Double Calcaneal Osteotomy with Percutaneous Steinmann Pin Fixation as Part of Treatment for Flexible Flatfoot Deformity – A Retrospective Review of Consecutive Cases Highlighting Our Experience with Simple Fixation

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STATEMENT OF PURPOSE
Surgical correction of flexible flat deformity and posterior tibial tendon dysfunction has been extensively reported in the literature. When appropriate, calcaneal osteotomies have long been a cornerstone of flat foot and ankle surgery due to the corrective power achieved without the need for midfoot or hindfoot joint fusion. A wide variety of fixation options have been described for the posterior displacement calcaneal osteotomy, all of which have had relatively good results (1-3,12-14). Several authors advocate for some form of fixation of the Evans anterior calcaneal osteotomy to prevent graft displacement (3,7-9,12-13). Prior to 2008, we did not routinely employ fixation of the Evans anterior calcaneal osteotomy and had traditionally used percutaneous Steinmann pins for the posterior heel osteotomy. As trends moved toward fixation of the Evans osteotomy, it was a natural progression to simply push the pins into the anterior calcaneus to achieve stabilization of both osteotomies with two pins, thereby preventing displacement of the bone graft. We have noted that the posterior heel osteotomy is advanced without using the Steinmann pins and these across the Evans anterior calcaneal osteotomy serves as insurance against graft displacement and elevation of the anterior calcaneal osteotomy. Steinmann pins do not have the calibre and length of the screw, but placement of the drill and large-diameter screw through the Achilles tendon insertion in the posterior calcaneus is less than optimal. Furthermore, a large screw through the center of the graft is less desirable, where we are able to space the incision as far apart as possible from each other. Steinmann pin fixation requires more extensive dissection, adds cost, and may require a second operation for removal.

METHODOLOGY & HYPOTHESIS
After IRB-approval, we performed a retrospective analysis of consecutive patients that underwent double calcaneal osteotomies that were fixed with percutaneous Steinmann pins from 2008-2013. Inclusion criteria for this study consisted of having two calcaneal osteotomies performed and follow-up of at least 6 weeks with appropriate follow-up interval postoperative visits. Patients with any other form of double calcaneal osteotomy were excluded. The senior author (TJB) performed all procedures. Both authors did radiographic evaluations to determine the time to radiographic healing. Clinical healing was determined by an absence of pain at the surgical site. Other data collected included age, sex, tobacco use at time of procedure, chronic medical conditions, comorbidities, and weight bearing status (full weight bearing vs. non-weight bearing) at (in months). Our hypothesis is that this technique is safe, reliable, and cost-effective.

PROCEDURE
The procedures are performed in the supine position under general anesthesia with the patient in a neutral rotation. A straight skin incision is made on the posteromedial surface of the foot. An anterior skin incision is made on the posterior calcaneal osteotomy and for the Evans anterior calcaneal osteotomy (Figure 1a). The sural nerve is typically anterior to the posterior calcaneal incision and inferior to the anterior calcaneal incision. We typically place the incision into the Achilles insertion and plantar fascia to allow us to ensure our posterior incision is in the ideal location (Figure 1b). The posterior incision is then carried down to bone, as we are posterior to the sural nerve. We try to minimize the peritendinous dissection and only dissect where the osteotomy will be made. A Cope elevator is then used to free up the dorsal and plantar regions of the osteotomy of the calcaneus. The osteotomy is made with a standard saw blade made at 3 cm with a 45° angle to the bone. We then place a bone cross pin to help maintain the bone block. These pins are then removed if the subsequent incision/osteotomy is not needed. We carry the dorsal/plantar displacement across the posterior osteotomy, as the pull of the Achilles tendon tends to disrupt the posterior osteotomy (Figure 3). Next, we then make a second incision, as the posterior incision ends at the lateral border of the sinus tarsi in preparation for the Evans osteotomy.

A 1 cm incision is made in the medial skin just proximal to the ankle joint line and then carried down to bone, while staying below the posteromedial border of the calcaneus and parallel to the skin, as we would then be sacrificing the posterior calcaneal incision and inferior to the anterior calcaneal incision. The incision lines serve as a retrograde incision, as we will then use them in the future for the construction of the posteromedial osteotomy. We then place 2 K-wires over the skin under imaging to ensure our posterior incision is in the ideal location. Proper placement of the incision allows minimal dissection.

After closure of the Evans osteotomy, a 2.0 Steinmann pin is placed in the posterior aspect of the calcaneus and advanced into the anterior calcaneal osteotomy. We watch the pin insertion into the osteotomy, and then back it up slightly. A 2 cm skin incision can be placed the anterior incision as a temporary stop once the posterior osteotomy has been displaced [optioned].

The pull of the Achilles tendon tends to displace the posterior tuber superiorly during medial displacement or fixation. Marking the incision across the osteotomy ensures that there is no dorsal/plantar pin displacement prior to advancement of fixation

Next, a guide pin is inserted almost parallel to the calcaneus/calcaneus joint and passes through the posterior incision (Figure 4). The osteotomy is made using a sagittal saw and the medial corticotomy is left intact.

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The pins are then bent, cut, and rotated with the ends toward each other and overlapping (Figure 7a). Stirrups are then wrapped around the bent portions of the pins, holding them together to prevent rotation or loosening of either osteotomy. The pins are inserted with using torquing on the pins as needed in the sagittal plane and we must take care to avoid pinning through the posterior osteotomy. This is then confirmed under image guidance. We confirm radiographic alignment at 3, 6, and 9 weeks. Standard closure is then performed and the patient is placed into a well-padded posterior splint. They are kept non-weight bearing for 4 weeks. No pain care is done post-op.

LITERATURE REVIEW
The double calcaneal osteotomy is a powerful and well-accepted procedure for correction of flexible flat deformity with or without posterior tibial tendon dysfunction. Several fixation options have been previously reported for the double calcaneal osteotomy (3). In 2011, DiCosmo et al reported a case study of using two cannulated screws, one floating the calcaneal cuneiform. The second cannulated screw had a long threaded shank, which was reamed and inserted, followed by reaming of the same incision and making of a second calcaneal osteotomy. The medial pin was then inserted through the footprint and lateral pin was inserted through the calcaneus. In this study, all patients had 10-12 weeks of healing time, with an average of 11 months. However, a similar study by Wright et al, 2012 showed similar results but had an average period of healing of 8 months. In this study, the authors noted that some patients required less healing time, while others took longer. A 2012 study by Naik et al reported a similar period of healing time but noted that patients healed faster when using a transverse osteotomy in the calcaneus. In this study, all patients had 12 weeks of healing time, with an average of 11 months.

In conclusion, this retrospective study of consecutive cases demonstrates that two percent of patients had complications from calcaneal osteotomies as safe, reliable, and cost-effective. Furthermore, no patient identified any identical Achilles tendon complications associated with pin placement with just over 12 months follow-up.

REFERENCES
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