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ORIGINAL ARTICLE

Comparison of Sinus Tarsi and Extensile Lateral Approach in Intra-articular Calcaneus Fractures

Eklem İçi Kalkaneus Kırıklarında Sinüs Tarsi ve Ekstensil Lateral Yaklaşımın Karşılaştırılması

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ABSTRACT

Objective: In this study, we aimed to compare the clinical and radiological results of the extensile lateral (EL) approach and sinus tarsi (ST) approach in calcaneal fracture surgery.
Materyal-Metod: A total of 40 patients with Sanders II-III calcaneal fractures, including 22 patients in the EL group and 18 patients in the ST group, were included in this retrospective study. In the radiological evaluation, changes in the calcaneus Bohler and Gissane angle, length, width, and height were measured during the preoperative and postoperative period. Clinically, American Orthopedic Foot and Ankle Society (AOFAS) and the visual analog scale (VAS) were evaluated. In addition, postoperative complications were also evaluated.
Results: In terms of demographic data, the results of both groups were similar. Both the length of hospital stay and the time to surgery were shorter in the ST group (p=0.019, p=0.02, respectively). There was no significant difference between the groups regarding radiological, clinical AOFAS and VAS scores. 13.6% superficial infection was seen in the EL group, and no wound problems were encountered in the ST group (p=0.102). The rate of sural nerve injury was 36.4% in the EL group and 5.6% in the ST group (p =0.003).
Conclusion: Both approaches clinical and radiological outcomes were similar. However, the advantages of the ST approach were shorter hospital stays, lower rate wound infections, and sural nerve injury problems.

Keywords: Calcaneus fracture, extensile lateral, sinus tarsi, minimally invasive

ÖZ

Amaç: Bu çalışmada kalkaneus kırığı cerrahisinde ekstansil lateral (EL) yaklaşım ile sinüs tarsi (ST) yaklaşımının klinik ve radyolojik sonuçlarını karşılaştırmayı amaçladık.
Gereç ve yöntem: Bu retrospektif çalışmaya, EL grupta 22 hasta ve sinüs tarsi grubunda 18 hasta olmak üzere Sanders II-III kalkaneus kırığı olan toplam 40 hasta dahil edildi. Radyolojik değerlendirmede, preoperative ve postoperative dönemde Bohler ve Gissane açısı, kalkaneusun uzunluğu, genişliği ve yüksekliğindeki değişiklikler ölçüldü. Klinik olarak ise Amerikan Ortopedik Ayak ve Ayak Bileği Derneği (AOFAS) ve görsel analog skalası (VAS) değerlendirildi. Ayrıca postoperative komplikasyonlar da değerlendirildi.
Bulgular: Demografik veriler açısından her iki grubun sonuçları benzerdi. ST grubundaki hastaların lateral ekstensil grubuna göre ameliyata alınma ve hastane kalış süresi açısından istatistiksel olarak anlamlı bir şekilde daha kısaydı (p=0.019, p=0.02, sırasıyla). Gruplar arasında radyolojik, klinik AOFAS ve VAS skorları açısından anlamlı fark bulunmadı. Ekstensile lateral grubunda %13,6 yüzeyel enfeksiyon görüldü ve sinüs tarsi grubunda herhangi bir yara sorununa rastlanmadı (p=0,102). Sural sinir yaralanması extensil lateral grupta 36.4% oranında, sinüs tarsi grubunda ise 5.6% oranında görüldü (p=0.003).
Sonuç: Her iki yaklaşımın klinik ve radyolojik sonuçları benzerdi. Ancak hastanede kısa yatış süresi, yara yeri enfeksiyon problemlerinin ve sural sinir yaralanmasının az olması ST yaklaşımının avantajıydı.

Anahtar kelimeler: Kalkaneus kırığı, ekstensil lateral, sinus tarsi, minival invaziv

Introduction

Calcaneus fractures constitute a significant portion of lower extremity fractures, and most of them are intra-articular fractures (1). Intra-articular calcaneal fractures are not just a subtalar joint problem. At the same time, the loss of height in the calcaneus affects the talus and impairs the biomechanics of the talonavicular and ankle joints. In order to reconstruct the foot biomechanics, the calcaneal articular surface, calcaneus width, length and height must be restored (2,3).

