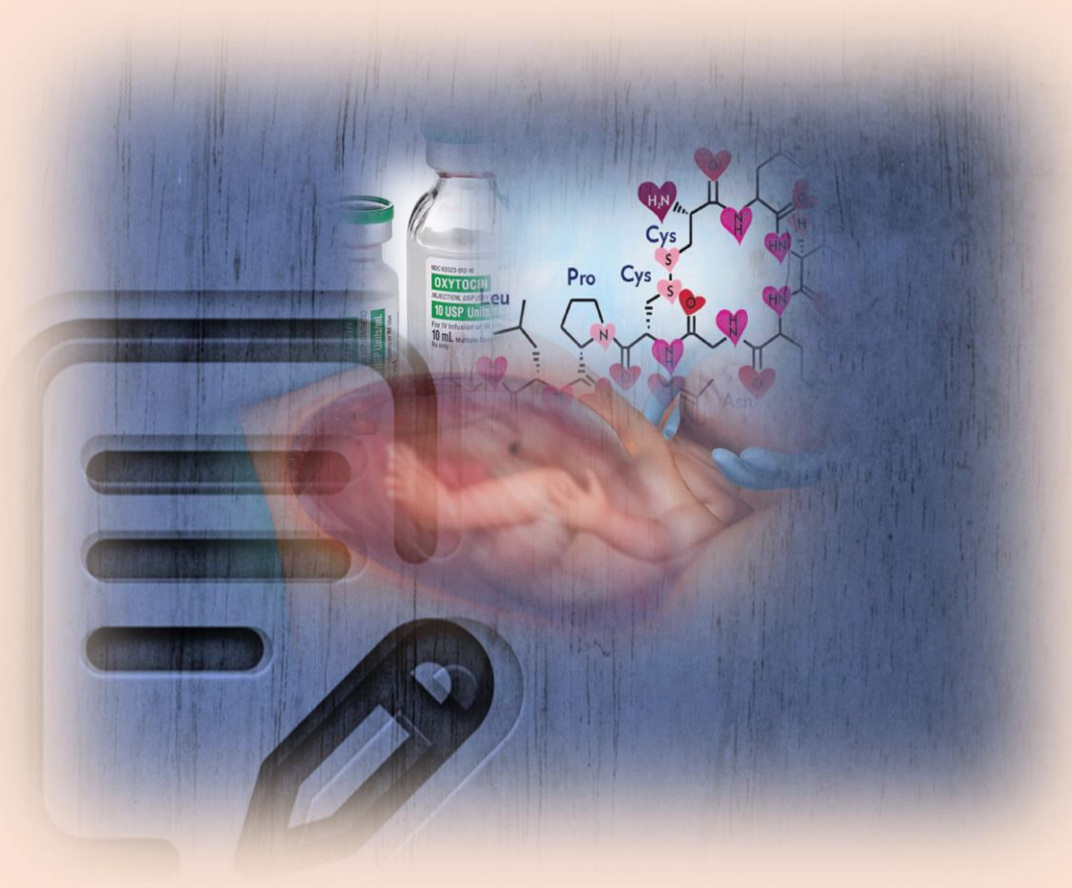

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Original Article

Suture Button Fixation for Treatment of Acute Distal Tibiofibular Syndesmotic Injury

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ABSTRACT

Introduction and Aim: Ankle fractures are common fractures encountered by the orthopedic surgeons in their daily clinical practice. The syndesmosis complex stabilizes the mortis by securing the fibula into the fibular notch. The current work aimed to evaluate the outcome of suture button fixation for treatment of distal tibiofibular syndesmotic injuries.

Patients and methods: This was a quasi-experimental study. It included twenty patients with distal tibiofibular syndesmotic injury. They were operated upon by suture button fixation at Al-Azhar University Hospital (New Damietta) and were assessed clinically and radiologically directly and followed up over four months after surgery.

