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ARAŞTIRMA / RESEARCH

The necessity of bone grafting in the surgical treatment of severely comminuted calcaneus fractures

Çok parçalı kalkaneus kırıkların cerrahi tedavisinde kemik greftlemenin gerekliliği

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Abstract

Purpose: The aim of this study was to evaluate the effect of grafting on postoperative radiological and clinical outcomes and complications of intra-articular calcaneal fractures treated with open reduction internal fixation.

Materials and Methods: Two groups as allograft used [Group 1 (n = 21)] and non-grafted [Group 2 (n = 31)] were compared for American Orthopedic Foot and Ankle Score (AOFAS), Bohler's angles, calcaneal heights, subtalar arthrosis, Sudeck's atrophy and infection rates.

Results: There were no statistically significant differences between the two groups in terms of last AOFAS, postoperative and last Bohler's angles and calcaneal heights. Although a statistically significant difference was not observed between the two groups for subtalar arthrosis and Sudeck's atrophy, there was a significant difference in infection rate.

Conclusion: In calcaneal fractures, the space which is created after anatomic reduction and fixation will be filled with new callus tissue thanks to the spongious nature of calcaneus, and there is no need for additional grafting.

Keywords: Calcaneal fractures, allograft, Bohler's angle

Öz

Amaç: Bu çalışmada açık redüksiyon internal fiksasyon ile tedavi edilen eklem içi kalkaneus kırıklarında greftlemenin ameliyat sonrası radyolojik ve klinik sonuçlara katkısını ve olası komplikasyonlara etkisi araştırılmıştır.

Gereç ve Yöntem: Greftleme yapılanlar [Grup 1 (n:21)] ve greftleme yapılmayanlar [Grup 2 (n:31)] hastalar klinik olarak Amerikan Ortopedik Ayak ve Bilek Skoru (AOFAS), radyolojik olarak Böhler açıları ve kalkaneal yükseklikleri komplikasyon olarak subtalar artroz, Sudeck atrofisi ve enfeksiyon oranları karşılaştırıldı.

Bulgular: Her iki grup arasında kontrol AOFAS, ameliyat sonrası ve kontrol böhler açıları ve kalkaneal yükseklikleri açısından istatistiksel olarak fark gözlenmedi. Komplikasyon olarak subtalar artroz ve Sudeck atrofisi açısından istatistiksel bir fark gözlenmez iken enfeksiyon oranında anlamlı fark gözlendi. Kalkaneus kırıklarında redüksiyon sonrası posterior faset altında oluşan boşluğun greftlenmesinin klinik ve radyolojik iyileşmeye katkısı tartışmalıdır. Çalışmamızda klinik ve radyolojik iyileşmeye greflemenin ek katkısı olmadığını bulduk.

Sonuç: Spongiyoz ve iyi kanlanan bir kemik olan kalkaneusun iyi bir redüksiyon ve tespit ardından oluşan boşluğu yeni kallus dokusu ile dolmaktadır ve ek olarak greftlemeye gerek yoktur.

Anahtar kelimeler: Kalkaneus kırıkları, allogreft, Böhler açısı

INTRODUCTION

The most common tarsal bone fracture is calcaneus fracture and accounts for about 2% of all fractures. Of them, 70-75% of calcaneus fractures are intra-articular fractures[1,2]. Intraarticular fractures are caused by axial overweighing due to high-energy trauma such as falling on the heel or internal car accidents[3]. The main purpose of the treatment is

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complete reconstruction of the three-dimensional calcaneus anatomy and restoration of the subtalar joints[4]. The most successful treatment method for this purpose is open reduction and plate osteosynthesis[5].

In Sanders type 3 and 4 calcaneus fractures a gap is formed under the subtalar joint after posterior facet reduction due to the collapse of the spongious bone in this region. This gap is trying to be filled with grafting methods. Grafting after calcaneus fractures was first used 90 years ago and is still in use. Autogenous or allogenic spongious bone grafts and polymethylmethacrylate (PMMA) are the primary materials that are used to fill the gap created. Grafting the gap under the posterior facet after calcaneus fractures can provide faster bone healing as well early weight-bearing as. The graft prevents the development of subtalar arthrosis by preventing the collapse of the calcaneus posterior facet[6,7]. There are contary reports with good results without grafting in Sanders type 3 and 4 calcaneus fractures[4,8]. In these studies, authors advocated that there is no definite need for grafting, and that radiographic ossification occurs within 4-8 weeks, even if grafting is not performed in fractures of calcaneus which is almost spongious and has good blood circulated bone[9,10]. Publications reporting the negative aspects of grafting are also available in the literature. Bone grafts have been shown to increase rates of infection, the interval of post-operative hospitalization, and pain[9,10]. In addition to the current trauma of the patient, donor site problems can also occur in autograft used patients. However, the contribution of grafting to clinical and radiological results for calcaneus fractures is still controversial. The purpose of our study is to compare the complication rates, radiological and clinical outcomes of patients with displaced intra-articular calcaneus fractures, treated with open reduction internal fixation with grafting or without grafting.

