ORIGINAL RESEARCH

Bagcilar Med Bull 2021;6(4):431-437
DOI: 10.4274/BMB.galenos.2021.05.068

Deltoid Ligament Repair in Addition to Syndesmotic Fixation in Distal Fibula Fractures is Associated with Better Clinical Results in Mid- and- Long-term Follow-up: A Comparative Study

Distal Fibula Kırıklarında Sindesmotik Fiksasyona Deltoid Ligament Tamirinin Eklenmesi Orta-uzun Dönem Takipte Daha İyi Klinik Sonuçlarla İlişkilidir: Karşılaştırmalı Bir Çalışma

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Abstract

Objective: To evaluate mid to long term effects of adding deltoid ligament repair (DLR) to syndesmotic screw fixation (SSF) in the treatment of distal fibula fractures -in terms of functional and radiographic results and quality of life.

Method: Seventy-eight patients who underwent SSF or SSF+DLR with the diagnosis of distal fibula fracture in the Maltepe University Hospital, Department of Orthopedics and Traumatology were included in the study retrospectively.

Results: 71.8% of the cases were male. The mean age was 39.24±11.95 years. The radiographic and functional results and quality of life were better in the SSF+DLR group compared to the SSF group. Additionally, the operation time was longer in the SSF+DLR group.

Conclusion: Performing DLR in appropriate cases of distal fibula fracture may contribute to better clinical outcomes in the mid to long term.

Keywords: Ankle, deltoid ligament repair, distal fibula fractures, syndesmosis

Öz

Amaç: Distal fibula kırıklarının tedavisinde sindesmotik vida fiksasyonuna (SSF) deltoid ligament tamirinin (DLR) eklenmesinin fonksiyonel ve radyografik sonuçlar ve yaşam kalitesi üzerindeki orta-uzun vadeli etkisini değerlendirmektir.

Yöntem: Maltepe Üniversite Hastanesi Ortopedi ve Travmatoloji Anabilim Dalı'nda distal fibula kırığı tanısı ile SSF veya SSF+DLR yapılan 78 hasta geriye dönük olarak çalışmaya dahil edildi.

Bulgular: Olguların %71,8'i erkekti. Ortalama yaş 39,24±11,95 yıldı. SSF grubu ile karşılaştırıldığında SSF+DLR grubunda radyografik, fonksiyonel sonuçlar ve yaşam kalitesi daha iyiydi. Ek olarak, SSF+DLR grubunda operasyon süresi daha uzundu.

Sonuç: Distal fibula kırıklarında uygun olgularda DLR yapılması orta-uzun vadede daha iyi klinik sonuçlara katkıda bulunabilir.

Anahtar kelimeler: Ayak bileği, deltoid ligament tamiri, distal fibula kırıkları, sindesmoz

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Cite this article as: Dağtaş MZ, Ünal ÖK. Deltoid Ligament Repair in Addition to Syndesmotic Fixation in Distal Fibula Fractures is Associated with Better Clinical Results in Mid- and- Long-term Follow-up: A Comparative Study. Bagcilar Med Bull 2021;6(4):431-437

Introduction

Fibula fractures are common ankle fractures and rarely require surgical stabilization. In some of these fractures, the syndesmosis, which contributes to the stability of the ankle, is also injured. Syndesmosis creates a mortise in the talotibial joint by tightly connecting the tibia and fibula (1,2). Besides, the deltoid ligament plays an important role in talar stability and its injury may accompany ankle fractures (3).

The deltoid ligament is the strongest ligament of the ankle and is a thick, triangular band of tissue that arises from the medial malleolus. Eversion forces can cause deltoid ligament injury, and deltoid ligament sprains typically require longer rehabilitation compared to anterior talofibular and calcaneofibular ligament sprains (4). In mild traumas of the foot and ankle, treatment may consist of medical options and immobilization with a splint/cast, while severe cases may require surgical intervention. Usually, treatment consists of a combination of these options. Many studies have investigated the benefits of deltoid ligament repair (DLR) for deltoid ligament injuries. The necessity of adding DLR to surgical treatment in ankle fractures is still not clear. While recent comprehensive studies evaluating ankle fractures have shown positive effects of DLR in terms of radiographic, functional, or quality of life findings (5-10), other studies have suggested that it has no beneficial effect (4,11-15).

Inadequately treated fractures and injuries can lead to instability, syndesmosis widening, and talar shift. Functional results are often poor in cases that do not undergo proper anatomic reduction and adequate fixation. When previous studies on this subject are reviewed, it is evident that there are very few studies reporting long-term results. In this study, it was aimed to evaluate the mid to long term effects of adding DLR to syndesmotic screw fixation (SSF) for the treatment of distal fibula fractures. Evaluations were based on functional and radiographic results and quality of life.