Results: Patient's age ranged from 25-54 years with the mean value of 39±7.3 years. Female patients were 15 (75%). The left side was 14(70%) affected in patients, while the right 6 patients (30%). The functional outcomes were 95% excellent and 5% good. There was no post-operative complication except one case complicated with superficial infection and another case complicated with wound dehiscent. All cases were operated on the same day of fracture except two cases presented by severe edema and skin bullae and the operation was delay one week until the edema subsided. Time to full weight bearing ranged 5 to 6 weeks.

Conclusion: The suture button technique is considered a viable alternative option to replace screw fixation for syndesmosis injuries. It normalizes the distal tibiofibular syndesmosis that remains normal throughout the follow up duration.

Keywords: Suture Button; Tibiofibular; Syndesmotic; Fixation.

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INTRODUCTION

Ankle fractures are one of the commonest fractures treated during daily practice of orthopedic surgeons. It usually requires surgical intervention to restore anatomic congruity of the ankle mortise. This lead to stable transmission of the load through the talocrural joint, easiness of rehabilitation and reduction of posttraumatic osteoarthritis [(1)].

The syndesmosis incorporates the anterior-inferior tibio-fibular, posterior-inferior tibiofibular, inferior transverse tibio-fibular, and the interosseous ligaments. This complex stabilizes the mortise by securing the fibula in the fibular notch [(2)].

The injury of the ankle syndesmosis is a common condition. It could be due to a simple fall, motor car accident, sports injury or falling from height. Clinically, the syndesmotic injury could be presented as an isolated ligamentous tear or associated with other fractures [(3)].

It accounts for about 13% of all ankle fractures, in pronation and external rotation injuries. In ankle fractures needing operative fixation, the syndesmotic injuries accounts for approximately 20% [(4,5)].

In misdiagnosis or inadequate treatment of syndesmotic injury, a persistent pain of the ankle, functional disability and early osteoarthritis are potential complications [(4)]. Thus, anatomic reconstruction of the ankle mortise, stable fixation of disrupted syndesmosis associated with an ankle fracture are essential for optimal outcome [(3,5,6)].

Traditionally, trans-osseous screw fixation was the standard surgical option for fixation of the reduced syndesmosis. However, it was associated with potential complications such as broken screws and a need for the secondary removal of the implant [(7)].

The suture-button fixation was suggested to preserve the fibular rotation during ankle motion when resisting diastasis [(8)]. Multiple studies confirmed that this novel fixation technique is effective as screw fixation, without a need of routine removal of the implant [(9,10)].

It is a tightrope procedure**,** with implantation of two to four cortical end buttons and looping a non-absorbable suture around them to offer semi rigid fixation [(11-13)]. However, criticism is continued regarding the efficacy and safety of the procedure.

The current study aimed to evaluate the clinical and radiological outcome of suture button fixation for treatment of distal tibiofibular syndesmotic injuries.

PATIENTS AND METHODS

This quasi-experimental study including twenty patients with distal tibiofibular syndesmotic injury will be operated upon by suture button fixation at Al-Azhar University Hospital in Damietta and were assessed clinically and radiologically by follow up over 4 months after surgery. The study completed between December 2020 to December 2021.

A convenient sample of twenty patients with distal tibiofibular syndesmotic injury, who fulfil inclusion criteria were included.

The inclusion criteria include patients with skeletal maturity, with acute syndesmotic injury with or without ankle fracture, any gender, and fit for surgery. The exclusion criteria on the other side included patients with pathological fractures, potentially infected ankle fractures, open fracture, skeletal immaturity, neuropathic arthropathy, Charcot joint, pilon fracture, neuropsychiatric and other disorders that may render patients unable to comply with instruction, and chronic syndesmotic injury.

Ethical aspects:

The study protocol was approved by the institutional review board of the Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt. All participants signed an informed consent after full explanation of the study protocol. The study had been completed in accordance with codes of the Helsinki declaration of research conduct and reporting.

Methodology:

All participants were clinically evaluated by history taking, physical examination (general and local). Local examination included ankle deformity, swelling, skin condition, tenderness and neurovascular status.

Radiologically, all patients underwent anteroposterior view (A-P), lateral and Mortise views of the ankle. The films were examined for type of fracture, the tibiofibular clear space, the tibiofibular overlap, shentons line, and the medial clear space. Finally, a blood sample was drawn for laboratory investigations (e.g., complete blood count, INR and serum creatinine).

