ORIGINAL ARTICLE

INVESTIGATION OF SHORT AND MEDIUM TERM RESULTS OF DYNAMIC FIXATION AND RIGID FIXATION IN THE TREATMENT OF SYNDESMOSIS INJURIES IN ANKLE FRACTURES

Sindesmos Yaralanmasının Eşlik Ettiği Ayak Bileği Kırıklarının Tedavisinde Dinamik Tespit ve Rijid Tespitin Kısa ve Orta Dönem Sonuçlarının İncelenmesi

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ABSTRACT

Objective: Our study compares the short- and medium-term radiological and clinical outcomes of patients who underwent syndesmosis fixation with double-button implants and screws.

Material and Methods: Patients aged between 18 and 75 years who underwent surgery for ankle fractures with syndesmosis injuries between 2018 and 2022 were retrospectively analyzed. The patients were divided into two groups: Patients who underwent dynamic fixation with double-button implants (Group I) and patients who underwent rigid fixation with screws (Group II). Computed tomography scans of both ankles were assessed to evaluate the reduction quality. A more than 2 mm difference between the syndesmosis widths of the two ankles was considered a malreduction. Functional assessment was performed using the American Orthopaedic Foot and Ankle Society (AOFAS) clinical assessment system at the last follow-up visit.

Results: Group I comprised 39 patients, and Group II of 37 patients. The mean age was 50.3±17.5 years, and the mean follow-up time was 22.6±10.9 months. On radiological examination, the width of the posterior syndesmosis on the healthy side was 4.03 mm in both groups. In comparison, the width on the fractured side was smaller in Group I (4.4 and 5.2 mm, respectively) (p=0.039). A reduction in malformation was observed in one patient in Group I and eight patients in Group II (p=0.013). The postoperative AOFAS score of Group I was significantly better than Group II's (88.6 and 84.8, respectively) (p=0.043).

Conclusion: Although both methods can be used safely, double-button implants are the more suitable as they offer better reduction and functional recovery and do not require a second operation.

Keywords: *Ankle Fracture; Syndesmosis İnjury; Dynamic Fixation; Rigid Fixation*

ÖZET

Amaç: Çalışmamızda çift düğme implant ve vida kullanılarak sindesmoz tespiti yapılan hastaların kısa ve orta dönem radyolojik ve klinik sonuçlarını karşılaştırılmaktadır.

Gereç ve Yöntemler: 2018-2022 yılları arasında sindesmoz yaralanmasının eşlik ettiği ayak bileği kırığı nedeniyle ameliyat edilen 18-75 yaş aralığındaki hastalar retrospektif olarak incelendi. Hastalar iki gruba ayrıldı: çift düğme implant kullanılarak dinamik tespit yapılan hastalar (Grup I) ve vida kullanılarak rijit fiksasyon yapılan hastalar (Grup II). Redüksiyon, her iki ayak bileğinde bilgisayarlı tomografi görüntüleri kullanılarak değerlendirildi. İki ayak bileğinin sindesmoz genişlikleri arasında 2 mm'den fazla fark olması malredüksiyon olarak kabul edildi. Fonksiyonel değerlendirme, son takip muayenesinde Amerikan Ortopedik Ayak ve Ayak Bileği Derneği'nin (AOFAS) klinik değerlendirme sistemi kullanılarak yapıldı.

Bulgular: Grup I 39 hastadan, Grup II ise 37 hastadan oluşuyordu. Ortalama yaş 50.3±17.5 yıl, ortalama takip süresi 22.6±10.9 aydı. Radyolojik incelemede her iki grupta da sağlam tarafta posterior sindesmoz genişliği 4.03 mm iken, kırık taraftaki genişlik Grup I'de daha düşük bulundu (sırasıyla 4.4 ve 5.2 mm) (p=0,039). Grup I'de bir hastada, Grup II'de ise sekiz hastada malredüksiyon saptandı (p=0,013). Ameliyat sonrası Grup I'in AOFAS skoru Grup II'ye göre anlamlı olarak daha iyi idi (sırasıyla 88.6 ve 84.8) (p=0.043).

Sonuç: Her iki yöntem de güvenle kullanılabilirken, çift düğme implantlarla daha iyi redüksiyon ve fonksiyonel iyileşme sağlandığı ve ikinci bir ameliyata gerek olmadığı için daha uygun yöntemdir.