MATERIALS AND METHODS

This study is approved by S.B.U. Kecioren SUAM TUEK with 43278876-929-43-838 numbered decision. This retrospective cohort study evaluated patients operated for displaced intra-articular calcaneus fractures. Between July 2010 and April 2016, 56 patients with displaced intra-articular calcaneus fractures were operated in our clinic.

Of them, 52 patients having full charts and x-rays were included in the study. One patient with open fracture and three patients with mini-open fixation excluded from the study. Inclusion criteria were having Sanders type 3 or type 4 calcaneus fractures, preoperative Bohler's angles less than 20°, at least 2 mm stepping in posterior facets, at least 1 year follow-up, and older than 18 years of age. The demographic data of the patients are presented in Table 1.

Table 1. Demographic data of patients

	Group 1	Group 2	Total (n/%)
Patients	21	31	52
Age	48.9 (27-71)	44.2 (21-68)	46.9 (21-71)
Gender			
Male	15	24	39 (%75)
Female	6	7	13 (%25)
Sanders			
Type 3	13	23	36 (%70)
Type 4	8	8	16 (%30)
BMI	30.6 (24-38)	29.4 (23-37)	30.2 (23-38)

BMI: Body mass index

Surgery

All patients included in the study were operated on average 8th day (4-14 day interval) after injury when soft tissue edema was decreased and wrinkle mark in the hindfoot soft tissue became positive. All of the operations were performed under spinal anesthesia while the patient was in the lateral decubitus position. Open reduction and plate-screw osteosynthesis were applied by the classic L incision approach (Figure 1). In the grafted group, human-induced allograft was applied to the void formed in the spongiosal part of the calcaneus under the posterior facet.

Postoperative period

Patients were followed for 14 days with short leg splint. After the sutures were removed, all patients begin early active and passive ankle ROM excersises. They were allowed partial loading of the effected foot at the end of second month. Full weight bearing was advised in third month.

Functional and radiological evaluation

Functional outcomes were assessed with the American Orthopedic Foot and Ankle Score (AOFAS). Bohler's angles and calcaneal heights were measured on the last graphs of the patients (Figures. 2 and 3).The contribution of the graft to the calcaneal height was measured with preoperative and postoperative radiographs. The permanency of the contribution of the graft to the calcaneal height was

evaluated by comparing the changes in the calcaneal height and the angle of the Bohler's in the radiographs taken at 3 and 12 months postoperatively.

Complication

Subtalar arthrosis, Sudeck's atrophy and infection status and soft tissue lesions were noted. Sudeck's atrophy and subtalar artrosis was diagnosed with clinical and radiologic evaluation. Infection was diagnosed when purulent discharge, redness and swelling of the wound existed and infection blood parameters (CRP and sedimentation rate) was increased. The patients, who have only wounds with redness and swelling not discharge, was evaluated as superficial mild infection. All of them were given oral antibiotic therapy and there was no infection at any of them at the end of the therapy.

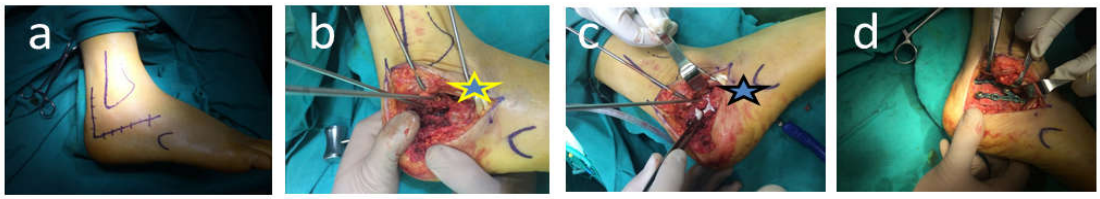

Figure 1. Surgery and grafting; a:incision, b: reduction of the subtalar joint, c: grafting d: plating.