Biomaterial used in syndesmotic fixation:

Suture button system:

It consists of the ToggleLoc Fixation Device for medial side fixation, Round top hat button for lateral fixation and MaxBraid Suture which connect the medial and lateral fixation devices.

Medial Fixation:

Smaller version of the ToggleLoc Fixation Device for medial side fixation (Figure 1).

Lateral Fixation:

Round top hat button for lateral fixation. It was used directly on the lateral cortex of the fibula or in conjunction with Fibula Plate (Figure 2).

MaxBraid:

Medial and lateral fixation devices connected with MaxBraid Suture.

Features:

Low profile, knotless suture fixation system. Fixation alternative to rigid stainless steel screws for repairing ankle syndesmosis joint disruptions. Permits micro-motion during healing which more closely mimics the patient's true joint

mechanics

Removal:

If removal is desired, a small incision over the ToggleLoc button on the medial tibia is made to expose the button. Similarly, a small incision is made over the round button on the lateral fibula. Using a blade or cautery, cut the suture at the round button. The round button can be removed. The ToggleLoc button and suture can then be removed from the medial side of the tibia.

II. Methods of treatment:

Preoperative management:

Grossly distorted ankles were reduced immediately in the emergency room to avoid skin necrosis and also to eliminate tension on the neurovascular structures. Simple splint and elevation were instituted until the time of operation. Management of the general condition was carried out as dictated by general status of the patient. Prophylactic broad-spectrum antibiotic in the form of cephalosporin was given one hour pre operatively.

Operative technique:

Step I:

Supine position in all patients without tourniquet, with bolster under the ipsilateral buttock the lateral aspect of the ankle was approached and an incision was carried down to bone on the lateral side of the ankle protecting branches of the superficial peroneal nerve anteriorly (Figures 3 and 4).

Step II:

The periosteum was minimally stripped at the fracture site, and blood clots were removed. Direct reduction was obtained by manipulating the fragments. Once length and rotation were restored, the fragments may be fixed with lag screw (Figure 5, 6) and a third plate and (3.5 mm) cortical screws with the lateral malleolus in an anatomic position and the plate being located lateral to the fibula.

Step III:

Intraoperative stress tests under X ray imaging by external rotation test and hook test (Figures 7, 8).

Step IV:

The endo button and suture were prepared then drilling all four cortices, in the transmalleolar plane (30˚ anterior to the coronal plane) using cannulated 3.2mm drill, create a drill pathway at or slightly above the incisura of the tibia at the distal tibio-fibular joint (Figure 9).

After the bone tunnels had been prepared, strands were passed through the tunnels from lateral to medial using the guide pin (Figure 10).

Carefully continue pulling until the ToggleLoc button exits the bone tunnel on the medial side of the tibia. Keeping the device taut from both ends keeps the ToggleLoc button angled so that it will easily flip on the medial cortex. As the button exits out of the medial tibial cortex, directing the hand inferiorly may aid in flipping the ToggleLoc button. Under fluoroscopic imaging, once the button appears to be out of the medial tibial cortex, pull the device back in the lateral direction so that the ToggleLoc button will flip and rest closely against the medial cortex of the tibia (Figure 11).

Step V:

Before tensioning the suture, the syndesmosis was reduced by reduction clamp and took an x ray to check radiological parameters. Tension the fibular endo button and strands were carefully cut down near the round top hat button with scissors (Figure 12).

The medial malleolus was then approached through a direct longitudinal curvilinear incision. The anteromedial part of the joint was then explored. The fracture was identified and cleared of hematoma and periosteum if present. The medial malleolar reduction was temporarily maintained by reduction clamp. The fracture was then fixed by two malleolar screws. If the medial malleolus was small tension band wiring was used.

Post-operative management:

The patient was placed in a post-operative splint, Antibiotic prophylaxis in the form of cephalosporin was administered for three days.