Materials and Methods

Patients who underwent SSF with a diagnosis of distal fibula fracture at Maltepe University Hospital, Department of Orthopedics and Traumatology between July 1, 2008 and December 31, 2015 were included in the study retrospectively. Ethical approval was obtained from Maltepe University.

Patients

Patients with distal fibula fractures who had syndesmosis injury, deltoid ligament rupture, more than 4 mm separation in the fracture line and had undergone SSF or SSF+DLR were included in the study, given that they were older than 18 years of age. All subjects included in the study had deltoid ligament rupture. The files of 118 patients who were operated for distal fibula fractures on the relevant dates were reviewed.

Exclusion criteria:

- Being younger than 18 years old,
- Having undergone different surgical procedures,
- Having additional fractures,
- Having additional health conditions affecting fracture healing (such as severe diabetes mellitus, malignancy, use of cortisone),
- Lost to follow-up.

Finally, 78 cases meeting the inclusion/exclusion criteria were included in the study. 71.8% of the cases were male. The mean age was 39.24±11.95 years, and the mean follow-up time was 66.90±6.11 weeks.

In our clinic, DLR was not performed between 2008 and 2012, while DLR was performed between 2013 and 2016. The cases were divided into two groups according to the surgical procedure. The cases in which plate and syndesmotic screw were applied to the fibula were defined as the “SSF group” (n=46), and cases that additionally underwent DLR were defined as the “SSF+DLR group” (n=32).

Surgical Procedure

SSF group: Operations were performed in the supine position, under general anesthesia or spinal anesthesia. After the tourniquet was applied to the thigh area, a longitudinal 10-15 cm incision was made over the lateral malleolus. The dissection plane was between the peroneus tertius (anteriorly) and the peroneus longus and brevis (posteriorly). Then, the periosteum was cut and the ends of the fracture were identified. The fracture edges were cleaned and reduced. Depending on the type of fracture, either the lateral fibula anatomic locking plate or the posterior fibula anatomic locking plate and locked/unlocked cortical screws were applied. The ankle was taken to maximum dorsiflexion and 4 cortex screws of 52.5 (50.0-55.0) mm were placed from the posterior to the anterior after drilling the tibia and fibula (4 cortex drilling) through the dynamic hole on the plate in parallel to the joint line.

SSF+DLR group: The procedures applied in the SSF group were also performed for the SSF procedure in this group. Afterwards, an approximately 6-cm incision was made,

extending from the upper middle part of the talus to the distal side, oriented at a slight oblique angle from proximal-posterior to distal-anterior, and centered on the posterior aspect of the medial malleolus. The posterior tibial tendon sheath was incised longitudinally to allow better visualization of the deltoid ligament. Anteromedial mini capsulotomy was performed to evaluate the condition of the deltoid ligament and joint reduction. If the deltoid ligament was separated from the medial malleolus, 1 or 2 suture anchors were applied to the medial malleolus. If it was separated from the talus, 1 or 2 suture anchors were placed in the talus. After checking the strength of the anchors, the deltoid fibers were tied with suture anchor threads, and the posterior tibial tendon sheath was repaired. The number of suture anchors applied was 1 in 26 of the cases (81.3%) and 2 in 6 of the cases (18.8%). The suture anchor location was the medial malleolus in 24 cases (75.0%) and the talus (posterior) in 8 cases (25.0%).

In both groups, the cases were immobilized with a short leg cast for 6 weeks in the postoperative period. All cases started muscle strengthening exercises within 6 weeks postoperatively. Syndesmotic screws were removed under general anesthesia on the 6th-8th week postoperatively. The day after the procedure, patients were mobilized with partial weight-bearing.

Measurements

The parameters evaluated in this study were as follows:

• Patients' characteristics (gender, age, side, energy of trauma, fracture classification),

• Surgery features (time to operation, operation duration, plate type, syndesmotic screw size, union time, time to syndesmotic screw removal, count and placement of suture anchors, follow-up time).

• American Orthopedic Foot and Ankle Society (AOFAS) score,

• Short form (SF) - 36 score,

• Medial clear space (MCS),

• Radiographic score.

The AO Foundation/Orthopedic Trauma Association (AO/OTA) classification was used for fracture classification. All evaluations were performed by an experienced surgeon blinded to the procedure performed.

Functional Assessment (AOFAS)

AOFAS is a scale developed by the American Foot and Ankle Orthopedic Society to evaluate ankle functions. A maximum of 100 points describes good functional condition of the ankle, while a score of 0 describes poor clinical condition (16). The 1st year and 5th year AOFAS scores of the cases were recorded.

