



Isolated subtalar fusion for neglected painful intra-articular calcaneal fractures

Umut YAVUZ, Sami SÖKÜCÜ, Bilal DEMİR, Devrim ÖZER,
Çağrı ÖZCAN, Yavuz S. KABUKÇUOĞLU

*Metin Sabancı Baltalimanı Bone Diseases Training and Research Hospital,
Department of Orthopedics and Traumatology, Istanbul, Turkey*

Objective: The objective of this study was to evaluate the radiological and clinical outcomes of treatment of subtalar arthrodesis in patients developing talocalcaneal arthrosis secondary to intra-articular calcaneal fractures.

Methods: The study included 20 patients (21 feet) who underwent subtalar arthrodesis due to symptomatic subtalar arthrosis following conservative treatment for intra-articular calcaneal fracture between 2005 and 2011. Autograft or allograft was used in 11 patients. Patients were evaluated clinically using the American Orthopedic Foot and Ankle Society (AOFAS) ankle hindfoot score. Hindfoot alignment, quality of subtalar fusion and arthritis occurring in other joints were used for the radiological evaluations.

Results: Mean duration of follow-up was 43 (range: 21 to 83) months. Mean preoperative AOFAS score was 61.7 (range: 40 to 67) and mean postoperative AOFAS score was 84.2 (range: 65 to 94). The difference between scores was statistically significant ($p=0.001$). Six patients had excellent, 8 good and 6 fair results. Complete fusion was achieved in 19 patients (20 feet). In 2 patients, arthritic changes were radiologically observed in the midtarsal joints. These changes were not symptomatic. There were no statistically significant differences between pre- and postoperative radiological measurements. No patients experienced malunion.

Conclusion: While subtalar arthrodesis appears to provide radiological and clinical benefits, it may cause moderate and asymptomatic osteoarthritis in the midtarsal joints.

Key words: AOFAS; arthrodesis; calcaneal fracture; graft; subtalar arthrosis.

Subtalar arthrosis is caused by many conditions, such as trauma, talocalcaneal coalition, failure of the posterior tibial tendon (PTT), isolated instability of the subtalar joint and inflammatory arthritis. Subtalar arthrodesis is an effective salvage method when conservative treatment methods fail in the presence of arthrosis in the subtalar joint.^[1,2] Calcaneofibular or tibiotalar impingement and

flattening of the long axis of the foot are more prominent, especially in the case of arthrosis following trauma because of impaired calcaneal height.^[3-5] Therefore, the rate of success and patient satisfaction varies from 44 to 89% in subtalar arthrosis secondary to trauma.^[4,6,7]

Although triple arthrodesis is a commonly used method due to the relationship between the subtalar and the

Correspondence: Umut Yavuz, MD. Metin Sabancı Baltalimanı Kemik Hastalıkları Eğitim ve Araştırma Hastanesi, Ortopedi ve Travmatoloji Kliniği, Rumeli Hisarı Caddesi No: 62, Baltalimanı 34470, Istanbul, Turkey
Tel: +90 212 -323 70 75 e-mail: umut78@yahoo.com

Submitted: December 07, 2013 **Accepted:** May 28, 2014

©2014 Turkish Association of Orthopaedics and Traumatology

Available online at
www.aott.org.tr
doi: 10.3944/AOTT.2014.13.0144
QR (Quick Response) Code



midtarsal joints, preserving the midtarsal joints provides a better functional outcome.^[8,9] Furthermore, isolated subtalar arthrodesis has some additional advantages such as facilitating the surgical method and avoiding complications like possible midtarsal nonunion or malunion.

The aim of this retrospective study was to specify the outcomes of isolated subtalar arthrodesis in the treatment of isolated subtalar arthrosis arising after calcaneal fractures, to assess the degenerative changes in the adjacent joints and to determine clinical or radiological factors that influence the outcome.

Patients and methods

The study included 20 patients (21 feet) who underwent subtalar arthrodesis due to symptomatic subtalar arthrosis after undergoing conservative treatment for intra-articular calcaneal fractures between 2005 and 2011.

Mean follow-up period was 43 (range: 21 to 83) months. Mean age was 44.3 (range: 23 to 64) years. Sixteen patients (80%) were males and 4 were (20%) females. The mean period after the initial calcaneal fracture was 30 (range: 8 to 44) months. Bone graft was used in 11 of 20 cases. Cancellous autografts (iliac crest-derived) were used in 8 cases and cancellous allografts in 3. Allograft was used instead of autograft in the patients who refused to sign the informed consent form for autograft application.