Check X-rays and CT scan were done postoperatively and examined with respect to: Reduction of bony fragments, Closure of inferior tibiofibular syndesmosis, Integrity of the articular surfaces and talar position and Security and position of the implants used.

Early active exercise of the knee was explained to the patient from the second postoperative day and was encouraged as tolerated. Weight bearing was not allowed by the affected ankle for the following four to six weeks. Sutures were removed at two to three weeks.

Follow up:

The patient was placed in a post-operative splint. Non-weight bearing is maintained for a minimum of four weeks or until sufficient callus ensures length stability of the fibula. patient was allowed to do gentle range of motion non-weight bearing at four weeks. In the presence of sufficient fibula healing, protected weight bearing was started on week six. Advancement to full weight bearing is progressed as clinically indicated. After surgery, every patient had clinical and radiological assessment.

The clinical assessment in the form of pain, limping, range of motion, maximum walking distance, gait abnormalities, and stability of the ankle. Radiological assessment performed by check X-rays to assess syndesmotic diastasis, radiological union, and condition of implants, radiological sign of infection, and delayed union.

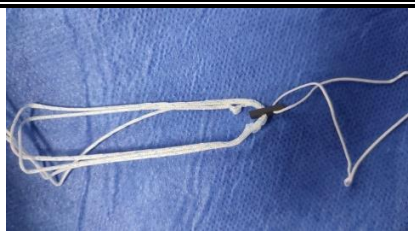

Figure (1): The ToggleLoc Fixation Device

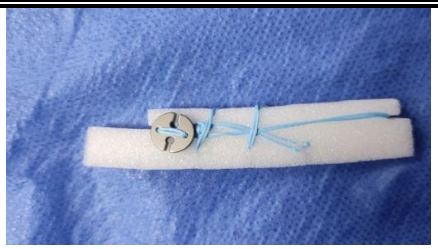

Figure (2): Round top hat button

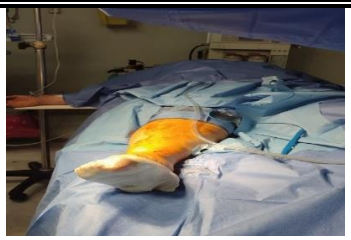

Figure (3): supine position

Figure (4): skin incision

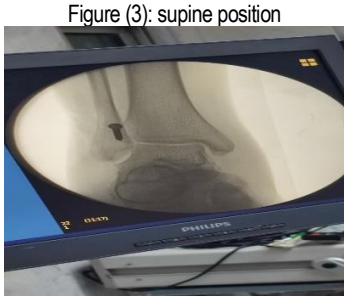

Figure (5): (the fragments were fixed with lag screw)

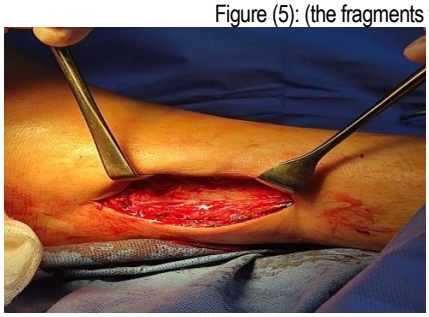

Figure (6): (fracture site before and after lag screw fixation)

Figure (7): (intra operative stress tests)

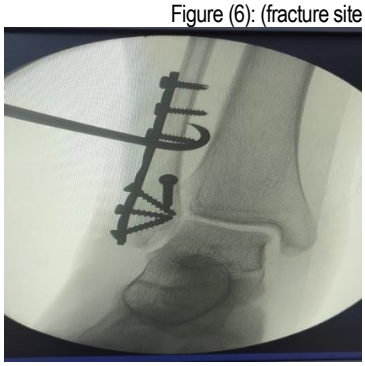

Figure (8): intra operative hook test)

