AMERICAN ORTHOPAEDIC FOOT & ANKLE SOCIETY

Foot & Ankle International®
1–7
© The Author(s) 2017
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1071100717737973
journals.sagepub.com/home/fai

Role of Extra-articular Tibiotalocalcaneal Arthrodesis and Posterior Approach in Highly Complex Cases

Sergio Eckholt, MD[1], Ruben Garcia-Elvira, MD[2], Nicolás Fontecilla, MD[3], Alvaro Fernandez-Reinales, MD[2], and Daniel Poggio, MD[2]

Abstract

Background: Tibiotalocalcaneal (TTC) arthrodesis is a procedure commonly used as salvage surgery for various pathologic processes that compromise the ankle and subtalar joints. It is a reasonably standardized procedure when performed as a primary surgery in advanced stages of TTC arthritis. For such cases, there are several alternative approaches, fixation materials, and bone substitutes that can be used. Most represent valid options with similar results in the literature. However, in highly complex cases requiring TTC arthrodesis, the options for the approach and fixation material can be limited. Understanding the alternative approaches and techniques is of great help to the surgeon when faced with highly complex cases, such as patients with multiple previous operations, lack of bone stock, severe deformities, or compromise of associated soft tissues. In this article, we describe the role of the posterior approach with some technical variation that allows extra-articular arthrodesis in highly complex cases, and we present a series of patients with tibiotalocalcaneal arthrodesis who were operated on using this technique.

Methods: Retrospective review of all patients who underwent tibiotalocalcaneal arthrodesis via posterior approach between 2008 and 2016. The surgeries were performed by 2 different surgeons with the same technique (posterior approach with sliding graft) but 2 different fixation methods. Radiographs and computed tomographic (CT) studies were reviewed and patient satisfaction was rated using the Coughlin scale. Mean follow-up was 38 months. We identified 20 patients. The Mean age was 51.2 years; 11 patients had post-traumatic arthritis whereas the others had other causes of arthritis (inflammatory disease, neurologic deformity, etc).

Results: The arthrodesis was performed using a tibiotalocalcaneal plate in 9 patients and retrograde intramedullary nail in 11 patients. Radiographic fusion was observed at an average of 3.1 months. Four patients had complications and 15 reported good or excellent results after surgery.

Conclusion: Our study found a fusion rate comparable to other studies in highly complex cases. There were no operative wound complications. We observed that the posterior approach, with an extra-articular fusion procedure, was a valid option for salvage surgery in highly complex cases that require tibiotalocalcaneal fusion.

Level of Evidence: Level IV, retrospective case series.

Keywords: osteoarthritis, arthritis, ankle arthritis, arthrodesis, ankle arthrodesis, tibiotalocalcaneal, posterior approach

Introduction

Tibiotalocalcaneal (TTC) arthrodesis is a salvage procedure for the treatment of ankle and subtalar arthritis, which may be associated with hindfoot deformities. The primary objective of this procedure is to achieve correct alignment of the hindfoot and attain a painless, plantigrade foot.[2,7] The most common causes of ankle or subtalar arthritis include post-traumatic arthritis, neurologic disease, inflammatory arthritis, and infection.[4] These conditions can cause joint destruction and with time can be associated with severe deformities, which influence the choice of treatment. It is a fairly standardized procedure when done as a primary surgery in advanced stages of TTC arthritis. For such cases, there are various alternative approaches, fixation materials, and bone substitutes that can

[1]Department of Orthopaedic Surgery & Traumatology, Hospital de Carabineros de Chile, Santiago, Chile
[2]Department of Orthopaedic Surgery & Traumatology, Hospital Clínic, Barcelona, España
[3]Department of Orthopaedic Surgery & Traumatology, Clínica Indisa, Santiago, Chile

Corresponding Author:
Daniel Poggio, MD, Hospital Clínic, Department of Orthopaedic Surgery & Traumatology, Carrer de Villarroel 170, Barcelona, 08036, España.
Email: DPOGGIO@clinic.cat

Table 1. Summary of Patient Data.