Anahtar Kelimeler: *Ayak Bilek Kırığı; Sindesmoz Yaralanması; Dinamik Tespit; Rijit Tespit*

INTRODUCTION

Ankle fractures and associated pathologies play an important role in routine orthopaedic practise (1). About 10% of ankle fractures are associated with syndesmosis injuries (2). The syndesmos ligament complex stabilises the joint between the tibia and fibula (3). If ankle fractures are treated surgically and this injury is misdiagnosed or not treated appropriately, it can lead to permanent pain, functional limitations and osteoarthritis in the ankle (4). When ankle fractures are classified according to the Weber classification, this injury is associated with all type C fractures and a significant proportion of Weber type B fractures (1).

The conventional treatment method for the treatment of syndesmosis injuries is rigid fixation with screws. It is recommended to remove the screws 3 months after the operation. If the screws are not removed, a screw fracture can occur, leading to pain and functional limitations in the ankle joint (5). The disadvantages of screw fixation are that it is a method that is prone to complications and that a second operation is required. Due to these problems, the suture button has been used in recent years as an alternative method to rigid fixation with screws for ankle fractures with syndesmosis injury (1). In addition to achieving similar stabilisation in biomechanical studies, the advantages of this method are that no additional surgery is required to remove the implant, that a dynamic and more physiological fixation similar to the syndesmos ligament complex is achieved and that the risk of secondary instability after removal of the implant is lower (1). Similar results were obtained in cadaver studies in which the two methods were compared (6,7).

Regardless of the method used to treat these injuries, adequate and anatomical fixation of the syndesmosis is the most important determinant of good clinical outcomes (8). To assess the reduction in size of the syndesmosis, computer tomography (CT) provides the most accurate results (8,9). In patients with screw fixation, false reduction rates of between 16% and 52% have been reported (10–12). On the other hand, there is little information on the results of fixation with the thread-button technique.

The purpose of this study was to evaluate the reduction performance of screw fixation and suture-button techniques using images obtained from CT. The functional outcomes of both techniques were also compared.

MATERIAL AND METHOD

Informed consent was obtained from all the participants and all procedures performed in the study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethics committee approval was obtained from the board (23-KAEK183).

This retrospective study included patients who underwent surgery for ankle fractures with syndesmosis injury between 2018 and 2022. Patients aged 18 to 75 years were enrolled in the study. The inclusion criteria were as follows: 1) Patients with a Weber type C fracture with significant syndesmosis injury on preoperative examination, 2) Patients with a Weber type B fracture with syndesmosis injury on intraoperative examination, 3) Patients with fixation using the suture-button technique and screws to fix the syndesmosis injury. Patients were excluded from the study if they had Weber Type A ankle fracture, metabolic bone disease, a history of ankle infection, open fractures, pathologic fractures, fracture and surgery history on the same ankle and a follow-up period of <1 year.

Patients who met the study inclusion criteria were divided into two groups: patients who underwent suture-button fixation (group I) and those who underwent screw fixation (group II). Functional evaluations of the patients with a follow-up period >1 year were assessed in the final examination.

The preoperative data of the patients were retrieved from their medical records (age, gender, mechanism of injury, fracture classification, side treated). Also the postoperative data of the patients were retrieved from their medical records (fixation technique, implant removal time, weight-bearing time, radiologic reduction parameters in the patients who had postoperative CT imaging and complications). The width of the syndesmos was measured using CT images of the ankle taken at the first scan after the fracture. The patients were evaluated by an independent investigator who was not part of the surgical team. The American

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Orthopaedic Foot & Ankle Society score (AOFAS) were used for the postoperative functional evaluations

The operations were performed in a single center by two different surgeons with 10 years (M.A.) and five years (M.G.) of experience in ankle surgery. Concomitant medial and posterior malleolar fractures were fixed after fixation of the lateral malleolar fracture. Syndesmosis injury was diagnosed in the preoperative imagings when the medial clear space was ≥5 mm (13).

While static fixation with screws was used for patients who underwent surgery up to 2020, dynamic fixation with suture buttons was used for patients who underwent surgery in the last two years in view of current developments in the literature.