Figure (9): guide pin and cannulated 3.2 mm drill

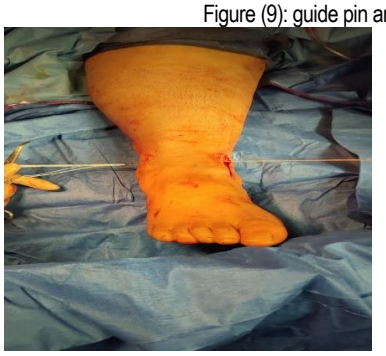

Figure (10): passing the suture and endo button

Figure (11): flipping the ToggleLoc button on medial tibial cortex

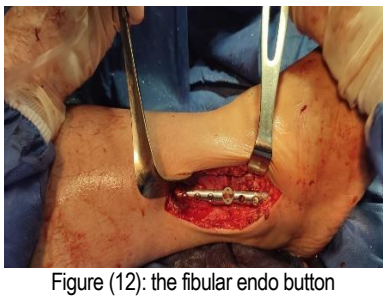

Figure (12): the fibular endo button

Methods of Assessment of the Results

1-Accuracy and maintenance of syndesmosis reduction*:* The accuracy of reduction was classified on radiological basis into good or poor **(Table 1)**

Table (1): Weber criteria of reduction

Score	Anatomical results of reduction of syndesmosis
Good	- Tibiofibular overlap > 6 mm - Tibiofibular clear space <6 mm - medial clear space < 3 mm. or =distance between talar dome and tibial plafond - Shentons line : not interrupted
Poor	- Tibiofibular overlap < 6 mm - Tibiofibular clear space >6 mm - medial clear space >4 mm. or not equal distance between talar dome and tibial plafond - Shentons line: interrupted.

2-FOLLOW UP**:** ***Functional outcomes and quality of*** **life** assessed by The American Orthopaedic Foot and Ankle Society (Modified AOFAS) Clinical Rating System (Ankle-Hindfoot Scale). All patients were evaluated regarding their clinical and functional outcome following the modified AOFAS Ankle**-**Hindfoot Scale **(Table 2)**

Table (2): Modified AOFAS Clinical Rating System (Ankle-Hindfoot Scale).

Category	Variable	Score
Pain (40 points)	None Mild, occasional Moderate, daily Severe, almost always present	30 20 10 0
Function (50 points)		
1) Activity	-No limitations, no support. -No limitation daily activities, limitations of recreational activities, no support. -Limited daily and recreational activities. - Severe limitation daily and recreational activities, walker, crutches, wheelchair, brace.	10 7 4 0
2) Maximum walking distance, blocks	> 6 4-6 1-3 <1	5 4 2 0
3) Walking surfaces	-No difficulty on any surface -Some difficulty on uneven terrain, stairs, inclines, ladders -Severe difficulty on uneven terrain, stairs, inclines, ladders	5 3 0
4) Gait abnormality	-None, slight -Obvious -Marked	8 4 0
5) Sagittal motion (flexion + extension)	-Normal/mild restriction (≥30°) -Moderate restriction (15-29°) -Severe restriction (<15%)	8 4 0
6) Hindfoot motion (inversion + eversion)	-Normal/mild restriction (75-100% normal) - Moderate restriction (25-74% normal) -Marked restriction (<25% normal)	6 3 0
7)Stability(anterior posterior, Varus-valgus)	-Stable -Definitely unstable	8 0
Alignment (10 points)	-Good, plantigrade foot, ankle hindfoot well aligned -Fair, plantigrade foot, some degree of ankle-hindfoot malalignment observed, no symptoms -Poor, non-plantigrade foot, severe malalignment, symptoms	10 5 0
Tibiofibular displacement (10 points)	-tibiofibular overlap > 9 mm or medial clear space < 3 mm -tibiofibular overlap 6-9 mm or medial clear space 3-5 mm -tibiofibular overlap < 6 mm or medial clear space > 5 mm	10 5 0
TOTAL		100

Scores 80-100 were excellent result, 60-79 as good, 40-59 as fair, as and less than 40 as poor. Patients with excellent and good results were classified as satisfactory while patients with fair and poor results were classified as unsatisfactory (Table 3).

Table (3): Relation between score and results.

