Periarticular opening wedge osteotomy for severe valgus deformity and associated rearfoot tarsal coalitions

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Introduction

There are multiple reported hindfoot reconstructive options for adult acquired flatfoot deformity, including the medial displacement calcaneal osteotomy, lateral based open wedge osteotomy, and Z-shaped osteotomies. The opening calcaneal osteotomy, also known as the Silver, is utilized to correct excessive heel valgus and attempts to realign the heel under the weight-bearing surface of the tibia. The relationship of the osteotomy site to the posterior subtalar facet can modify the biomechanics of the foot in several ways, with posterior tuberosity osteotomies correcting frontal plane deformity. There are multiple theoretical advantages of a lateral open wedge calcaneal osteotomy with bony allograft augmentation in adult acquired flatfoot deformity, one being the absence of long term calcaneal fixation devices and related comorbidities (intolerance, mobilization, and rupture), another being the large interface of cancellous bone tissue and stable mechanical support from the bony wedge that avoids the mismatch described for the MDCO, and finally the degree of correction of valgus can be calculated preoperatively. The periarticular midcalcaneal osteotomy has been described in one retrospective study by Colo et al, which highlights a smaller graft wedge that is more anterior than a traditional calcaneal slide osteotomy, allowing for maximum valgus correction. They determined that a correction of 3° correlates with a 4 mm wedge, 6° with 8mm wedge, and 9° with 12 mm wedge. This study however did not detail a specific reproducible osteotomy technique.

We highlight one case to describe our decision making and operative technique. A 57 year old female with a personal and familial history of multiple tarsal coalitions presented for evaluation of right foot and ankle pain. She had a prior history of a right ankle joint diagnostic and therapeutic injection into her subtalar joint which significantly helped her pain for several months. Physical exam demonstrated valgus ankle deformity with severe degenerative osteoarthritides, midfoot collapse, and rigid calcaneal valgus (Fig. 1a-d). Stress imaging (Fig. 1e) demonstrated reducibility of her tibiotalar valgus deformity. Evidence of a talocalcaneal coalition with osseous fusion at the middle and anterior facets, calcaneal navicular osseous coalition, posterior tibialis and peroneal tendon synovitis, and degenerative changes with osseous remodeling to the posterior talar dome were seen on MRI. Weight-bearing CT imaging confirmed the extent of the osteoarthritic degenerative changes in her tibiotalar joint with valgus tilt, talocalcaneal coalitions at the anterior and middle facets, and calcaneonavicular osseous coalition (Fig. 2a-b). Lateral weight-bearing foot radiograph demonstrated midfoot collapse.
with joint fault and flat talus dome associated with rearfoot coalition (Fig. 2c). She initially underwent stage I total ankle replacement (TAR) with the intent to correct the valgus foot deformity with stage II reconstructive surgery. Rectus ankle alignment was obtained with total ankle arthroplasty despite residual severe heel valgus deformity (Fig. 3a-b). The traditional 2 stage approach addresses foot deformity first followed by stage II TAR but the decision was made in this case to straighten the ankle first and then match the foot alignment to achieve rectus function. The stage 2 procedure was performed 9 months later involving naviculo-cuneiform fusion, opening wedge osteotomy, and gastrocnemius recession.

Surgical Technique

The procedure is performed in the supine position with a thigh tourniquet. The incision for midcalcaneal osteotomy is over the peroneal tendons with the tendons retracted posteriorly or anteriorly. The osteotomy is placed at a midcalcaneal location that is adjacent and just posterior to the subtalar joint. The midcalcaneal opening wedge osteotomy is completed with precision, ensuring the medial hinge is intact as to not disrupt the medial neurovascular structures (4a). Figs. 4b and 4c demonstrate the midcalcaneal osteotomy on axial and lateral imaging prior to graft insertion. A guide pin is placed in the posterior tuberosity prior to graft insertion which allows visualization of where the screw will ultimately cross the graft. The medial hinge is weakened using an osteotome (Fig. 4d). A smooth lamina spreader helps to determine size of graft needed (Fig. 4e). Two 7mm stacked wedges from a femoral allograft were inserted (Fig. 4f) but a variety of graft options are appropriate. The osteotomy site was fixated using 3 partially threaded cannulated screws from the posterior tuberosity, with full correction of valgus heel on axial image with intact medial hinge (Fig. 4g). Serial intraoperative axial imaging are used to assess the osteotomy technique, correction, and fixation. Fig. 5 demonstrates 6 week post-op imaging demonstrating graft incorporation without evidence of hardware loosening or fractures.