Patient	Diagnosis	Fixation Method	Time to Fusion	Complication
Male	Post-traumatic arthritis	Plate	2 mo	Peri-implant fracture
Male	Post-traumatic arthritis	Intramedullary nail	3 mo	No
Male	Charcot-Marie-Tooth disease	Plate	2 mo	No
Male	Post-traumatic arthritis	Plate	6 mo	No
Female	Poliomyelitis disease	Plate	2 mo	No
Male	Post-traumatic arthritis	Intramedullary nail	3 mo	No
Male	Poliomyelitis disease	Plate	4 mo	Peri-implant fracture
Male	Post-traumatic arthritis	Intramedullary nail	6 mo	No
Female	Post-traumatic arthritis	Intramedullary nail	2 mo	No
Female	Psoriatic arthritis	Intramedullary nail	3 mo	Minor fixation material infection
Male	Charcot-Marie-Tooth disease	Plate	3 mo	No
Male	Post-traumatic arthritis	Plate	2 mo	No
Male	Post-traumatic arthritis	Intramedullary nail	6 mo	No
Male	Charcot neuroarthropathy	Intramedullary nail	3 mo	No
Female	Charcot-Marie-Tooth disease	Plate	2 mo	No
Male	Post-traumatic arthritis	Intramedullary nail	2 mo	Subtalar pseudoarthrosis
Female	Post-traumatic arthritis	Intramedullary nail	3 mo	No
Male	Psoriatic arthritis	Intramedullary nail	2 mo	No
Female	Post-traumatic arthritis	Plate	3 mo	No
Female	Juvenile idiopathic arthritis	Intramedullary nail	3 mo	No

be used. Most are valid options and have similar results in the literature.[1,11,13]

The complexity of the procedure depends on the associated variables such as the patient's age, comorbidities, bone stock, severity of intra- and extra-articular deformity, number and type of previous operations, and status of soft tissues. These and other variables can increase the complexity of the process and make treatment more difficult. For these situations, the options for approach and fixation material can be very limited. Understanding the alternative approaches and techniques helps the surgeon greatly when dealing with such cases. In complex cases, the combination of a posterior approach and extra-articular arthrodesis can help greatly; it can allow the surgeon to use an approach via healthy tissue, avoid adhesions and retractions due to previous scars, improve soft tissue coverage, and operate on an area with good bone quality.

We present our experience and results from cases of extra-articular arthrodesis via a posterior approach in highly complex cases.

Methods

We retrospectively reviewed those patients who underwent TTC arthrodesis via posterior approach with a sliding bone graft in our hospital between 2008 and 2016. All the surgeries were performed by 2 different surgeons with the same technique: arthrodesis via posterior approach with sliding graft, but with 2 different fixation methods depending on the patient. The mean follow-up time was 38 months (range, 6-87 months). We reviewed radiographs and computed tomographs (CTs) when available (8 patients) at 1, 3, and 6 months postoperatively, to assess fusion, alignment, and the implants. We looked at the complications that occurred. We also assessed patient satisfaction at 1 year postsurgery, using the Coughlin satisfaction scale (with the exception of 1 patient who did not come to the 1-year review).[6]

We collected information on 20 consecutive patients (20 operated ankles): 13 men and 7 women. Mean age was 51.2 years (range, 28-72 years). The reason for operation was post-traumatic arthritis in 11 joints, neurologic deformity in 5 (2 patients with sequel of poliomyelitis disease and 3 Charcot-Marie-Tooth disease), inflammatory arthritis in 3, and Charcot neuroarthropathy in 1. Table 1 shows a summary of patient data.

Operative Technique

Once anesthetized, the patient was positioned prone with the feet protruding over the end of the operating table, such that dorsiflexion of the ankle to a neutral position was possible and a thigh tourniquet used. A curved posterior incision of approximately 15 cm was made in the midline, directly over the Achilles tendon, the concave edge of the incision facing medially (Figure 1). This reduced the risk of sural nerve damage or subsequent entrapment in scar. The paratenon was opened to achieve a full-thickness flap of skin, subcutaneous tissue, and paratenon that limited the risk of cutaneous vascular damage.