Quality of Life Assessment (SF-36 questionnaire)

The SF-36 was developed to evaluate quality of life. The last 4 weeks of life are taken into consideration in the evaluation of SF-36, and it consists of 36 items. Higher scores indicate better quality of life (17). The 1st year and 5th year SF-36 scores of the cases were recorded.

Radiographic Assessment

In the mortise view, the distance between the lateral border of the medial malleolus and the medial border of the talus was recorded as the MCS. If this interval is greater than 4 mm, it is considered to be abnormal and indicates lateral displacement of the talus (18). In addition to this finding, cases with tenderness and ecchymosis below the medial malleolus in clinical preoperative examination were considered to have deltoid ligament rupture. MCS values were recorded in the pre-operative period, postoperative period (before discharge), 1st year, and 5th year.

The radiographic osteoarthritis scoring system of Kraus et al. (19) was used in the evaluation of osteoarthritis. Higher scores on this scale indicate increased osteoarthritis. The 1st year and 5th year radiographic scores of the cases were recorded.

Statistical Analysis

All analyses were performed on SPSS v21 (SPSS Inc., Chicago, IL, USA). For the normality check, the Shapiro-Wilk test was used. Data are given as mean ± standard deviation or median (1st quartile-3rd quartile) for continuous variables according to the normality of distribution, and as frequency (percentage) for categorical variables. Normally distributed variables were analyzed with the independent samples t-test. Non-normally distributed variables were analyzed with the Mann-Whitney U test. Categorical variables were evaluated using the chi-square tests. Non-normally distributed variables were analyzed with the Wilcoxon Signed Ranks test for repeated measurements. Between-groups comparison of these variables were performed by analyzing differences between measurements with the Mann-Whitney U test or the Kruskall-Wallis test depending on the group count. Pairwise comparisons were performed with the Bonferroni correction method. Two-tailed p-values of less than 0.05 were considered statistically significant.

Results

Operation time was significantly longer in the SSF+DLR group compared to the SSF group (p<0.001). There was no statistically significant difference between the groups in terms of other characteristics (p>0.05, for each). The summary of patients' characteristics with regard to the surgery group is shown in Table 1.

While the MCS value was similar between the groups in the preoperative period (p=0.661), it was significantly lower in the SSF+DLR group in the postoperative, 1st year, and 5th year measurements (p<0.001, for each). Compared to preoperative MCS, postoperative MCS was significantly reduced in both groups (p<0.001, for each). Compared to the postoperative MCS value, 1st year MCS value increased significantly in the SSF group (p<0.001), whereas there was no significant change in the SSF+DLR group (p=0.599). Compared with the 1st year, neither group showed a significant change in terms of MCS value on the 5th year (p=1.000, for each).

The SF-36 score was higher in the SSF+DLR group at both the 1st year and 5th year comparisons (p<0.001, for each). In the SSF group, compared to the 1st year, the 5th year SF-36 value was significantly decreased (p<0.001), while there was no significant difference in the SSF+DLR group (p=0.805).

While the 1st year AOFAS score was similar between the groups (p=0.316), the 5th year AOFAS score was significantly higher in the SSF+DLR group (p<0.001). The 5th year AOFAS score decreased significantly (p<0.001) in the SSF group compared to the 1st year, while it increased significantly in the SSF+DLR group (p<0.001).

The radiographic score was significantly lower in the SSF+DLR group in both the 1st and 5th year comparisons

Table 1. Summary of patients' characteristics with regard to the surgery group

	Group			
	SSF (n=46)	**SSF+DLR (n=32)**	**Total (n=78)**	**p**
Age (year)	39.74±11.82	38.53±12.29	39.24±11.95	0.664
Gender				
Male	34 (73.90%)	22 (68.80%)	56 (71.80%)	0.618
Female	12 (26.10%)	10 (31.30%)	22 (28.20%)	
Side				
Right	24 (52.17%)	14 (43.75%)	38 (48.72%)	0.464
Left	22 (47.83%)	18 (56.25%)	40 (51.28%)	
Energy of trauma				
Low	34 (73.90%)	25 (78.10%)	59 (75.60%)	0.670
High	12 (26.10%)	7 (21.90%)	19 (24.40%)	
AO/OTA classification				
44B2.1	13 (28.26%)	11 (34.38%)	24 (30.77%)	0.927
44B3.1	8 (17.39%)	6 (18.75%)	14 (17.95%)	
44C1.1	17 (36.39%)	10 (31.25%)	27 (34.62%)	
44C2.1	8 (17.39%)	5 (15.63%)	13 (16.67%)	
Time to operation (days)	2.0 (2.0-3.0)	2.0 (1.0-3.0)	2.0 (2.0-3.0)	0.581
Operation time (minutes)	64.35±3.96	91.25±8.47	75.38±14.68	<0.001
Plate type				
Lateral	28 (60.87%)	21 (65.63%)	49 (62.82%)	0.669
Posterior	18 (39.13%)	11 (34.38%)	29 (37.18%)	
Syndesmotic screw size (mm)	52.5 (50.0-55.0)	50.0 (50.0-55.0)	50.0 (50.0-55.0)	0.792
Union time (weeks)	7.0 (7.0-8.0)	7.0 (7.0-8.0)	7.0 (7.0-8.0)	0.644
Time to remove the syndesmotic screw (weeks)	8.0 (7.0-8.0)	8.0 (7.0-8.0)	8.0 (7.0-8.0)	0.515
Follow-up time (weeks)	66.87±5.58	66.93±6.91	66.90±6.11	0.950