In all cases while osteosynthesis of the fractures completed, syndesmosis injury was assessed with the cotton/hook test under fluoroscopy (14). Syndesmosis reduction was performed using a reduction clamp. For syndesmosis repair, a suture-button fixation system (Doratek Medikal, Ankara, Turkey) was used in group I and a 3.5-mm cortical screw (Response Ortho, Istanbul, Turkey) was used in group II. In both methods, fixation of the syndesmosis was through the cortical screw hole of the plate used to fix the lateral malleolus. After dorsiflexion of the ankle to 90 degrees, syndesmosis fixation was performed at a 30-degree angle from posterolateral to anteromedial 2 cm proximal to the ankle plafond under fluoroscopic control.

In group I, after the elliptical button was passed through the tunnel, fixed to the medial cortex of the tibia, and the system was tightened, the round button was knotted to the lateral malleolus plate. When the syndesmos was fixed in group II, the screw was passed through four cortices.

Short leg splints were applied for four weeks on all patients. After splint removal, active and passive ankle joint movement was started and partial weight bearing was allowed. At the sixth postoperative week, full weight bearing was allowed. Syndesmotic screws were removed at third month of surgery.

The accuracy of syndesmotic reduction on axial CT scans was considered the primary outcome variable for comparing the two treatment options. The reduction of sindesmosis was assessed using bilateral CT scans of the ankle according to the method described by Elgafy et al. (15) (Figure 1). In this method, the authors reported the average syndesmosis width as 4 mm. As stated in other studies in the literature, a difference of more than 2 mm between the two syndesmosis widths of the ankle was considered a false reduction (2,12). Functional evaluation was done using the American Orthopaedic Foot & Ankle Society (AOFAS) ankle hindfoot scale clinical rating system at the final follow-up and full weight-bearing time after the prior surgery.

The data were analysed using SPSS Statistics Software (version 23.0, IBM Corp.). The distribution of the data was evaluated with the Kolmogorov-Smirnov test. The categorical data were assessed with the Pearson Chi-square and Fisher exact. The parametric and non-parametric data were evaluated with the Student t-test and Mann-Whitney U test, respectively.

Figure 1. Measurement of syndesmotic width on axial CT images; A-B: anterior syndesmotic width, C-D: posterior syndesmotic width.

RESULTS

We identified 202 patients who underwent surgery for ankle fracture during the study period. Eighty-two patients had concomitant syndesmosis injury. Six were excluded based on our exclusion criteria. Seventy-six patients were participated in the study. There were 39 patients in Group I and 37 patients in Group II.

The mean age of the all patients was 50.3± 17.5; in Group I 47±17 and in Group II 53.8±17 years. (p=0.104)

The mean follow-up period of all patients was 22.6 ± 10.9 months; in Group I 16±3.8 and in Group II 29.3±12 months. (p<0.05) The average weight-bearing time was 6.59 ± 1.2 weeks; in Group I 6.6±1.2 weeks and in Group II 6.5±1.2. (p=0.837) The average screw removal time was 13.3±2.8 weeks (range, 10-15 weeks) in Group II. Patient's demographics, injuried side, mechanisms of injury, fixation distance, and fracture classification were described in Table 1.

While the preoperative syndesmosis widths were significantly higher in both groups compared to the healthy side (7.96±0.84 vs. 8.08±0.97), the examination of the measurements at the final follow-up examination showed a significant improvement in the syndesmosis width in both groups (p<0.05) (Table 2). When the syndesmosis widths were examined, it was found that the syndesmosis width on the healthy side was 4.03 mm in both groups. When the operated extremity was examined, it was found that the syndesmosis width was significantly smaller in group I (4.48±0.73 vs. 5.21±1.59; p=0.039).

If there was a difference of more than 2 mm between the syndesmosis widths of the healthy and the operated ankle, the syndesmosis was considered to be poorly reduced. Malreduction was present in only one patient in group I, while malreduction was present in eight patients in group II. The characteristics of our patients with malreduction are detailed in Table 3. These results showed that syndesmosis reduction was statistically better achieved in patients who underwent suture button fixation (p=0.013) (Table 2).