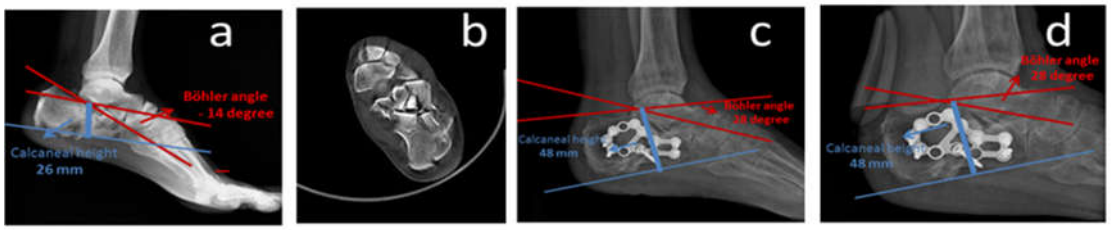

Figure 2.Grafting; a: preoperative x-ray, b: preoperative CT, c: 3th month x-ray, d: 12th month x-ray.

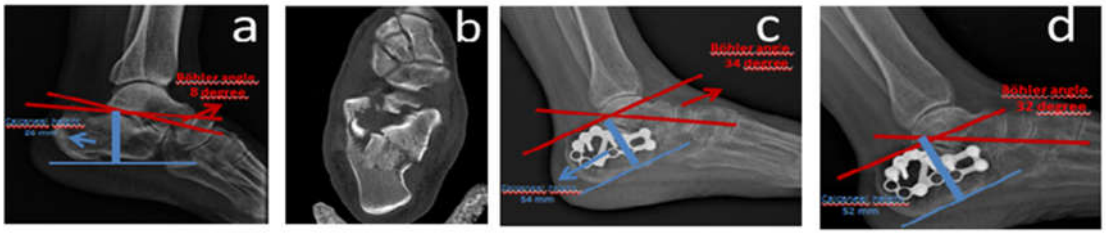

Figure 3. Non-grafting; a: preoperative graph, b: preoperative CT, c: 3th month x-ray, d: 12th month x-ray

Statistical analysis

SPSS V.13 (Inc. USA) program was used for statistical evaluation. Parametric values were checked by Shapiro-wilk test. After the control, nonparametric Mann-Whitney U test or Fisher test was used for comparation. Both two groups were compared in terms of age, sex, Sander's classification, bone union time, length of stay in hospital, wound complications, AOFAS values and criteria for nonunıon. A $p < 0.05$ was considered statistically significant.

RESULTS

Comparison of data obtained in patients' follow-up are shown in Table 2. The grafting group was included (Group 1) 21 patients while without grafting group (Group 2) included 31 patients. The mean follow-up was 16 months (range, 12-14 s). The mean age of the patients was 46.9 (range, 21-71) years. Of them, 39 were male and 13 were female (M/F: 3/1). Twenty-four of the fractures were in the right foot (46%), 23 were in the left foot (44%), and 5 were bilateral (10%). In 48 of the patients, the injury mechanism was falling from higher ground (92%) while in 4 patients it was traffic accident (8%). Three of the patients had additional injuries (2 vertebral fractures, 1 tibial plateau fracture and pneumothorax).

Table 2. Comparison of data of patients' follow-up

	Group 1	Group 2	p
Waiting time before surgery (days)	7.8 (5-11)	8.1 (4-14)	
Average follow-up time (months)	16.4 (12-24)	15.3 (12-24)	
Nonunion	0	0	
Arthrosis	1 (%1)	2 (%6.2)	0.556
Infection	2 (%9.9)	1 (%3.3)	0.012
AOFAS	80.2 (72-89)	78.6 (67-89)	0.218
Sudeck's atrophy	3 (%14)	5 (%16)	0.456

*AOFAS:American Orthopedic Foot and Ankle Score

The mean AOFAS values in the last controls of both groups were 80.2 (72-89) and 78.6 (67-89) in the grafted and ungrafted groups, respectively (p=0.218). As a result of this data, it was seen that grafting did not contribute significantly to AOFAS scores.

Between Group 1 and Group 2, the mean increase in Bohler's angles were 19.5° and 17.7 °, respectively. Between postoperative and first year controls, the mean Bohler's angle loss were 1.5° and 0.9° in group 1 and group 2, respectively (Fig. 4). There was no difference between the groups in the reduction of Bohler's angle in the follow-ups (p = 0.458). In terms of Bohler's angles, grafting did not make a statistically significant difference but it was seen to contribute to reduction during surgery (p = 0.541).