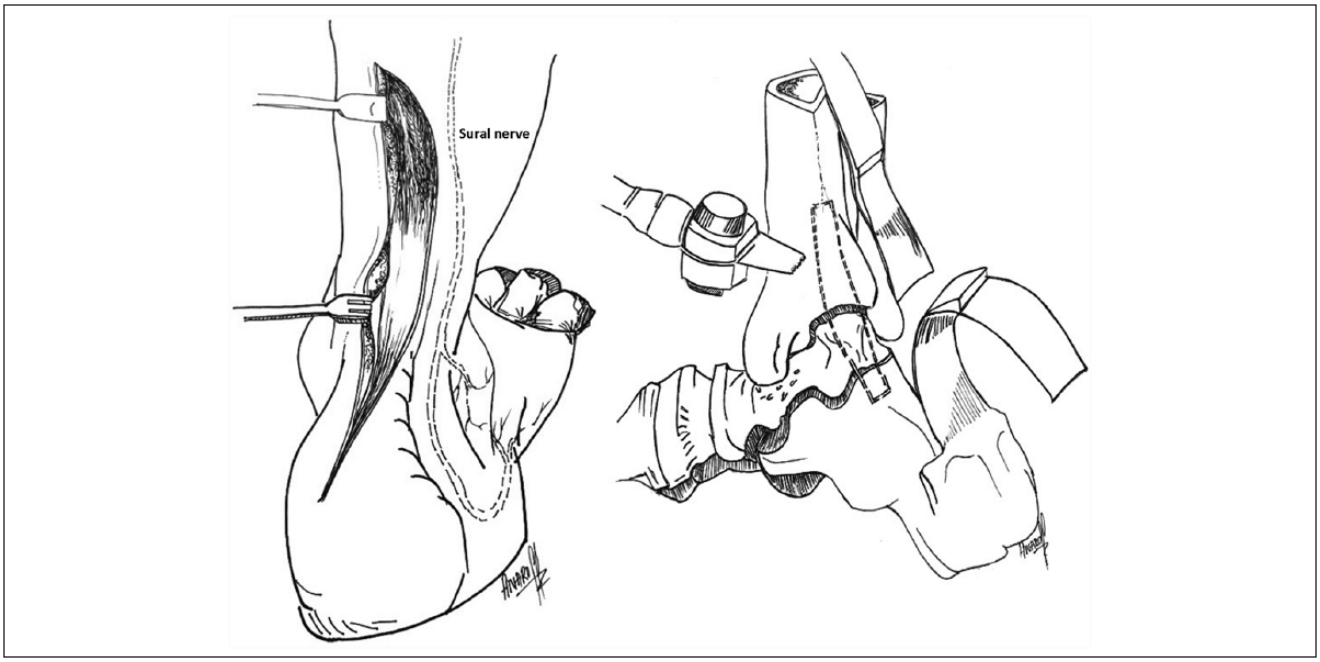


Figure 1. Drawings showing the curved posterior incision and the Z-tenotomy of the Achilles tendon.

We believe it was important that these structures remain intact to achieve adequate closure and isolate the tendon from the superficial tissues.

Z-tenotomy of the distal third of the Achilles tendon was performed in the coronal plane. The anterior part of the tendon was divided at the most distal part, while the posterior portion was divided at the most proximal part of the coronal cut. This allowed the creation of 2 long tendinous flaps of equal thickness. The deep fascia was opened to expose the flexor hallucis longus (FHL) muscle and tendon. The FHL muscle was retracted medially protecting the neurovascular bundle. The posterior joint capsules were cut to expose the posterior distal tibia, the tibiotalar joint, the tubercle of the talus, the subtalar joint, and the posterosuperior calcaneal tuberosity. To achieve adequate visualization, the Achilles tendon was partially detached. Then, a triangular bone wedge approximately 7 cm long was cut from the posterior distal cortex of the tibia to the tibiotalar joint, which was later used as a graft for the extra-articular arthrodesis. This cut was extended distally to perform the wedge osteotomy of the posterior apophysis of the talus. The superior cortex of the calcaneal tuberosity was resected and a bed of approximately 1 to 2 cm depth was created, where the autograft from the posterior tibial cortex was put at the end of the procedure (Figure 2). The tibiotalar and subtalar articular surfaces were then prepared. Extensive resection of the articular surfaces was unnecessary because most of the fusion was extra-articular via the graft. With wedge resection, approximately 40% to 50% of the articular surfaces were included; therefore, the fusion was by the posterior wedge but also included almost 50% of the articular surface. In cases of severe deformity, the correction of malposition of the ankle was achieved with asymmetric osteotomies or joint resection of the distal tibia or talar dome, similar to an anterior approach. The ankle was positioned with correct alignment and fixed with the chosen fixation technique (plate or intramedullary nail). Cancellous bone graft was placed between the articular surfaces (if necessary) and the bone wedge from the posterior tibial cortex was positioned rotated 180 degrees from its initial position (Figure 3). The wedge was fixed with one of the screws from the nail or plate used for fixation of the arthrodesis. The FHL was returned to its initial position to provide coverage to the area of the arthrodesis. The Achilles tendon was sutured without tension with resorbable material. The paratenon was sutured without being separated from the subcutaneous tissue as much as possible. Subcutaneous tissue and skin were then closed in conventional fashion.