The time of weight bearing and the AOFAS score were used to assess the postoperative functional status. It was found that the AOFAS scores of patients in Group I were statistically significantly better. (88.6±4.3 versus 84.8±4.1; p=0.043). The time of weight bearing was 6.6 weeks in group I and 6.5 weeks in group II, and no statistically significant difference was found between the two groups (p=0.837) (Table 1).

All patients who participated in our study were found to have complete union on the radiographs taken at the last follow-up examination. The total duration of complete union was 11.6±4.3 (range 8-22) weeks. It was found that union was achieved in 31.5 of the patients

Table 1. Descriptive characteristics of patients

		Group I (n=37)	Group II (n=39)	P
Age (SD)**		53.8 (17)	47 (17)	0.104
Follow-up (SD)***		29.3 (12)	16 (3.8	<0.05
Weight-bearing time (SD)**		6.5 (1.2)	6.6 (1.2)	0.837
Gender	Female	19	25	0.260
	Male	18	14	
Injured limb	Right	17	24	0.173
	Left	20	15	
Fracture mechanism	Falling from height	14	14	0.869
	Falling on ground	18	18	
	Sport injury	5	7	
Complication	No	31	35	0.511*
	Yes	6	4	
Fracture type	Weber B	17	24	0.173
	Weber C	20	15	
Malreduction	No	29	38	0.013*
	Yes	8	1	
Distance to plafond (SD)		18.8 (2)	18.4 (1.4)	0.751
AOFAS (SD)**		88.6 (4.1)	84.8 (4.3)	0.043

AOFAS: American Orthopaedic Foot and Ankle Society, SD: standard deviation. Chi-square was performed, *Fisher exact test was performed, ** Mann-Whitney U test was performed, *** Student T test was performed

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Table 2. Investigation of the syndesmosis width changings preoperative and postoperative period.

Posterior syndesmotic width	Overall (n=76)	Group I (n=37)	Group II (n=39)	P
Preoperative	8±0.9	7.96±0.84	8.08±0.97	0.365
Postoperative	4.8±1.2	5.2±1.5	4.4±0.7	0.039
p	<0.001	<0.001	<0.001	

Mann Whitney U was performed.

Table 3. Characteristics of our patients who had malreduction at the final follow-up

No	Gender	Age	Fixation Type	Side	Follow-up time	Weber classification	SRT	WBT	PPW	PWFL	PWHL	DTP	AOFAS
1	M	75	S	L	30	B	13	6	10.1	9.4	4.7	21.2	80
2	F	63	S	L	12	B	6	7	7.6	9.8	4.5	24.3	82
3	F	73	S	L	40	C	10	7	8.8	5.2	3.1	18	76
4	M	59	S	R	38	C	8	8	8.2	6.1	4	18.1	76
5	M	59	S	R	38	C	12	9	7.9	6.2	4	22.2	76
6	F	33	S	L	32	C	8	9	8.4	6.1	3.8	23.4	82
7	M	56	S	R	29	C	6	7	9	8.2	4.4	18.4	86
8	M	57	S	L	20	C	15	8	11	9.1	3.2	24.5	82
9	F	31	SB	L	12	C	-	8	8.1	6.6	4.1	22.2	82

M: male, F:female, S: Screw, SB: Suture-button, SRT: Screw remowal time, WBT: Weight-bearing time, PPW: preoperative posterior width, PWFL: Posterior width fractured limb, PWHL: Posterior width healthy limb, DTP: Distance to plafond, AOFAS: American Orthopaedic Foot and Ankle Society

after the 12th week. Delayed union was achieved on average after 15.7 (range 12.5-22) weeks. No arthritic changes in the ankle joint were detected in our patients at the last check-up.

While complications were observed in four patients (12.8%) in group I, and six patients (16.2%) in group II (p=0.511). These complications included superficial wound infection, button irritation, screw breakage and distal tibiofibular synostosis. Two of the four patients with button irritation in group I were found to have a superficial wound infection. In these patients, the implants were removed in a second operation under local anaesthesia (Table 1).

DISCUSSION

Our study showed that the fixation of syndesmosis injury after ankle fracture had successful results in both groups. Postoperatively, the width of syndesmosis ($p < .05$) and syndesmosis reduction ($p < .05$) were significantly better in group I than group II. In addition, it was found that the number of complications was lower in group I, although this was not statistically significant.