DLR: Deltoid ligament repair, SSF: Syndesmotic screw fixation, AO/OTA: The AO Foundation/Orthopedic Trauma Association, data are given as mean ± standard deviation or median (1st quartile-3rd quartile) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables

(p<0.001, for each). In both groups, the 5th year radiographic score was significantly increased compared to the 1st year (p<0.001, for each).

The summary of patients' measurements with regard to treatment groups is shown in Table 2.

Discussion

Although there have been many innovations in the approach to distal fibula fractures, the debate on ideal treatment method continues. In this study, in which the mid- and long-term results of DLR in addition to SSF in distal fibula fractures were evaluated, it was determined that the radiographic and functional results and quality of life were better in the SSF+DLR group compared to the SSF group. Of note, operation duration was longer in the SSF+DLR group.

Functional recovery after surgery is an important indicator of success and satisfaction. In our study, ankle functions were evaluated with the AOFAS score. Ankle functions worsened significantly in the SSF group at the 5th year compared to the 1st year but improved significantly in the DLR group during the same time interval. In addition, it was similar between the groups at the 1st year but was significantly better in the DLR group compared to the SSF group at the 5th year comparison. Consistent with our study, Gu et al. (5) reported that the AOFAS score was significantly better in DLR recipients among patients treated for ankle fractures. In some other studies, it has been shown that ankle functions improve after DLR in ankle fracture cases (6,7). In contrast, Li et al. (11) reported that postoperative functions were at a similar level between the groups treated with and without DLR application. In various studies supporting this study, it has been shown that ankle functions are not significantly different between the groups with and without DLR (8-10,12,13). However, in our study, it was shown that DLR had positive effects on ankle function, especially in the long term.

One of the most important evaluation methods after fracture surgery is radiographic examination. In this respect, MCS values and radiographic scores of the cases were recorded in our study. In a study similar to ours, in which the results of groups treated for supination external rotation type IV ankle fracture with and without DLR were published, Choi et al. (20) reported that the MCS value decreased significantly in the postoperative period in both

Table 2. Summary of patients' measurements with regard to the treatment groups

	Group		
	SSF (n=46)	**SSF+DLR (n=32)**	**p[a]**
MCS (mm)			
Pre-operative	4.40 (3.80-4.60)[x]	4.40 (3.85-4.55)[x]	0.661
Post-operative	3.70 (3.50-3.90)[y]	2.90 (2.80-3.05)[y]	<0.001
1st year	4.15 (3.80-4.40)[z]	3.00 (2.90-3.15)[y]	<0.001
5th year	4.40 (3.90-4.40)[z]	3.00 (2.85-3.20)[y]	<0.001
p-value[b]	<0.001	<0.001	
SF-36			
1st year	74 (68-78)	78 (78-84)	<0.001
5th year	68 (66-74)	79 (78-84)	<0.001
p-value[b]	<0.001	0.805	
AOFAS			
1st year	76 (74-78)	77 (76-79)	0.316
5th year	66 (64-70)	80 (78-82)	<0.001
p-value[b]	<0.001	<0.001	
Radiographic score			
1st year	2 (1-2)	0 (0-1)	<0.001
5th year	9 (8-12)	2 (2-3)	<0.001
p-value[b]	<0.001	<0.001	

AOFAS: American Orthopedic Foot and Ankle Association, DLR: Deltoid ligament repair, MCS: Medial clear space, SF: Short form, SSF: Syndesmotic screw fixation

[a]: Comparison between groups, [b]: Comparison within groups, [x], [y], [z]: Different letters indicate significant differences between repeated measurements within groups.