Results

The arthrodesis was performed using a tibiotalocalcaneal plate in 9 patients and retrograde intramedullary nail in 11 patients. Additional bone graft was not used in any of the cases. Radiographic fusion of the arthrodesis was observed at an average of 3.1 months, 2.9 months in patients with a plate, and 3.3 months in those with an intramedullary nail.

Four patients (20%) had complications. Two of these patients had an intramedullary nail and 2 had a posterior plate. In the patients with a nail, there was 1 case of proximal

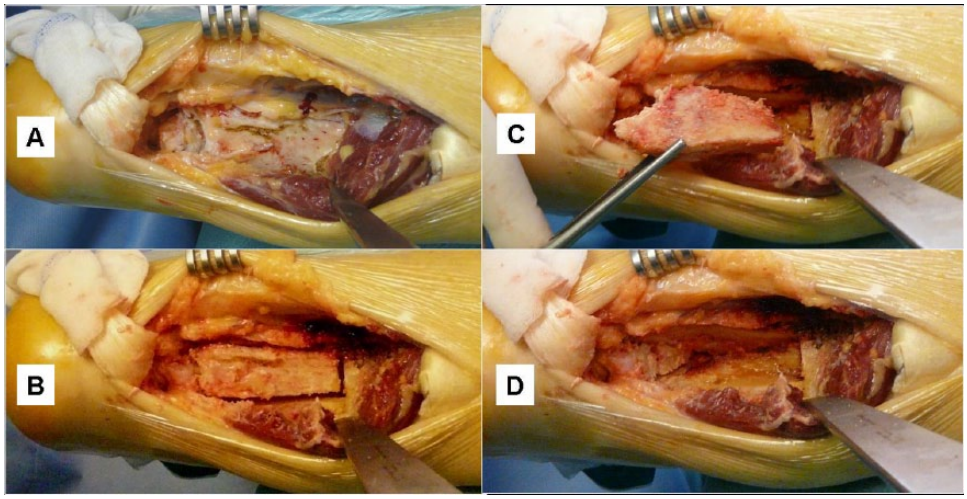


Figure 2. (A) Flexor hallucis longus medially displaced. (B) The triangular bone wedge cut from the posterior distal cortex of the tibia. (C) Complete wedge resection. (D) Final bed of where the autograft from the posterior tibial cortex will be put at the end of the procedure.