Intra-articular fractures of the calcaneus are treated conservatively and surgically but debate remains about the ideal treatment. Some authors emphasize conservative treatment due to wound site problems and infection development in surgically treated calcaneal fractures (4,5). However, long-term immobilization and the possibility of developing early subtalar arthritis stand out as disadvantages of conservative treatment (6). In recent years, the tendency for surgery has increased to prevent intra-articular displacement and reduce the possibility of developing arthrosis (7-10).

Different open surgical techniques have been described for calcaneus fractures, with the EL approach being the most commonly used technique (7,11). An important advantage of this approach is the wide surgical approach of view, facilitating direct reduction of the articular surface and the lateral calcaneal wall. However, wound site problems have

been reported with an average rate of 14-18% in patients operated with this approach (12,13). Various minimally invasive techniques, including mini-incision technique, percutaneous fixation, and arthroscopic assisted fixation, have been reported to reduce the risk of complications (8,14). With the ST approach, one of these techniques, in addition to providing joint restoration by directly seeing the subtalar joint, a rigid fracture fixation can be provided without causing soft tissue damage (15). In recent years, comparative studies have become popular with the application of the ST approach in calcaneal fracture surgery (6,8,16).

It is aimed to compare the results of the recently popular ST approach and the classical EL approach in calcaneus fractures.

Material and Methods

Our study evaluated 65 patients who were opereted for calcaneal fractures in our center between May 2018 and March 2022.

Study,Van Yuzuncu Yıl University Non-invasive Ethics committee approval numbered 2022/04-14 was obtained by the ethics committee. Patients aged 18-65 years who were operated on for calcaneal fracture in our clinic and who had Sanders type II and III fractures detected with preoperative computed tomography (CT) were included. Talus, navicular, etc., accompanying the calcaneal fractures and those with a history of bilateral calcaneal fractures, patients treated for osteoporosis and rheumatic disease were excluded. Forty patients (22 EL, 18 ST) were included in the study. Data such as age, gender, smoking, diabetes history, side of injury, time to surgery, length of hospital stay, and follow-up time were collected for all patients.

Surgical Technique

Sinus tarsi approach

Surgery was performed with tourniquet in the lateral decubitus position. A 3-5 cm oblique incision was made, extending from 1 cm posterior to the lateral malleolus to the metatarsals. After the sural nerve and peroneal tendons were preserved, the calcaneofibular ligament was dissected and the posterior facet, anterior process and calcaneocuboid joint were visualized. In order to correct the calcaneus length, height, and varus deformity, a kirschner (K) wire was inserted retrograde from the calcaneal tubercle. Then, after the reduction of the posterior facet fracture, a fixation was provided with one screw. The other fracture fragments were reduced and they were fixed with temporary K wires. One or two cannulated screws were inserted percutaneously from the posterior to the anterior aspect of the calcaneus. For patients with insufficient posterior facet support, additional fixation was performed with a small-sized plate. Fluoroscopy was used for all procedures. After providing rigid fixation, the incision site was closed with sutures. The drain was not used (Figure 1).

Figure 1: A) Preoperative lateral view of the intra-articular calcaneal fracture in which the posterior facet collapsed. **B)** Intraoperative view of the surgery with the ST approach **C,D)** postoperative radiological images

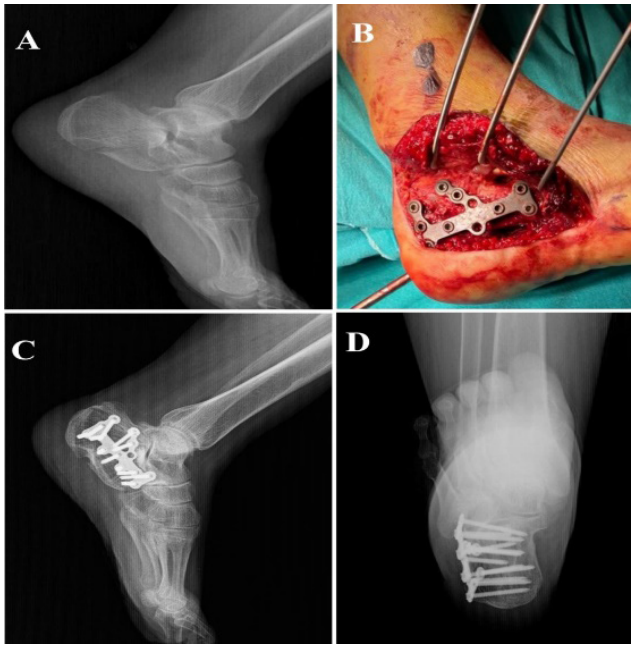

Figure 2: A) Preoperative lateral view of the intra-articular calcaneal fracture in which the posterior facet collapsed. **B)** Intraoperative view of the surgery with the EL approach **C,D)** postoperative radiological images