The overall refinement of calcaneal heights were13.2 mm and 12.6 mm in Group 1 and Group 2, respectively. The calcaneal height loss measured in the postoperative and first year controls were 1.3 mm and 1.1 mm in Group 1 and Group 2, respectively (Fig. 5). There was no effect of grafting on the increase in calcaneal height between the groups (p = 0,728). Likewise, there was no contribution in terms of height loss changes measured at follow-ups (p = 0.603)

Figure 4. Comparison of Bohler's angles

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Figure 5. Comparison of calcaneal height measurements

Infection was seen in 2 of the grafted patients and 1 in the patients who were not grafted. In infected patients implant extraction and debridement was delayed until union. The purulent discharge disappeared after 2 weeks of parenteral and 4 weeks of oral antibiotic use in these patients.

Statistically, there was no difference between the two groups in terms of nonunion rates, arthrosis, AOFAS and Sudeck's atrophy (p>.05). Subtalar arthrosis was observed in 3 patients and arthodesis was not needed for any patients. Sudeck atrophy was observed in 8 patients (15,2%), these patients were prescribed Vitamin-C and recommended physical therapy program.

DISCUSSION

In the treatment of displaced intra-articular calcaneal fractures, the aims should be anatomical reduction of the subtalar joint and providing of calcaneal height[4]. Open reduction and plate screw fixation is recommended for this purpose. After posterior facet reduction is achieved during surgery, a gap is formed under the posterior of subtalar joint due to spongious bone collapse. Surgeons who used bone grafts to fill this space found results supporting early loading and recovery in their studies[6,7]. On the other hand, surgeons who performed plate screw fixation after open reduction without filling the spongious bone space also achieved good results in their studies[4,8]. In our study, patients' postoperative and two-year follow-up charts were retrospectively reviewed, and the loss of Bohler's angle and clinical outcomes were compared between the two groups. There was no difference statistically between the two groups in terms of the clinical scoring applied to the patients' follow-up and the findings of union in the radiographs. In our study, we reached the conclusion that allograft and grafts had no effect on the radiological and clinical results in follow-up, and no affect on the restoration of the Bohler's angle during surgery.

Letournel et al. reported that the posterior reduction plate screw support the joint well enough and that grafting of the gap is unnecessary[13]. Lowery et al. have thoroughly reviewed treatment methods applied to calcaneus fractures and reported that it is unnecessary to try to fill the gap created due to high vascular supply of calcaneus[14]. Similar to our study, in addition to locked plate osteosynthesis, Longino et al. did not find a significant difference between the two groups[15]. Huang et al. did not use bone grafts in addition to open reduction and osteosynthesis for filling the space and showed no late collapse[12]. They also emphasized that patients should be followed closely for at least 10 weeks to avoid the possibility of collapse in the joint. In their extensive studies in 2012, Yunfeng Yang et al. found that grafting did not contribute to the clinical outcome but radiologically contributed to the postoperative improvement of the Bohler's angle[16]. Although similar clinical outcomes have been reported in studies using autografts, the Bohler's angle was better provided in these studies and loss of reduction in follow-ups was less[17,18].

In some studies in the literature, high infection rates have been reported for intra-articular calcaneal fractures treated with bone grafts[11,12]. Similarly, in our study, we found that the rates of infection in patients treated with allograft bone graft were significantly different from that of the non-grafted patient group. Although infection rates in our study were significantly lower in both groups, there was significantly more infections in allograft patients. However, the use of allografts prevents donor site morbidity, which can occur in patients due to autografting.

The most important shortcoming of our study is the lack of objective reasons for whether or not patient grafting will be performed because retrospective nature of this study. However, this limitation may be overlooked because there is no difference between preoperative and postoperative Bohler's angles between the grafted and non-grafted groups of patients; they're being the same types of fractures. Another limitation of our work may be the small number of patients.

In conclusion, the most important targets in the treatment of intra-articular calcaneal fractures are subtalar joint reduction and adequate increase in Bohler's angle. That is why the calcaneus, a spongious and highly vascularised bone, can be filled with new callus tissue after a good reduction and fixation in the calcaneus fractures where the subtalar joint is collapsed. Therefore grafting may not be necessary for achieving this reduction, for increasing the Bohler's angle and for maintaining reduction and height. But of course, further prospective randomized studies should be done in this issue.