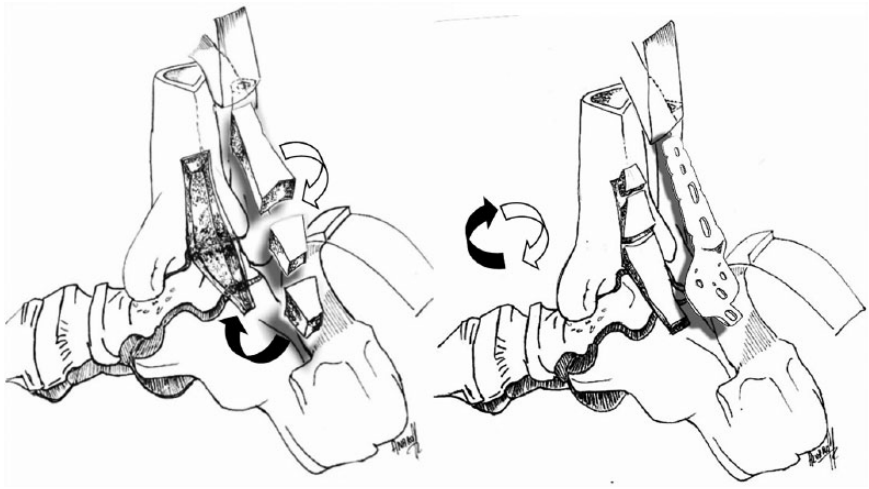


Figure 3. Drawings showing the preparation of the posterior sliding graft and its posterior 180-degree rotation to set it in its position.

screw infection requiring screw removal and 1 case of subtalar pseudoarthrosis. In the patients with a locking plate, there were 2 cases of stress fracture of the tibia proximal to the implant: one patient was treated conservatively and the other patient developed a pseudoarthrosis at the fracture site in the presence of a neuropathic foot. There were no cases of operative wound complication of the posterior approach or neurovascular compromise of the extremity.

Fifteen patients (75%) reported good or excellent results after surgery, according to the Coughlin satisfaction scale. All of these patients said they would repeat the procedure.

Discussion

Hammit et al in 2006 described a variant of the posterior approach, reporting a low rate of wound complications and proposing it as an alternative to other approaches at the ankle.[9] The posterior approach offers good bone stock in cases with significant anterior bone defects, making use of the posterior bone of the ankle to perform an extra-articular arthrodesis and avoid the use of structural grafts. It can also be a good alternative in cases with significant posterior tissue retraction, such as severe equinovarus deformities because of significant soft tissue retraction, in which it allows adequate posterior release and elongation of the Achilles tendon, and also in cases where there is damage to the surrounding soft tissues (e.g., multiple previous operations) where the approach options may be limited or risky. Hanson et al described the use of the posterior approach using a 95-degree plate for tibiotalocalcaneal arthrodesis in patients with moderate to severe hindfoot deformity, failed arthrodesis, and compromised soft tissues due to previous



Figure 4. (A and B) Computed tomography showing severe ankle arthrosis with a large anterior tibial bone defect. (C and D) Postoperative anteroposterior and lateral radiographs showing tibiotalocalcaneal arthrodesis with posterior approach and intramedullary nail fixation.

surgery.[10] It is important to assess the quality of blood supply of the limb and the potential need for other approaches to remove previous implants: if this is the case, the posterior approach may not be the best option. If the soft tissues of the posterior region of the ankle are compromised, this approach is contraindicated.

For the treatment to be successful, it is essential to obtain stable fixation and preserve the soft tissues. The intramedullary nail is a rigid fixation method that allows compression of the articular surfaces to be fused (Figure 4), with good reported clinical and biomechanical results.[14,17] Modern plates, designed specifically for fusion of the ankle, with angular stability systems and the option of polyaxial locking screws, currently provide an alternative to an intramedullary nail (Figure 5). Kile et al reported a 93% fusion rate in 30 patients operated on via a posteromedial approach with intramedullary nail fixation.[12] Their results were similar to those from Hanson and his group where the 10 patients in the study showed radiographic fusion at an average of 14.5 weeks; in their study, fixation was performed using a 95-degree posterior plate to give increased rigidity to the fixation.[9] These studies included both primary and complex procedures. Recent studies by Gorman and colleagues showed fusion in 73% of patients operated on with a posterior plate within 6 months following surgery, although 10% had delayed union after 6 months and 18% had nonunion.[8] Another retrospective study showed 78% fusion and 22% non-union in 9 patients who underwent tibiotalocalcaneal fusion with a posterior anatomic plate.[15] In our study, the fusion rate was 95% at a mean follow-up of 38 months (range, 3-87 months). There was only 1 case of nonunion, which was in the subtalar joint.

Our 20% complication rate was similar to other similar studies in highly complex cases.[10,12,15] We think the low rate of pseudoarthrosis in our series was due to the extra-articular arthrodesis procedure with sliding bone graft technique, similar to that described by Blair for cases of avascular necrosis of the talus.[3] We used a sliding graft from the posterior surface of the tibia toward the calcaneus passing through both the tibiotalar and talocalcaneal articular surfaces.