Lateral Extensile Approach

Surgery was performed with tourniquet in the lateral decubitus position. For the EL approach, an L-shaped incision was made extending from the 5 cm proximal

posterior of the lateral malleolus to the fifth metatarsal. After the full-thickness flap was seperated from the bone, it was temporarily fixed with K-wires. Articular surface was restored, all fragments were reduced and checked with fluoroscopy. Fracture fixation of the calcaneus was performed with an anatomical locking plate. After controlling the bleeding, a hemovac drain was placed.

Bone grafting was not required in both approach. All procedures were performed by 2 surgeons with at least 5 years of experience. The patients in both groups were followed for two or three weeks in a short leg splint, active movement was initiated when the wound healed. Weight-bearing was allowed at 10 to 12 weeks. Lateral and axial radiographic images were taken to evaluate the calcaneal fracture preoperatively. Computed tomography was taken to confirm the Sanders (11) classification, which evaluated the intra-articular condition of the fracture before surgery. In addition to the Bohler and Gissane angle, the height, length and width of the calcaneus were also evaluated radiologically (17).

The American Orthopedic Foot and Ankle Association ankle-posterior foot score was used to evaluate the function in the postoperative period (15). A visual analog score was used to evaluate pre-and postoperative pain scores. The pain score consists of a scale ranging from 0 (no pain) to 10 (unbearable pain) (18).

In the postoperative period, wound complications, deep infection, sural nerve injury, nonunion, revision surgery, and subtalar arthritis were evaluated.

Statistical analysis

The study's sample size was calculated using the G*Power statistical program (ver.3.1.9.7). Accordingly, the sample size was determined as 40 samples in two groups, with a Power (test power) of 0.90, an effect size of 0.9, and a Type-1 error (α) of 0.05. Descriptive statistics for variables; expressed as mean (mean ± standard deviation), median (min-max), number (n), and percent (%). Shapiro-Wilk (n<50) and Skewness-Kurtosis tests were used to ensure that the continuous measurements in the study conformed to the normal distribution. For normally distributed measurements, the Independent T-test was used to compare continuous measurements Mann-Whitney U test was used for non-normally distributed measurements. Chi- square test and Binary Z-ratio test were used to determine the relationships between categorical variables. The statistical significance level was taken as 5% in the study and SPSS (IBM SPSS for Windows, ver.26) program was used for analysis.

Results

Eighteen patients were operated on with the ST approach and 22 with the EL approach. The EL group consisted of 17 men (77.3%) and five women (22.7%) with a mean age of 40.6±13.7 years. There were 15 men (83.3%) and 3 (16.7%) women in the ST group with a mean age of 38.9±12.9 years. The results of the two groups were similar in terms of age and gender. (p=0.698, p= 0.634, respectively). According to the Sanders classification, seven patients (31.8%) had type II fractures and 15 weeks (68.2%) type III fractures in the EL group. In the ST group, type II fractures were observed in 9 patients (50%), and type III fractures were observed in 9 patients. There was no significant difference between the two groups regarding Sanders fracture classification (p=0.243). In addition, there was no statistically significant difference between the two groups in terms of extremity sides, follow-up time, and presence of diabetes mellitus (p=0.822, p= 0.597, p=0.083, respectively). The mean time to surgery was 6.1±4.3 days in the ST group and 11.1±6.6 days in the EL group. Regarding time to surgery and hospital stay, patients in the ST group had significantly shorter periods than the EL group (p=0.019, p=0.02, respectively). In addition, the extensil lateral group was significantly higher than the ST group in terms of smoking (p=0.013).