Yazar Katkıları: Çalışma konsepti/Tasarımı: MCO, AA; Veri toplama: YUY; Veri analizi ve yorumlama: AA; Yazı taslağı: YUY; İçeriğin eleştirel incelenmesi: MA; Son onay ve sorumluluk: MCO, AA, YUY, İD, ATE, MT; Teknik ve malzeme desteği: ATE; Süpervizyon: İD; Fon sağlama (mevcut ise): yok.
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REFERENCES

1. Clare MP, Sanders RW. Fractures and dislocations of

the calcaneus. In Rockwood and Green's Fractures in Adults. 6th ed. (Eds RW Bucholz, JD Heckman, C Court-Brown, P Tornetta):2293-336. Philadelphia, Lippincott Williams & Wilkins, 2005.
2. Nork SE, Barei DP. Ankle and hindfoot trauma. In Orthopaedic Knowledge Update (Ed JS Fischgrund):493-509. Rosemont, American Academy of the Orthopaedic Surgeons, 2008.
3. Aşik M, Sen C, Bilen FE, Hamzaoğlu A. Surgical management of intraarticular calcaneus fractures. Acta Orthop Traumatol Turc. 2002;36:35-41.
4. Zwipp H, Rammelt S, Barthel S. Calcaneus fracture. Unfallchirurg. 2005;108:737-48.
5. Weber M, Lehmann O, Sagesser D, Krause F. Limited open reduction and internal fixation of displaced intra-articular fractures of the calcaneum. J Bone Joint Surg. 2008;90:1608–16.
6. Di Schino M, Bensaida M, Vandenbussche E, Augereau B, Nich C. Results of open reduction and cortico-cancellous autograft of intra-articular calcaneal fractures according to Palmer. Rev Chir Orthop Reparatrice Appar Mot. 2008;94:8-16.
7. Elsner A, Jubel A, Prokop A, Koebke J, Rehm KE, Andermahr J. Augmentation of intraarticular calcaneal fractures with injectable calcium phosphate cement: Densitometry, histology, and functional outcome of 18 patients. J Foot Ankle Surg. 2005;44:390–5.
8. Sanders R., Fortin P, DiPasquale T, Walling A. Operative treatment in 120 displaced intra-articular calcaneal fractures. Clin Orthop Relat Res. 1993;290:87–95.
9. Eastwood DM, Langkamer VG, Atkins RM. Intra-articular fractures of the calcaneum. Part II: Open reduction and internal fixation by the extended lateral transcalcaneal approach. J Bone Joint Surg Br. 1993;75:189–95.
10. Ebraheim NA, Elgafy H, Sabry FF, Freih M, Abou-Chakra IS.. Sinus tarsi approach with trans-articular fixation for displaced intra-articular fractures of the calcaneus. Foot Ankle Int. 2000;21:105–13.
11. Baumgaertel FR., Gotzen L. Two-stage operative treatment of comminuted os calcis fractures.Primary indirect reduction with medial external fixation and delayed lateral plate fixation. Clin Orthop Relat Res. 1993;290:132–41.
12. Huang PJ, Huang HT, Chen TB, Chen JC, Lin YK, Cheng YM et al. Open reduction and internal fixation of displaced intra-articular fractures of the calcaneus. J Trauma. 2002;52:946–50.
13. Letournel E. Open treatment of acute calcaneal fractures. Clin Orthop Relat Res. 1993;290:60–7.
14. Lowery RBW, Calhoun JH. Fractures of the calcaneus (current topic review). Foot Ankle Int. 1996;17;230–5.
15. Longino D, Buckley RE. Bone graft in the operative treatment of displaced intraarticular calcaneal fractures: is it helpful? J Orthop Trauma. 2001;15:280–6.
16. Yunfeng Y, Homgmou Z, Zhou J, Yu G. Treatment displaced intraarticular calcaneal fractures with or wthout bone grafts: A systematic review of the literatüre. Indian J Orthop. 2012;46:130–7.
17. Cao H, Li YG. Short-term outcomes of open reduction and internal fixation for Sanders type iii calcaneal fractures with and without bone grafts. Foot Ankle Surg. 2017;1067:2516-7.
18. Singh A, Narsaria A, Verma I. Effect of bone grafting in short and long term outcomes of displaced intraarticular calcaneal fractures: A prospective comparative study. Int J Orthop 2016;183:505-11.