Inadequately treated or undiagnosed syndesmosis injuries can cause instability of the ankle joint and lead to early osteoarthritis (16). When studies on syndesmosis injuries were examined, it was shown that there was a decrease of approximately 42% in the ankle joint contact area in case of 1 mm lateral displacement of the talus and 1 mm increase in syndesmosis width (17,18). As this is such an important area, implants and the rehabilitation process in the treatment of syndesmosis injuries are still under development.

The Sindesmos ligament complex can withstand a force of 500N when walking and 1200N when running. (19,20) An intact syndesmosis complex can widen by 1-2 mm during movement, rotate by up to 5 degrees and move up to 3 mm proximally (21). Although the gold standard treatment method is still screw fixation, it is obvious that these movements cannot be performed with rigid fixation with screws and the effect persists even when the screws are removed (1). For this reason, the suture button technique, which only allows minimal movement, has become established as a more physiological method and has been widely used, especially in the last decade (22–26).

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If an anatomical reduction cannot be performed, the fibula cannot perform the movements it performs in the healthy ankle joint, which leads to poor results (1,11). When analysed according to our criteria, eight patients who underwent screw fixation were found to have malreduction, while only one patient who underwent suture-button fixation was found to have malreduction. In the analysis of publications comparing the two methods, a reduction in staining in the range of 16 to 52 was found in patients who had undergone screw fixation (2,8,11,12,27). In their study, Weening et al. showed that there is a direct correlation between malreduction and poor functional results (11). In our study, we found that patients with malreduction had lower AOFAS scores, which is consistent with this finding. In studies conducted on patients with suture button fixation, Naqvi et al. showed that there was no malreduction at 18-month follow-up (2). In other studies, there are publications that show that malreduction can occur in 3% to 11% of patients treated with a suture button (28,29). In our patients, the malreduction rate in group I was consistent with the literature.

It is recommended to remove the screws within three months after surgery before starting full weight bearing to reduce the risk of screw breakage (1). Three patients in group II experienced a fracture of the screw head and the mean time to screw removal was reported as 13.3±2.8 (range 12-15) weeks. If the implant is not removed after screw fixation, this restricts joint movement and has a negative effect on the results (5). For this reason, even if the screw head was broken in all our patients, the screws were removed in a second operation to avoid both restricted movement and pain due to irritation of the screw head.

Although routine removal of the implant is not required in patients with suture button fixation, removal of the implant may be necessary in less than 10% of patients due to implant irritation that may develop on the medial or lateral side of the ankle (2,30). Studies investigating the sutureand button fixation technique reported that the syndesmosis reduction was maintained after removal of the implant (1,31). In Group I, we performed implant removal in three patients due to implant irritation (2 lateral, 1 medial) and in one patient due to wound infection. After implant removal,a reduction in symptoms was observed in all patients. In accordance with the literature, no recurrent syndesmotic diastasis developed in these four patients in whom we performed implant removal.

Fracture union was defined as (a) resolution of the fracture line on radiographs, (b) painless weight-bearing, and (c) zero to minimal tenderness to palpation over the fracture site (32). Delayed union was defined as time from definitive management to fracture union greater than 12 weeks (32,33). The literature reports that delayed union may develop in 20% to 60% of patients undergoing ankle fracture surgery (33–35). When we examined the results of the patients included in our study, we found that the rates of delayed union in our patients were consistent with the literature.

The retrospective design of our study and the fact that the operations were performed by different surgeons may influence the results. Despite the homogeneous demographic distribution between groups, the retrospective nature of the study and the collection of descriptive data from records may not have clearly documented systemic diseases, with the exception of physical therapy performed in patients after surgery, which increased the risk of bias. In addition to the limiting factors mentioned here, the longer follow-up time of patients who underwent screw fixation may have influenced the functional results, because the method of fixation with suture and button has been used more recently. The relatively large number of patients, the narrow inclusion criteria, the long follow-up period, assessment with CT imaging are the strengths of our study.

CONCLUSION

In ankle injuries associated with syndesmosis injuries, anatomical reduction and fixation are of great importance to maintain normal ankle motion and biomechanics and reduce the risk of long-term complications. Both screw fixation and suture-button techniques are used safely for this purpose. However, suture-button fixation is the more favourable method as it allows better reduction and does not require a second operation.

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