Tibiotalocalcaneal Arthrodesis with Fibular Inlay Graft for Biological Fixation

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Statement of Purpose

The Goal is to present a viable alternative to traditional fixation for a Tibiotalocalcaneal (TTC) arthrodesis. The fibula can provide biological fixation as a hybrid strut/inlay graft. The fibula can function as a biological auto-graft plate for primary fixation for a successful TTC arthrodesis.

Introduction/ Literature Review

TTC arthrodesis is commonly used for end stage arthritis and/or significant deformity of the ankle and subtalar joint. The goal of this procedure to provide a pain free, stable, functional limb (1-8). Many techniques are available for fixation (1-18). To our knowledge, use of the fibula as a biological plate in a hybrid strut/inlay graft fashion for primary fixation of a TTC fusion has not been described. A fibular on-lay strut graft has been described for an isolated ankle arthrodesis (23). Roukis et al. described use of the vascularized pedicle on-lay fibular graft to augment bony fusion across a TTC fusion but used an IM nail as primary fixation for stabilization (24).

Fig. A

Fig. B

Fig. C

Surgical Technique

The patient is placed in the supine position. A 15cm direct lateral incision over the fibula. A transverse fibular osteotomy is performed 13cm proximal to the distal tip of fibula. The fibula is then completely detached. The joints are prepped in standard fashion and any osteotomy to correct any angular deformity is performed at this time. The medial fibular graft is decorticated/morselized for autograft of the fusion site. A 0.6-1.0cm V-cut depression is created with osteotomes/power-saw into the lateral aspect of tibia, talus, and calcaneus. The fibula is positioned into the lateral aspect of the fusion site 3cm inferior to its natural position. The fibula should sit in a depressed position into the tibia and calcaneus laterally. The fibula is then fixated to the tibia with bi-cortical lag screws. To supplement the primary fixation, Two large cannulated fully threaded cannulated screws placed from posterior inferior to superior anterior obliquely across the ankle and subtalar joint and one screw across the ankle joint.

Fig. D

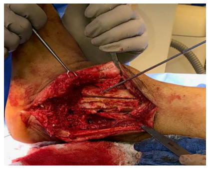

Fig. E

Fig. F

Case Illustration

61M with Type II Diabetes and peripheral neuropathy. He developed a left ankle charcot deformity with an ankle varus deformity from previous neglected trauma. The ankle and subtalar joint were clinically unstable. Conservative bracing did not adequately stabilize the hind-foot. Figure A,B,C pre-operative radiographs. Figure D, Harvested fibular graft. Figure E, V-cut depression for the biological plate. Figure F, fibular plate temporarily fixated. Figure G,H,I, final radiographs with bony fusion. Sutures were removed at 4 weeks. Patient was non-weight-bearing for 6 weeks. Protected weight-bearing weeks 6-12 post-operatively. Patient transitioned to full weight-bearing at 12 weeks and showed clinical fusion. Figure J,K,L, final clinical appearance

Results

Case Series of 3 patients. All patients required TTC fusion for end-stage arthrosis with instability. All patients were neuropathic. All 3 patients successfully had complete bony fusion following the TTC fusion with the described technique. All returned to normal shoe gear and were full weight-bearing within 12 months of the procedure. All patients maintained good anatomical alignment and have returned to activities of daily life.

Fig. G

Fig. H

Fig. I

Discussion

All patients in our series required a TTC fusion. The goal was to achieve a well-aligned stable hind-foot/ankle with comparable fusion and structural integrity as conventional fixation. The fibular autograft was used as biological fixation in a lateral strut graft/In-lay hybrid technique. This construct only required minimal internal fixation to secure the arthrodesis. This provides a cost effective technique while also decreasing the probability of bacterial adhesion to the overall construct. Use of this biological fixation also secondarily provides autografting properties to augment the fusion site. The autograft is harvested from the same surgical incision, thus does not add any donor site morbidity. Creating the depression for the fibula allows the plate to become more centralized and allows for increased the surface area of bony contact, both of which should create more stability to the overall construct. Additionally this hybrid inlay Strut configuration provides mechanical fixation that mimics both intramedullary fixation and plating fixation simultaneously (25). We feel this provides similar stability and fusion time as traditional fixation.

Fig. J

Fig. K

Fig. L

Conclusion

We present a case series of 3 patients who underwent a successful TTC fusion using the fibula as a biological fixation functioning as a plate for primary fixation. The fibula was used in a hybrid strut/inlay graft which provided adequate stability for successful TTC fusion. The fibular graft also provided a cost effective method of fixation as minimal hardware is needed to fixate the arthrodesis. The fibula was harvested in the same incision used for the arthrodesis and thus did not add any additional donor site morbidity while also providing autogenous grafting properties to aid in bony healing. We believe this viable alternative to traditional fixation for a TTC fusion.