Although the posterior approach is sometimes considered a risky area for healing, in our study there were no operative wound complications, and these results were similar to those obtained by Hammit et al in their study.[9] As described in the articles by Taylor and Clemens, the vascularization and distribution of angiosomes is favorable in this approach.[5,16]

Limitations of this study include its retrospective nature and the disparity of the patient population, as these were reoperations and cases of high complexity, making it difficult to homogenize the sample. The lack of CT studies in the majority of patients to assess fusion is also a limitation.

Although our results are encouraging for the continued use of this technique, they need to be confirmed with new prospective comparative studies with more patients. The choice of fixation method should also be standardized, as should the rehabilitation protocol and postoperative assessment, to obtain more conclusive results.

Conclusion

A posterior approach, with an extra-articular fusion procedure, appears to be a valid option for salvage surgery in highly complex cases that require tibiotalocalcaneal fusion. The complications rate in our study was similar to other studies of TTC arthrodesis in highly complex cases. Of particular note was the absence of operative wound complications. The fusion rate in our study was comparable to other similar studies.

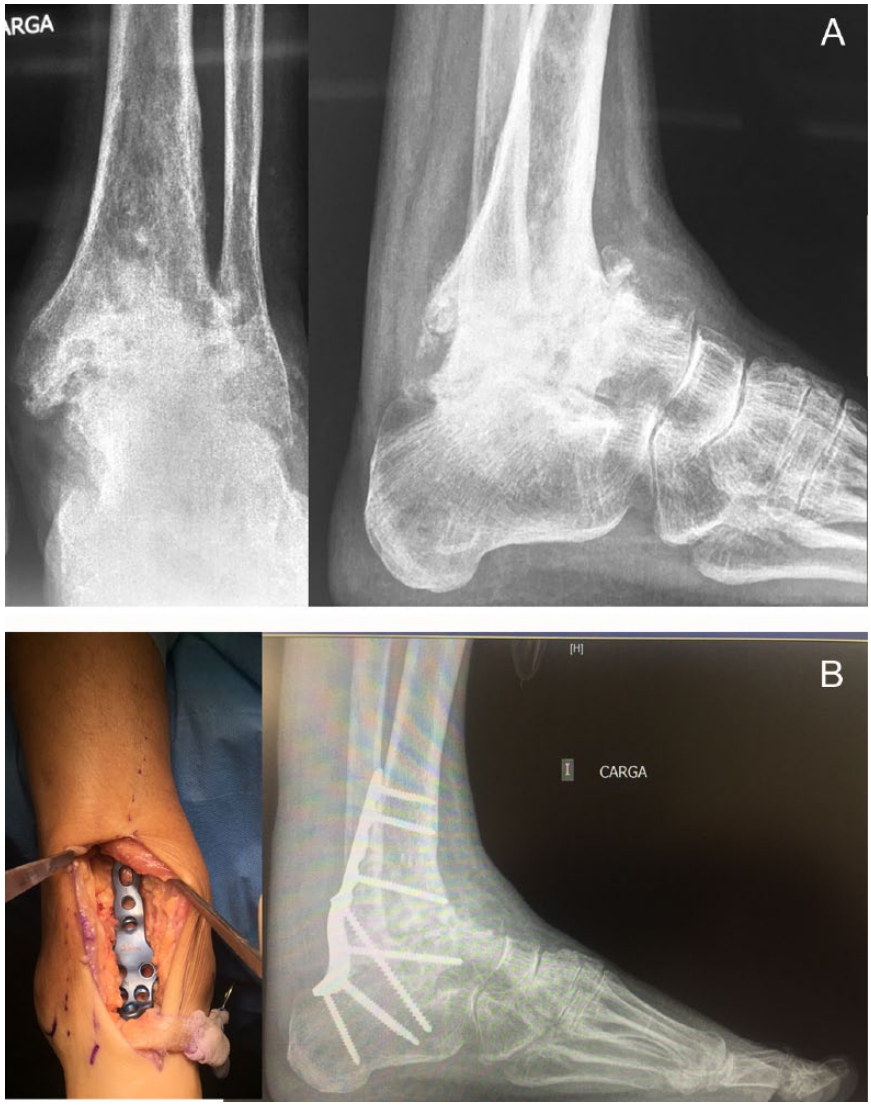


Figure 5. (A) Preoperative anteroposterior and lateral radiographs showing severe ankle osteoarthritis. (B) Postoperative picture and lateral radiograph showing tibiotalocalcaneal arthrodesis with posterior approach and posterior plate fixation in situ.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. Ahmad J, Pour AE, Raikin SM. The modified use of a proximal humeral locking plate for tibiotalocalcaneal arthrodesis. *Foot Ankle Int*. 2007;28(9):977-983.
2. Asomugha EU, Den Hartog BD, Junko JT, Alexander IJ. Tibiotalocalcaneal fusion for severe deformity and bone loss. *J Am Acad Orthop Surg*. 2016;24(3):125-134.
3. Blair HC. Comminuted fractures and fracture dislocations of the body of the astragalus, operative treatment. *Am J Surg*. 1943;59(1):37-43.
4. Cinar M, Derincek A, Akpinar S. Tibiocalcaneal arthrodesis with posterior blade plate in diabetic neuroarthropathy. *Foot Ankle Int*. 2010;31(6):511-516.