Score	Grade
80-100	Excellent
60-79	Good
40-59	Fair
< 40	Poor

RESULTS

Patient characteristics: Patient's age ranged from 25-54 years with the mean value of 39±7.3 years. Female patients were 15 (75%) while 5 were males (25%). A considerable spectrum of occupations could be found: 13 patients were house-wives (65%), two (10%) heavy-manual workers, and 5 patients (25%) were light-workers in different occupations. Bilateral cases were not encountered in this study. The left side was 14(70%) affected in patients, while the right 6 patients (30%) (Table 4).

Clinical and operative data (Table 5): In the current work, 17 patients (85%) had SER III ankle fracture and 3 patients (15%) had SER IV. The functional outcomes and quality of life assessed using the life assessed by Modified AOFAS Clinical Rating System (Ankle-Hind Foot Scale and radiological parameters: the results were 95% excellent and 5% good. There was no post-operative complication except one case complicated with superficial infection and treated by frequent dressing, antibiotic and anti-inflammatory another case complicated with wound dehiscent and treated by frequent dressing by Iruxol cream after plastic consultation. All cases were operated on the same day of fracture except two cases presented by sever edema and skin bullae and the operation was delay one week until the edema subsided. Time to full weight bearing ranged 5 to 6 weeks (Table 5).

Table (4): Demographic data of the studied population N=20

		Statistics
Age (years): Mean±SD; range		39±7.3; 24-54
Sex	Female	15 (75.0%)
	Male	5 (25.0%)
Occupation	Housewife	13 (65.0%)
	Employee	1 (5.0%)
	Waiter	1 (5.0%)
	Fisher man	1 (5.0%)
	Carpenter	1 (5.0%)
	Teacher	1 (5.0%)
	Worker	2 (10.0%)
Affected side	Left	14 (70.0%)
	Right	6 (30.0%)

Table (5): Laugh Hansen classification of the operated cases N=20

		Statistics
Luagh Hansen classification	**SER III**	17 (85.0%)
	SER IV	3 (15.0%)
AOFAS Scale	Excellent	19 (95.0%)
	Good	1 (5.0%)
	Poor	0 (0.0%)
Complications	Dehiscent	1 (5.0%)
	Superficial infection	1 (5.0%)
Time lapse before surgery	Less than 24 hours	17 (85.0%)
	24 hours	1 (5.0%)
	6 days	1 (5.0%)
	7 days	1 (5.0%)
Time to full weight bearing	5 weeks	7 (35.0%)
	6 weeks	13 (65.0%)

Case Presentations

Case 1 (Figures 13- 17): Female patient 35-year-old presented to Al-Azhar university hospital in Damietta by left fracture lateral malleolus with talar shift (SER III) after ankle twist. Operated on the same day of trauma by plate and screws for lateral malleolus and tight rope for the syndesmotic injury. At

follow up complete union occur with full range of motion and without complication. The AOFAS was excellent.

Figure (13): Case 1, Preoperative x ray

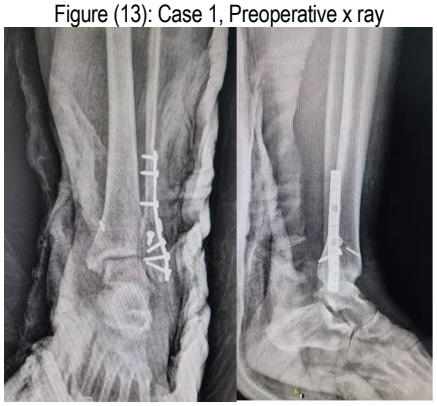

Figure (14): Case 1, Immediate Postoperative x-ray

Figure (15): Case 1. Six weeks' postoperative x ray

Figure (16): Case 1. Four months' postoperative x ray

Figure (17): Case 1 range of motion

Case 2 (figures 18-22): Female patient 32-year-old presented to Al-Azhar university hospital in Damietta by left fracture lateral malleolus with talar shift (SER III) after ankle twist. Operated on the same day of trauma by plate and screws for lateral malleolus and tight rope for the syndesmotic injury. At follow up complete union occur with full range of motion and without complication. The AOFAS was excellent.