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References

1. Alvarez, R. G., Barbour, T. M., & Perkins, T. D. (1994). Tibiocalcaneal arthrodesis for nonbraceable neuropathic ankle deformity. *Foot & ankle international, 15*(7), 354-359.
2. Gruen, G. S., & Mears, D. C. (1991). Arthrodesis of the ankle and subtalar joints. *Clinical orthopaedics and related research*, (268), 15-20.
3. Kile, T. A., Donnelly, R. E., Gehrke, J. C., Werner, M. E., & Johnson, K. A. (1994). Tibiotalocalcaneal arthrodesis with an intramedullary device. *Foot & ankle international, 15*(12), 669-673.
4. Kitaoka, H. B. (1991). Salvage of nonunion following ankle arthrodesis for failed total ankle arthroplasty. *Clinical orthopaedics and related research*, (268), 37-43.
5. Papa, J., Myerson, M., & Girard, P. (1993). Salvage, with arthrodesis, in intractable diabetic neuropathic arthropathy of the foot and ankle. *The Journal of bone and joint surgery. American volume, 75*(7), 1056-1066.
6. Quill, G. E. (1996). Tibiotalocalcaneal arthrodesis. *TECHNIQUES IN ORTHOPAEDICS-QUARTERLY-, 11*, 269-273.
7. Mann, R. A., & Chou, L. B. (1995). Tibiocalcaneal arthrodesis. *Foot & ankle international, 16*(7), 401-405.
8. Myerson, M. S., Alvarez, R. G., & Lam, P. W. (2000). Tibiocalcaneal arthrodesis for the management of severe ankle and hindfoot deformities. *Foot & ankle international, 21*(8), 643-650.
9. Chiodo, C. P., Acevedo, J. I., Sammarco, V. J., Parks, B. G., Boucher, H. R., Myerson, M. S., & Schon, L. C. (2003). Intramedullary rod fixation compared with blade-plate-and-screw fixation for tibiotalocalcaneal arthrodesis: a biomechanical investigation. *JBJS, 85*(12), 2425-2428.
10. Lee, A. T., Sundberg, E. B., Lindsey, D. P., Harris, A. H., & Chou, L. B. (2010). Biomechanical comparison of blade plate and intramedullary nail fixation for tibiocalcaneal arthrodesis. *Foot & ankle international, 31*(2), 164-171.
11. Dennison, M. G., Pool, R. D., Simonis, R. B., & Singh, B. S. (2001). Tibiocalcaneal fusion for avascular necrosis of the talus. *The Journal of bone and joint surgery. British volume, 83*(2), 199-203.
12. Rochman, R., Hutson, J. J., & Alade, O. (2008). Tibiocalcaneal arthrodesis using the Ilizarov technique in the presence of bone loss and infection of the talus. *Foot & ankle international, 29*(10), 1001-1008.
13. Kolker, D., & Wilson, M. G. (2004). Tibiocalcaneal arthrodesis after total talectomy for treatment of osteomyelits of the talus. *Foot & ankle international, 25*(12), 861-865.
14. Cooper, P. S. (2001). Complications of ankle and tibiotalocalcaneal arthrodesis. *Clinical Orthopaedics and Related Research (1976-2007), 391*, 33-44.
15. Klos, K., Drechsel, T., Gras, F., Beimel, C., Tiemann, A., Hofmann, G. O., & Mückley, T. (2009). The use of a retrograde fixed-angle intramedullary nail for tibiocalcaneal arthrodesis after severe loss of the talus. *Strategies in Trauma and Limb Reconstruction, 4*(2), 95-102.
16. Caravaggi, C. M., Sganzaroli, A. B., Galenda, P., Balaudo, M., Gherardi, P., Simonetti, D., ... & Morandi, A. (2012). Long-term follow-up of tibiocalcaneal arthrodesis in diabetic patients with early chronic Charcot osteoarthropathy. *The Journal of Foot and Ankle Surgery, 51*(4), 408-411.
17. Clements, J. R. (2012). Use of allograft cellular bone matrix in multistage talectomy with tibiocalcaneal arthrodesis: a case report. *The Journal of Foot and Ankle Surgery, 51*(1), 83-86.
18. Ptaszek, A. J. (1999). Immediate tibiocalcaneal arthrodesis with interposition fibular auto-graft for salvage after talus fracture: a case report. *Journal of orthopaedic trauma, 13*(8), 589-592.
19. Lareau, C. R., Deren, M. E., Fantry, A., Donahue, R. M., & DiGiovanni, C. W. (2015). Does autogenous bone graft work? A logistic regression analysis of data from 159 papers in the foot and ankle literature. *Foot and Ankle Surgery, 21*(3), 150-159.
20. Manfrini, M., Vanel, D., De Paolis, M., Malaguti, C., Innocenti, M., Ceruso, M., ... & Mercuri, M. (2004). Imaging of vascularized fibula auto-graft placed inside a massive allograft in reconstruction of lower limb bone tumors. *American Journal of Roentgenology, 182*(4), 963-970.
21. Nagi, O. N., Dhillon, M. S., & Goni, V. G. (1998). Open reduction, internal fixation and fibular auto-grafting for neglected fracture of the femoral neck. *The Journal of bone and joint surgery. British volume, 80*(5), 798-804.
22. Ebraheim, N. A., Elgafy, H., & Stefancin, J. J. (2001). Intramedullary fibular graft for tibiotalocalcaneal arthrodesis. *Clinical Orthopaedics and Related Research®, 385*, 165-169.
23. Sung, W., Greenhagen, R. M., Hobizal, K. B., Burns, P. R., & Wukich, D. K. (2010). Technical guide: transfibular ankle arthrodesis with fibular-onlay strut graft. *The Journal of Foot and Ankle Surgery, 49*(6), 566-570.
24. Roukis, T. S., & Kang, R. B. (2016). Vascularized pedicled fibula onlay bone graft augmentation for complicated tibiotalocalcaneal arthrodesis with retrograde intramedullary nail fixation: A case series. *The Journal of Foot and Ankle Surgery, 55*(4), 857-867.
25. Fibular Nail/Strut Graft for Hindfoot Fusion" *Ashish B. Shah, MD,* Ibukunoluwa Araoye, MS,w Osama Elattar, MD,z and Sameer M. Naranje, MD, MRCS** (*Tech Orthop* 2017;00: 000–000)

Disclosures: None