All procedures were performed under spinal anesthesia. Patients were placed in a lateral decubitus position on the unaffected side and a tourniquet was applied to the thigh. Each patient received a preoperative prophylactic dose of intravenous antibiotics. A lateral incision was made from 1 cm posterior the tip of the fibula to the lateral border of the extensor digitorum brevis tendon. Peroneal tendons and the sural nerve were avoided. Capsular tissue was removed to expose the subtalar joint. A lamina spreader was used to improve visualization of the subtalar joint. Making a series of osteotomies, the residual cartilage and sclerotic subchondral bone of the talar and calcaneal joint surfaces were removed until bleeding surfaces were obtained. Surface congruency between the talus and the calcaneus was checked manually. Grafting was performed in the absence of an appropriate contact. In all patients, 2 cannulated screws with a diameter of 6.5 mm were used to fix the arthrodesis site. Screws were inserted parallel, from the posteroinferior of the calcaneus to the middle of the talus through a guide wire.

Postoperative radiographies were taken. For soft tissue healing, a short-leg splint was applied for 2 weeks. Sutures were removed at the end of the 2nd postoperative



Fig. 1. Angles measured in the weight-bearing foot-ankle radiographs. TCA: talocalcaneal angle, TCH: talocalcaneal height, TIA: talus inclination angle

week and a short leg circular cast was applied. Control radiographies were taken at the end of the 1st, 3rd and 6th postoperative weeks and the 3rd postoperative month. The cast was removed and radiographies were taken 3 months postoperatively. Fusion was expected in those cases in which osseous callus tissue with the same radiopacity of the surrounding healthy bone was observed in the subtalar area. If union was present, full weight-bearing was permitted and rehabilitation initiated.

Functional results were evaluated pre- and postoperatively using the AOFAS (American Orthopedic Foot and Ankle Society) ankle hindfoot rating system.⁽¹⁰⁾ The 6 points for the subtalar motion were not assigned; the maximal score at final follow-up was 94 points. A score between 90 and 94 points was rated as excellent, 75 to 89 good, 50 to 74 fair and less than 50 poor.

Radiographic assessment at the final follow-up was made using anteroposterior and lateral weight-bearing radiographies. The bony union, talus inclination angle, talocalcaneal angle, talus-first metatarsal angle and talocalcaneal height were assessed on the lateral weight-bearing radiography (Fig. 1). Arthritic changes in the ankle and midtarsal joints were noted.

The chi-square and Fisher's exact tests were used to analyze qualitative data. When quantitative values were evaluated, ANOVA was performed to determine significance. A p value of 0.05 or less was considered significant.

Results

Complete union was achieved in 20 feet of 19 patients (95%). Mean duration until radiological union was 15.1 ± 5.24 (range: 11 to 32) weeks. Delayed union was observed in 1 patient (32nd week). There was no significant difference between patients that did and did not receive bone grafting in terms of time required for unifi-

Table 1. Pre- and postoperative radiological and functional findings of the patients.

	Preoperative	Postoperative	p
	Mean (range)	Mean (range)	
AOFAS score	61.7 (40-67)	84.2 (65-94)	0.001
Talocalcaneal angle (°)	37.6 (22-50)	30.2 (18-43)	0.121
Talus inclination angle (°)	18.7 (13-25)	15.5 (12-19)	0.196
Talocalcaneal height (mm)	74.7 (51-85)	70.2 (60-83)	0.743

cation ($p=0.544$).

Mean preoperative AOFAS score was 61.7 (range: 40 to 67) and 84.2 (range: 65 to 94) at the final follow-up. The difference was significant ($p=0.001$) (Table 1). Six patients had excellent, 8 good and 6 fair results (Fig. 2).

Radiological evaluation was made in the preoperative period and at the final follow-up. The mean talocalcaneal angle was 37.6° preoperatively and 30.2° at the final follow-up. Mean pre- and postoperative talus inclination angle was 18.7° and 15.5° , respectively. Mean preoperative talocalcaneal height was 74.7 mm and 70.2 mm at the final follow-up. No statistically significant difference was found among the radiological values (Table 1). Arthritic changes were observed in the midtarsal joints in 2 patients (10%). Three patients had pain which did not negatively impact their daily activities and shoe modifications and sole plates were recommended. Only one patient changed their job.

Postoperative infection occurred in 2 patients. Allografting was performed in one and autografting in the other, and both were treated with serial debridement and vacuum assisted closure (VAC). Delayed union was observed in 1 patient. He was followed up without weight-bearing. Complete union was observed in 8 months. Two patients received physical therapy for complex regional pain syndrome (CRPS) and a good clinical outcome was achieved after 6 weeks. Arthrosis was observed radiologi-

cally in the talonavicular joints in 2 patients and no treatment was given because it did not cause any complaints. Shoe modification and sole plates were recommended. In 1 patient, the screws were removed at the end of the first postoperative year due to irritation of the implant.