Figure (18): Case 2 preoperative x ray

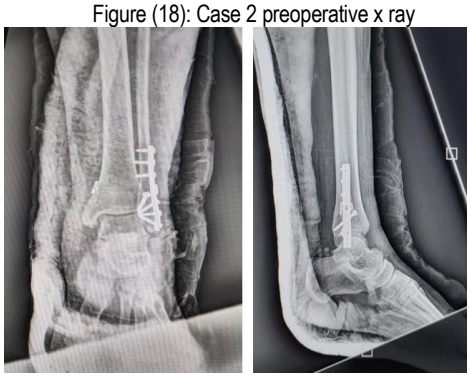

Figure (19): Case 2 immediate postoperative x ray

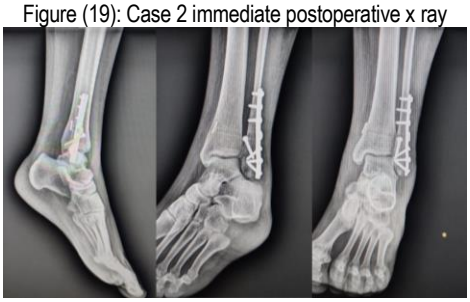

Figure (20): Case 2. Six weeks' postoperative x ray

Figure (21): Case 2. 4 months' postoperative x ray

Figure (22): Case 2 Range of motion

DISCUSSION

Our results are comparable to those obtained by other authors. DeGroot *et al*. [14] SER/Weber B (37.5%) 9 cases, PER/Weber C (54.2%) 13 cases and PAB/ Weber B (8.3%) 2 cases. In the study of Naqvi *et al.* [15], six patients had type B fracture (12.2%), 29 patients (59.2%) had type C fracture, Maisennouve fracture occurred in 11 patients (22.4%), and three patients (6.2%) had soft tissue only injury. In the study of Cottom *et al*. [16] eight patients (32%) had type B fracture, five patients (20%) had type C fracture, Maisennouve fracture occurred in four patients (16%), and eight patients (32%) had soft tissue only injury.

As regard to time lapse before operation most of our cases were operated in the day of presentation 17 cases (84) one case after 24hr, 6 days and 7 days for each. These results are comparable to those obtained by other authors: In study of in Xu *et al*. [17], mean days before operation was 4.2 days. Previous studies state that normal weight bearing was regained more quickly in with the suture button than in the conventional metal screws [18].

In this study, full weight bearing was resumed at an average of 5 to 6 weeks (65% at 6 weeks). Due to the lack of a control group, we cannot conclude that the device allows more rapid weight bearing than screw fixation. These results are comparable to those obtained by other authors: This come in line with study of DeGroot *et al*. [14]. They found in their study patients regain their previous full weight bearing at an average of 5.7 weeks. Also, in Xu *et al*. [17], the mean time of full weight bearing was 6.6 weeks in suture button fixation group. In the study of Cottom *et al*. [16] the mean time to full weight bearing was 5.52 (range 2–8) wk. for the entire patient population in suture button group 10.52 (range 8–14) wk. for the group treated with screws. Initial published reports found that none of the Arthrex tightropes had to be removed [18,19].

As a result of the early reports, removal of the suture buttons in this study was not expected and the patients were told that removal was not needed. Unlike our finding study of DeGroot *et al*. [14], 25% of patients in their study had the suture button removed due to local irritation or pain. Removal may be needed even after significant time has passed, as shown in study of DeGreoot *et al*., by one patient who requested removal after 35 months.

Prominent suture-buttons related complications with a need for removal of the implant was reported in ten studies out of the 11 included in a meta-analysis on the treatment of syndesmotic injury with a suture-button. These studies treated a total of 220 patients with a Tightrope, of which 22 (10%) were removed at an average of 16 months, with a range of an implant removal between zero and 25% [4].

As regard to postoperative complications, we noticed only one case of infected wound which had treated with debridement, local and systemic antibiotic. The infection subsided with no need for removal of the implant, and one case of dehiscent. These results are comparable to those obtained by other authors. For example, in study of Xu *et al*. [17], there was 1 case of implant irritation, 2 cases of recurrent diastasis of distal tibiofibular syndesmosis, 2 cases of deep vein thrombosis and 1 case of surgical site infection in the suture button group. In study of DeGroot *et al*. [14], there were no nonunion, infections, or other operative complications. One patient had delayed healing of the skin on the lateral side of the ankle, and required dressing changes to promote healing.