Fig. 1. Initial presentation of right valgus foot and ankle (a-d) with reducible ankle valgus on stress reduction imaging (e). Note extensive rearfoot coalition and associated midtarsal joint abnormality (c, d). Primary pain was from end-stage ankle DJD and sub-fibalar impingement on the calcaneus.

Fig. 2. Preoperative CT scan identified severe calcaneo-navicular and talocalcaneal coalition (a, b), with valgus talar tilt due to end stage degenerative arthritis (b). Lateral weight-bearing radiograph (c) demonstrates talocalcaneal coalition with the “C” sign, decreased calcaneal inclination angle, and naviculo-cuneiform fault.
Discussion and conclusion

Multiple coalitions with rigid heel valgus and midtarsal joint deformity created significant reconstructive challenges that required an alternative approach to correcting valgus heel deformity. Medial displacement calcaneal osteotomy (MDCO) is made posterior within the tuberosity as transposition procedures are not impacted by lever arm (Fig. 6a). The traditional technique for open wedge osteotomy is at this same posterior location which may be ineffective for correction of large valgus deformity without a large wedge due to lack of lever arm effect (Fig. 6b). The periarticular opening wedge osteotomy is made close to the subtalar joint (Fig. 6c) to achieve more correction using a smaller wedge due to the lever arm effect.

The patient was non-weightbearing in a posterior splint then removable boot for 6 weeks followed by four weeks of progressive weightbearing in the boot. She was back into regular shoes with custom orthotics at 10 weeks postop (Fig. 7). There was substantial improvement from prior severe calcaneal valgus deformity to rectus rearfoot alignment by utilizing the periarticular opening wedge osteotomy technique combined with TAR and midfoot fusion (Fig. 7e,f). She had returned to pain-free activities and standing work at 1 year follow up. There was no incidence of postop complications such as nonunion, delayed union, infection, DVT, wound healing complications, graft subsidence, hardware loosening or fracture. Lateral soft tissue closure was not a concern due to the smaller graft wedge size which also contributes to faster bone healing.

We described a case with a novel surgical technique in a patient with severe valgus deformity, multiple coalitions, and prior stage 1 total ankle replacement. Consideration of other rearfoot reconstructive surgical options such as the MDCO, traditional open osteotomy, or subtalar joint fusion with coalition resection would not likely have provided full

![Fig. 3.](image1)
![Fig. 4.](image2)
valgus rearfoot deformity correction. The periarticular opening wedge osteotomy placement is more anterior than the MDCO and traditional lateral opening wedge osteotomy. The advantages of the periarticular opening wedge osteotomy include a more anteriorly based osteotomy that increases the lever arm, thus achieving deformity correction with use of a smaller bone graft. With a smaller bone graft there is less tension on the lateral soft tissues which decreases the risk of wound complications along the lateral incision. Risks of the procedure include lateral dehiscence, nonunion, and delayed union like the traditional open osteotomy. The midcalcaneal osteotomy location is not ideal when considering medial displacement of the tuberosity due to risk of injury to the medial neurovascular structures. There is also risk of subtalar joint articular damage when fixing an osteotomy at the periarticular midcalcaneal location. Surgical pearls include planning the osteotomy

Fig. 5. Progressive healing and stable fixation is noted 6 weeks post-operative on AP (a) medial oblique (b) long leg axial (c) and lateral imaging (d).

Fig. 6. Preoperative planning on axial imaging is helpful to determine the optimal level and type of posterior heel osteotomy. Medial displacement calcaneal osteotomy was not expected to correct this degree of deformity since extent of slide is limited by soft tissue and bone overlap (a). The traditional lateral opening wedge osteotomy site is made in the posterior tuberosity where a large wedge is needed to achieve correction due to the short lever arm (b). We choose a less traditional midcalcaneal osteotomy location with the intent to obtain large deformity correction with a smaller graft wedge thickness (c). Large graft insertion can complicate soft tissue coverage and bone healing.
preoperatively to determine graft size and weakening the medial cortex using an osteotome. Overall, the periarticular opening wedge osteotomy is a useful rearfoot surgery for severe valgus deformity correction as demonstrated in Fig. 6. Additional studies are needed to long term outcomes.

Declaration of competing interest

None reported.

References


Fig. 7. 3 months post-operative clinical and radiographic result. Note rectus foot alignment with weight-bearing (a-c). Note the more anterior lateral heel incision location without healing issues despite closure issues commonly encountered with open wedge osteotomy (d). Comparison of the preoperative axial radiograph (e) and 6 week postoperative axial (f) demonstrates substantial improvement of severe valgus heel deformity achieved with midcalcaneal osteotomy.