Discussion

This retrospective study reports the short-term results of subtalar arthrodesis after calcaneal fractures. Total bony union was achieved in all patients but one. Arthrodesis treatment significantly increased the AOFAS score. Based on radiological results, union time and functional outcomes, subtalar arthrodesis appears to be an effective salvage method and bone union and tibio-calcaneal alignment seem to be the most important clinical factors.

Subtalar arthrosis following intra-articular calcaneal fractures is a common complication. As a salvage treatment, fusion of the subtalar joint has been preferred for many years. Isolated subtalar arthrodesis and triple arthrodesis have been applied. Any radiological or functional advantage of each method relative to each other has not been demonstrated in publications comparing both treatment options.^[4,11]

Although screws are commonly used for subtalar arthrodesis, some series have reported cases in which arthrodesis was performed using staples.^[12-14] These studies have shown no differences in terms of outcomes and requirement of implant removal. However, based on clinical experience, staple removal has been reported as more difficult than screw removal. In the present study, all patients underwent arthrodesis using screws and no patient required revision due to material failure. Screws were sufficient for successful subtalar fusion in all our patients.

Many studies reported high rates of union.^[12,15-17] However, radiological determination of union is not always obvious in cases undergoing isolated subtalar arthrodesis. Therefore, radiological and clinical findings should be evaluated together to determine union. Eas-



Fig. 2. Pre- and postoperative radiographs of the 45-year-old male patient. Arthrodesis was applied 26 months after the calcaneal fracture. The patient had excellent results according to the AOFAS and normal space of the tibiotalar joint at the 2nd postoperative year.

ley et al. reported no radiological union in 23% of 184 patients undergoing subtalar arthrodesis due to various etiologies and no clinical signs in one third of these.^[1] Davies et al. recommended computerized tomography (CT) to assess patients in which no radiological union was observed and CT scans revealed that union of the posterior facet was achieved in more than half of these patients.^[2] Jones et al. noted that hindfoot pain continued in patients in whom union was observed radiologically and that confirming the union by means of CT would be helpful in these patients.^[18] As suggested by the clinical studies, there is not always a correlation between radiological union and clinical outcome. In our study, assessment of bony union was difficult with radiographs alone as the feet remained in short-leg casts. For a definite decision, all casts were removed at the 3rd postoperative month and radiological evaluation was made. In the patient without complete radiological union, no surgical intervention was performed due to the lack of pain in the functional assessment.

The effects of grafting on unification are controversial. Scranton advocated that grafting was required for non-union avoidance.^[19] However, Kitaoka and Patzer^[13] reported that all of their patients achieved union without grafting and Dahm and Kitaoka^[20] noted that grafting was not routinely necessary in terms of achieving union in the patients who underwent subtalar arthrodesis following intra-articular calcaneal fracture. Joveniaux et al. evaluated patients undergoing subtalar arthrodesis by grafting and found no statistically significant difference between patients with and without grafting in terms of union time.^[14] In the present study, we observed nonunion in only one of the nine feet in which we did not use grafting. As the clinical and the radiological results of the patients were compared by means of graft application, results of patients in whom grafting was performed were as successful as those who did not receive grafting ($p=0.544$).

Following intra-articular comminuted calcaneal fractures, the talocalcaneal relationship is impaired, the talus becomes more parallel to the ground and talocalcaneal height is reduced. In addition to their suggestion that such alignment disorders should be corrected during subtalar arthrodesis, many authors reported that impingement would develop between the anterior part of the tibiotalar joint and the talus neck unless talus parallelism was corrected, and that difficulties might be experienced in putting on shoes due to relative extension of the Achilles tendon unless talocalcaneal height was corrected.^[3,16,21,22] In our study, we observed that the talocalcaneal height and talus inclination angles were within

optimal limits in postoperative radiographs. We believe that intervention should aim to achieve not only union but also appropriate alignment.

Arthrosis occurs in 10 to 20% of other joints and is usually mild following subtalar arthrodesis.^[16,23-25] We observed arthrosis of the midtarsal joint not requiring surgical intervention and not causing clinical symptoms in 2 patients. No relationship was observed with the degree of subtalar arthrosis and it was considered that the arthrosis might be secondary to articular damage that might have occurred during the trauma.

In conclusion, isolated subtalar arthrodesis appears to be an effective salvage method in the treatment of subtalar arthrosis developing after neglected intra-articular calcaneal fractures. The subtalar arthrodesis technique permits significant clinical improvement in cases with isolated subtalar arthrosis. Grafting does not decrease union time and osteoarthritis in the adjacent joints seems to be moderate and asymptomatic.