Table.1: Demographic data of the patients.

n		EL group		ST group		*p.
		%	n	%		
Sex male/ female	E	17	77.3%	15	83.3%	0.634
	K	5	22.7%	3	16.7%	
Sanders classification	II	7	31.8%	9	50.0%	0.243
	III	15	68.2%	9	50.0%	
Side of injury	Right	9	40.9%	8	44.4%	0.822
	Left	13	59.1%	10	55.6%	
Tobacco		8	36.4%	6	33.3%	***0.013***
DM		1	4.5%	0	0.0%	0.083
		Mean ± SD		Mean ± SD		**p.
Age, years		40.6 ± 3.7		38.9 ± 2.9		0.698
Follow-up duration, months		25.4 ± 3.6		23.0 ± 1.1		0.597
Time to surgery, days		11.1 ± 6.6		6.1 ± 4.3		***0.019***
Length of stay in hospital, days		13.4 ± 5.4		9.0 ± 4.5		***0.021***

SD: Standard deviation, **DM:** Diabetes mellitus; *Chi-square test **Independent T-test.

A satisfactory postoperative fracture reduction was achieved in both groups compared to preoperatively. There was no significant difference between the groups in the radiological evaluation (Table 2).

In both groups, the postoperative VAS scores at the last follow-up were statistically significantly lower than those during the preoperative period (P=0.001, P=0.001, respectively). There was no statistically significant difference between the groups in terms of preoperative and postoperative VAS scores (P=0.268, P=0.299, respectively). Although the AOFAS clinical

Table 2: Preoperative and postoperative X-ray measurements of the EL and ST groups

		EL group	ST group	
		Mean±SD Median (min-max)	Mean±SD Median (min-max)	*p.
Bohler angle preoperative		8.0 (2-26)	7.5 (3-28)	*0.742*
Bohler angle postoperative		22.9±10.0	26.1±9.8	*0.428*
	**p.	***0.001***	***0.001***	
Gıssane angle preoperative		104.6±22.4	113.8±11.9	*0.243*
Gıssane angle postoperative		117.4±9.5	120.9±9.1	*0.353*
	**p.	*0.059*	*0.243*	
Length preoperative		76.9±5.1	74.6±7.3	*0.370*
Length postoperative		81.5±5.5	79.1±6.9	*0.395*
	**p.	***0.005***	*0.176*	
Width preoperative		48.5±6.0	48.4±7.8	*0.973*
Width postoperative		43.0±8.6	42.0±6.0	*0.783*
	**p.	***0.011***	***0.009***	
Height preoperative		44.8±6.3	45.7±9.8	*0.791*
Height postoperative		51.9±4.9	46.9±9.7	*0.101*
	**p.	***0.002***	*0.736*	

SD: Standart deviation;, ***** Independant T-test / Mann- Whitney U test ****** Dependent (paired) T-test

score of the ST group was slightly higher than the EL group (p=0.585) (Table 3).

Table 3: Functional evaluation results of the EL and ST groups.

	EL group	ST group	
	Median (min-max)	Median (min-max)	*p.
VAS preoperative	8.0 (6-10)	9.0 (8-10)	*0.268*
VAS postoperative	5.0 (2-8)	3.5 (3-5)	*0.299*
***p.**	***0.001***	***0.001***	
AOFAS score	64.5 (27-100)	84.5 (26-88)	*0.585*

***** *Independant T-test/ Mann- Whitney U test*

Table 4: Postoperative complications

n	EL group		ST group		
	%	n	%	*p.	
Superficial infection	3	13.6%	0	0.0%	*0.102*
Deep infection	0	0.0%	0	0.0%	
Sural nerve injury	8	36.4%	1	5.6%	***0.003***
Nonunion	0	0.0%	0	0.0%	
Revision surgery	0	0.0%	0	0.0%	
Subtalar arthritis	6	27.3%	4	22.2%	*0.656*

*Binary Z-ratio test

Superficial infection was observed in 3 cases in the EL group (13.6%), and no wound site problems were encountered in the ST group. Sural nerve injury was seen in 8 cases (36.4%) in the EL group and 1 case (5.6%) in the ST group (p=0.003). Sural nerve injury was not observed visually in any of the cases during the operations. The diagnosis was made by sensory examination performed in the postoperative period. There was no case of nonunion or revision in both groups. Subtalar arthritis was observed in 6 cases (27.3%) in the EL group and 4 cases (22.2%) in the ST group on the last follow-up radiographs (p=0.656) (Table 4).

Discussion

Our study aimed to retrospectively compare the results of intra-articular calcaneal fractures in a group of patients treated with ST or EL approach. Our results showed that the reduction quality, stability of internal fixation, and functional results were similar in both surgical approaches. There were more wound complications in the EL group, but there was no statistically significant difference. The sural nerve injury was significantly higher in the EL group. The hospital discharge time was shorter in the ST group. In addition, the time to surgery after injury was shorter in the ST group.