5. Clemens MW, Attinger CE. Angiosomes and wound care in the diabetic foot. *Foot Ankle Clin*. 2010;15(3):439-464.
6. Coughlin MJ. Treatment of bunionette deformity with longitudinal diaphyseal osteotomy with distal soft tissue repair. *Foot Ankle*. 1991;11(4):195-203.
7. Didomenico LA, Sann P. Posterior approach using anterior ankle arthrodesis locking plate for tibiotalocalcaneal arthrodesis. *J Foot Ankle Surg*. 2011;50(5):626-629.
8. Gorman TM, Beals TC, Nickisch F, Saltzman CL, Lyman M, Barg A. Hindfoot arthrodesis with the blade plate: increased risk of complications and nonunion in a complex

patient population. *Clin Orthop Relat Res*. 2016;474(10): 2280-2299.
9. Hammit MD, Hobgood ER, Tarquinio TA. Midline posterior approach to the ankle and hindfoot. *Foot Ankle Int*. 2006;27:711-715.
10. Hanson TW, Cracchiolo A 3rd. The use of a 95 degree blade plate and a posterior approach to achieve tibiotalocalcaneal arthrodesis. *Foot Ankle Int*. 2002;23(8):704-710.
11. Jeng CL, Campbell JT, Tang EY, Cerrato RA, Myerson MS. Tibiotalocalcaneal arthrodesis with bulk femoral head allograft for salvage of large defects in the ankle. *Foot Ankle Int*. 2013;34(9):1256-1266.
12. Kile TA, Donnelly RE, Gehrke JC, Werner ME, Johnson KA. Tibiotalocalcaneal arthrodesis with an intramedullary device. *Foot Ankle Int*. 1994;15(12):669-673.
13. Lucas Y, Hernandez J, Abad J, Remy S, Darcel V, Chauveaux D, Laffenetre O. Tibiotalocalcaneal arthrodesis using a straight intramedullary nail. *Foot Ankle Int*. 2015;36(5): 539-546.
14. Mückley T, Klos K, Drechsel T, Beimel C, Gras F, Hofmann GO. Short-term outcome of retrograde tibiotalocalcaneal arthrodesis with a curved intramedullary nail. *Foot Ankle Int*. 2011;32(1):47-56.
15. Peterson KS, Chapman WD, Hyer CF, Berlet GC. Short-term radiographic results and technique of tibiotalocalcaneal arthrodesis with a posterior anatomic locking plate. *J Foot Ankle Surg*. 2016;55(5):906-909.
16. Taylor GI, Pan WR. Angiosomes of the leg: anatomic study and clinical implications. *Plast Reconstr Surg*. 1998;102(3):599-616, discussion 617-618.
17. Thomas AE, Guyver PM, Taylor JM, Czipri M, Talbot NJ, Sharpe IT. Tibiotalocalcaneal arthrodesis with a compressive retrograde nail: a retrospective study of 59 nails. *Foot Ankle Surg*. 2015;21(3):202-205.