References

1. Easley ME, Trnka HJ, Schon LC, Myerson MS. Isolated subtalar arthrodesis. *J Bone Joint Surg Am* 2000;82:613-24.
2. Davies MB, Rosenfeld PF, Stavrou P, Saxby TS. A comprehensive review of subtalar arthrodesis. *Foot Ankle Int* 2007;28:295-7. [CrossRef](#)
3. Myerson M, Quill GE Jr. Late complications of fractures of the calcaneus. *J Bone Joint Surg Am* 1993;75:331-41.
4. Johansson JE, Harrison J, Greenwood FA. Subtalar arthrodesis for adult traumatic arthritis. *Foot Ankle* 1982;2:294-8.
5. Mizel MS, Temple HT, Michelson JD, Alvarez RG, Clanton TO, Frey CC, et al. Thromboembolism after foot and ankle surgery. A multicenter study. *Clin Orthop Relat Res* 1998;348:180-5. [CrossRef](#)
6. Mann RA, Baumgarten M. Subtalar fusion for isolated subtalar disorders. Preliminary report. *Clin Orthop Relat Res* 1988;226:260-5.
7. Russotti GM, Cass JR, Johnson KA. Isolated talocalcaneal arthrodesis. A technique using moldable bone graft. *J Bone Joint Surg Am* 1988;70:1472-8.
8. Astion DJ, Deland JT, Otis JC, Kenneally S. Motion of the hindfoot after simulated arthrodesis. *J Bone Joint Surg Am* 1997;79:241-6.
9. Wülker N, Stukenborg C, Savory KM, Alfke D. Hindfoot motion after isolated and combined arthrodeses: measurements in anatomic specimens. *Foot Ankle Int* 2000;21:921-7.
10. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. *Foot Ankle Int* 1994;15:349-53. [CrossRef](#)

11. Zwipp H, Rammelt S, Barthel S. Calcaneal fractures--open reduction and internal fixation (ORIF). *Injury* 2004;35 Suppl 2:SB46-54. [CrossRef](#)
12. Huang PJ, Chen SK, Chen YW, Cheng YM, Lin SY, Hsu CY. Subtalar arthrodesis for subtalar arthritis. *Kaohsiung J Med Sci* 1997;13:677-81.
13. Kitaoka HB, Patzer GL. Subtalar arthrodesis for posterior tibial tendon dysfunction and pes planus. *Clin Orthop Relat Res* 1997;345:187-94. [CrossRef](#)
14. Joveniaux P, Harisboure A, Ohl X, Dehoux E. Long-term results of in situ subtalar arthrodesis. *Int Orthop* 2010;34:1199-205. [CrossRef](#)
15. Amendola A, Lammens P. Subtalar arthrodesis using interposition iliac crest bone graft after calcaneal fracture. *Foot Ankle Int* 1996;17:608-14. [CrossRef](#)
16. Rammelt S, Grass R, Zawadski T, Biewener A, Zwipp H. Foot function after subtalar distraction bone-block arthrodesis. A prospective study. *J Bone Joint Surg Br* 2004;86:659-68. [CrossRef](#)
17. Chandler JT, Bonar SK, Anderson RB, Davis WH. Results of in situ subtalar arthrodesis for late sequelae of calcaneus fractures. *Foot Ankle Int* 1999;20:18-24.
18. Jones CP, Coughlin MJ, Shurnas PS. Prospective CT scan evaluation of hindfoot nonunions treated with revision surgery and low-intensity ultrasound stimulation. *Foot Ankle Int* 2006;27:229-35.
19. Scranton PE Jr. Results of arthrodesis of the tarsus: talocalcaneal, midtarsal, and subtalar joints. *Foot Ankle* 1991;12:156-64. [CrossRef](#)
20. Dahm DL, Kitaoka HB. Subtalar arthrodesis with internal compression for post-traumatic arthritis. *J Bone Joint Surg Br* 1998;80:134-8. [CrossRef](#)
21. Huang PJ, Fu YC, Cheng YM, Lin SY. Subtalar arthrodesis for late sequelae of calcaneal fractures: fusion in situ versus fusion with sliding corrective osteotomy. *Foot Ankle Int* 1999;20:166-70. [CrossRef](#)
22. Carr JB, Hansen ST, Benirschke SK. Subtalar distraction bone block fusion for late complications of os calcis fractures. *Foot Ankle* 1988;9:81-6. [CrossRef](#)
23. Jardé O, Trinquier JL, Renaux P, Mauger S, Vives P. Subtalar arthrodesis for sequelae of calcaneal fractures. Apropos of 57 cases. [Article in French] *Rev Chir Orthop Reparatrice Appar Mot* 1994;80:728-33. [Abstract]
24. Trnka HJ, Easley ME, Lam PW, Anderson CD, Schon LC, Myerson MS. Subtalar distraction bone block arthrodesis. *J Bone Joint Surg Br* 2001;83:849-54. [CrossRef](#)
25. de Heus JA, Marti RK, Besselaar PP, Albers GH. The influence of subtalar and triple arthrodesis on the tibiotalar joint. A long-term follow-up study. *J Bone Joint Surg Br* 1997;79:644-7. [CrossRef](#)