Data are given as median (1st quartile-3rd quartile) for continuous variables

groups, but there was no significant difference between the groups. In a study comparing DLR and syndesmotic fixation results of lateral malleolar fractures, Rosa et al. (13) reported that MCS values were similar between the groups at the 24-month follow-up. Similarly, in another study, it was reported that there was no statistically significant difference between the groups in terms of MCS values (14). Unlike these studies, it was shown in two different studies that the postoperative MCS value decreased significantly when compared to the preoperative values in the groups with and without DLR, and also that the decrease in MCS in the DLR group was significantly higher than in the group without DLR (9,10). In our study, the follow-up period of the cases was longer. It was determined that the postoperative MCS value of both groups decreased significantly, but ultimately increased in the group without DLR. While the preoperative MCS was similar between the groups, it was significantly lower in the SSF+DLR group compared to the SSF group at all postoperative follow-up measurements. The permanence of stability in the SSF+DLR group may have been due to the fact that both medial and lateral support were present. In the SSF group, although lateral support is good, medial support is poor. Therefore, even if the postoperative recovery is satisfactory, the stability of the ankle may be reduced in the following time period due to insufficient medial support. Eventually, MCS value may increase, and the functional and radiographic outcomes may deteriorate.

In various studies examining different radiographic features, it has been shown that the radiographic results of cases with and without DLR are similar (10,15). There are also studies reporting that DLR improves radiographic results (7). To the best of our knowledge, this is the first study evaluating these effects of DLR with long-term follow-up. Accordingly, the osteoarthritis scores of the DLR cases were better at both the 1st and 5th year follow-ups. The reasons for better radiographic results in the SSF+DLR group may be the associated with the presence of relatively smoother joint line and better support of the ankle after DLR.

The contribution of surgery to the well-being of the cases will also increase the quality of life. This is one of the main goals of the surgery. In two different studies, the quality of life of patients with and without DLR was examined and it was reported that the postoperative quality of life was similar between those with and without DLR (8,13). In studies evaluating the quality of life of patients who underwent DLR alone, it was shown that the quality of life after DLR increased significantly (6,7). In our study, when compared to the SSF group, the quality of life of the SSF+DLR group at the 1st and 5th years was significantly better. In addition, it was determined that the quality of life at the 5th year had significantly decreased in the SSF group compared to the 1st year. Quality of life can be affected by many variables. If we interpret the difference in the quality of life found in our study within the scope of ankle surgery, it can be said that better radiographic and functional results after DLR may have been associated with the increased quality of life in patients.

The most important strength of our study is that it is the first study in which the mid- and long-term effects of DLR+SSF surgery were evaluated comprehensively -with respect to functional and radiographic results and quality of life- in patients with distal fibula fractures. In addition, to our knowledge, there are no previous studies that have examined the effects of additional DLR application on osteoarthritis findings in long-term follow-up. We believe the comprehensive analysis of patients and the long-term follow-up of patients are important highlights of our study.

Study Limitations

The facts that the study design is retrospective and it is a single-center study are important limitations. Muscle-strengthening exercises, nutritional status, body mass index, physical activity level, ankle protective behaviors, and complication development status were not examined. Different distribution of such variables among groups may have affected the results. The scores and some measurements of the cases were not evaluated in the preoperative and early postoperative periods, except for MCS. Therefore, it could not be interpreted whether the differences in scores (AOFAS, SF-36, and radiographic scores) that were present at the postoperative comparisons existed before the surgery, but considering the similarities between the groups, it is feasible to assume that the distribution of these scores before the operation was similar between the groups.

Conclusion

In this study, when compared to syndesmotic fixation in distal fibula fractures, it was found that performing DLR in addition to syndesmotic fixation (despite longer operation duration) is superior in terms of radiographic results, functional results, and quality of life in both the mid and long term. In addition, while results appeared to be worsening at long-term assessment in the SSF group, the positive results were persistent in the SSF+DLR group. Performing DLR in

appropriate cases in distal fibula fractures may contribute to better clinical outcomes in the mid-long term. These inferences can be supported by more comprehensive and prospective future studies.

Ethics

Ethics Committee Approval: All procedures performed in the study involving human participants 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. The ethical approval was obtained from Maltepe University Faculty of Medicine Ethics Committee (no: 2021/900/41).

Informed Consent: Written informed consent was obtained from all participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: M.Z.D., Ö.K.Ü., Design: M.Z.D., Ö.K.Ü., Data Collection or Processing: M.Z.D., Analysis or Interpretation: M.Z.D., Ö.K.Ü., Literature Search: M.Z.D., Ö.K.Ü., Writing: M.Z.D.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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