In our study, The American Orthopedic Foot & Ankle Society (AOFAS) scales were excellent in all cases except one case were good. The results of a pooled statistical analysis of three studies indicate that the AOFAS score at 3rd months postoperatively was significantly higher in the suture button group than that in the conventional screw group. In the Tightrope group, two of studies showed a higher AOFAS score (ten and six points increase, respectively) [4].

In the study of Thornes *et al*. [20], who reported treating 16 patient with inferior tibiofibular syndesmosis injury using Suture-Button and syndesmotic screw at one year postoperative they achieved excellent result (satisfactory) in 93% ,83% respectively. In the study of Cottom *et al*. [16], they used modified AOFAS Hind foot scoring system that the maximum score was 63 points on 25 patients suture button and 25 patients syndesmotic screw, the mean postoperative score was 50.64 (range 30 to 63) and 53.45 (range 25 to 63) respectively in the screw group. While in the study of Naqvi *et al*. [15], the mean AOFAS score was 85.57 (95% CI 77.96– 93.18).

As regard to age of patients: In this study, the age of the patients ranged from 25-54 years with the mean value of 39±7.3 years. Various studies reported some variations e.g. Cottom *et al*. [16] reported a mean of 34.68 years with a range 15-55 years [21], while Naqvi *et al*. [15] had a mean age of 37.71 years with a range of 18-69 years. In the present study, there was insignificant correlation between age of the patient and the final result. This is similar to the results of Cottom *et al*. [16] and Naqvi *et al.* [15] studies.

As regard to sex of patients: in this study, 15 patients were females (75%), while 5 were males (25%). In the study of Cottom *et al*. [16] there were 14 males (56%) and 11 females (44%). While in the study of Coetzee JC and Ebeling PB, nine patients were males (75%) and three patients were females (25%). In the present study, there was insignificant correlation between sex of the patient and the final results. This is similar to what Cottom *et al*. [16] found in their study. The study of Coetzee JC and Ebeling PB also revealed insignificant correlation between sex of the patient and the final results.

In the current study, different mechanisms of injury were encountered, 15 ankles (75%) were injured after fall on ground, 1 (5%) in motor car accidents and 4 ankles (20%) sustained their fracture as a result of falling from a height. This is different from the study of Naqvi *et al*. [15] as it revealed that only three patients (6.1%) were injured after fall on ground. In their study, 20 patients (40.8%) had trip and fall injury and this was the most common mechanism of injury, 13 patients (26.6%)were injured during sports, falling from height was the mechanism of trauma

in eight patients (16.3%), three patients (6.1%) were injured during dance, and two patients (4.1%) had motor car accidents. In our study, as well in Naqvi *et al*. [15] study, there was an insignificant correlation between the mechanism of injury and the final results.

As regard to the affected side: In this series, bilateral cases were not encountered in this study. The left side in was 12(60%) affected in patients, while the right 8 patients (40%). In the study of Naqvi *et al*. [15] there were 29 patients (59.2%) with affected left side and 20 patients (40.8%) with affected right side. In the series of Thornes *et al*. [20], nine patients had affected left side (56.3%) and seven patients had affected right side (43.7%).

In this study, there was no significant correlation between the side affected and the final results. The study of Naqvi *et al*. [15] revealed the same result. And this goes in harmony, with the report of Thornes *et al*. [20] as they also concluded that there was no significant relation between the side affected and the final results when they studied the results of treatment of syndesmotic disruption with suture-buttons.

We believe the suture button device represents a viable alternative to screw fixation for syndesmosis injuries. The disrupted syndesmotic relationships were normalized by the application of the suture-button and remained within normal limits throughout the study period in all cases. Because of the ease of use of the device and the ability to allow full weight bearing without concerns about implant breakage, we feel that suture button fixation is superior to conventional metallic screws.

Conflict of interest: None.

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