It has been reported that adequate radiological improvement was achieved with the EL and ST approach in the surgery of calcaneus fractures, and the postoperative VAS score and AOFAS clinical results were also good. It has been shown that these two approaches are not superior to each other in terms of radiological and clinical results (8,16,17,19). In our

study, it was observed that radiological improvement was sufficient in both EL and ST groups, but there was no statistically significant difference between them. There was a similar significant improvement in VAS scores in both groups in the postoperative period. The AOFAS clinical scores of the ST group were slightly higher than the EL group, although it was not statistically significant. According to the results of our study, radiological and clinical similar results were obtained in both surgical approaches.

A literature review examining calcaneus fractures report that there are generally more wound site problems in patient groups operated with the EL approach compared to the ST approach. Ma et al. (15) found the complication rate related to wound healing to be 14.75% in the EL approach and 5.36% in the ST approach, and they reported that the difference was statistically significant. Lin et al. (20) found that the wound infection rate was higher in Sanders type IV fractures, which were 34.04% in the EL approach and 14.28% in the ST approach. In another study comparing both methods, the infection rate was 13.3% in the EL approach and 5% in the ST approach (8). In our study, the infection rate was 13.6% in the EL approach. No wound site problem was observed in the ST approach.

One of the critical complications in calcaneus fracture surgery is sural nerve injury. Weber et al. (21) reported the rate of sural nerve injury as 7.7% in their patients treated with the EL approach. Yeo et al.(8) reported sural nerve injury at a rate of 6.6% in the EL group and 5% in the ST group in their comparative study. A study on Sanders type IV fractures observed 14.89% sural nerve injury in the EL group. It was not seen in the ST group (20). In a cadaveric study, it was reported that sural nerve injury developed in the ST approach at a relatively lower rate compared to the EL approach, but the approach should be modified to minimize this complication (22). In our study, complications related to the sural nerve were reported at a higher rate (36.4%) in the EL group than in the literature. In the ST group, it was seen with a rate of 5.6%. The difference was statistically significant.

One of the complications after intra-articular calcaneal fracture surgery is subtalar arthritis seen during follow-up. Despite the anatomic reconstruction, many patients treated with open reduction and internal fixation progress to painful posttraumatic subtalar arthritis and required subtalar fusion in the late stage (23). Problems related to the subtalar joint have been reported, especially in publications on the EL approach (24). In a large-series study with a mean follow-up of 91 months, the rate of subtalar arthritis was found to be 77%, and it was reported that fusion was required in 18% of them (25). Lin et al.(20) found subtalar arthritis with a rate of 31.43% in the ST group and 27.66% in the EL group in Sanders type IV fractures. In our study, subtalar arthritis findings were observed in 27.3% of the EL group and 22.2% of the ST group. The difference was not statistically significant. Most of our patients did not have enough clinical findings to require fusion.

In the EL approach, it is necessary to wait for the foot edema to regress and skin lines to appear to avoid complications related to the surgical area. In the ST approach, surgery can be performed without waiting, even when there are blisters on the skin. It may enable the patient to undergo surgery earlier. However, Shuler et al. (26) showed that the longer the time between injury and surgery, the higher the wound healing complications. On the other hand, Kwon et al. (27) found that postponing surgery did not reduce the wound complication rates when the EL approach was used, while the wound complication rate increased when minimally invasive approaches were used. Ma et al. (15) reported that the patients in the ST group had a significantly shorter waiting time from injury to surgery than the EL group and that the wound site problem was less in the ST group. They stated that this resulted in a shorter hospital stay and lower costs in the ST group. Patients in the ST group were discharged from the hospital earlier than the EL group, and this time was significantly shorter.

Our study has some limitations: The most important of these can be considered operations by more than one surgeon. Another significant limitation is the small number of patients and the retrospective study. The strength of our study is the patient population with similar age and gender groups, follow-up periods.

Conclusion

Many methods have been described in the literature for the surgery of intra-articular calcaneal fractures. It was observed that the clinical and radiological results of the minimally invasive ST approach, which has become popular recently, and the EL approach was similar. However, the advantages of the ST approach were short hospital stays, lower rate wound infection problems, and sural nerve injury. Furter studies are recommended large series and prospective studies for both approaches.

Conflict of Interest: The authors declare no conflict of interest.

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