CHAPTER **18**

EVANS CALCANEAL OSTEOTOMY: Surgical Pearls

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The Evans calcaneal osteotomy, first described by Dillwyn Evans in 1975, is a lateral column lengthening procedure that preserves the calcaneocuboid joint (1). This laterally based opening wedge osteotomy is historically known to provide transverse plane correction for pes planovalgus deformities. In reality, the Evans calcaneal osteotomy provides multi planal correction and is routinely used by foot and ankle surgeons to correct both pediatric and adult pes planovalgus deformities (2-7). In addition to lengthening the lateral column and reducing forefoot abduction, the Evans calcaneal osteotomy realigns the midtarsal joint and reduces calcaneal eversion. It also places tension on the long plantar ligaments and provides significant arch elevation and stabilization. It is because of this powerful, triplanal correction that the Evans calcaneal osteotomy has become the cornerstone of flexible flatfoot correction for the author. However, additional procedures in the medial column and a posterior lengthening typically accompany the Evans calcaneal osteotomy, in order to adequately gain full reduction of the complex pes planovalgus deformity. There is a small learning curve but few complications result when the Evans calcaneal osteotomy is technically performed correctly. The author offers some surgical pearls to ensure predictable, successful results.

The Evans calcaneal osteotomy is usually performed under general anesthesia with the patient in a supine position. The leg is then bumped over in a lateral position with an inflatable bean bag. The bean bag can then be deflated upon completion of the osteotomy to access other areas of the foot and lower extremity for additional procedures. A thigh tourniquet is also used to ensure good visualization and provide access for a gastrocnemius recession or Achilles tendon lengthening, which is routinely performed concomitantly with the Evans calcaneal osteotomy.

An oblique incision is placed over the anterior lateral calcaneus (Figure 1). The incision starts just dorsal to the most superior aspect of the anterior process of the calcaneus and continues proximally and plantarly in line with the relaxed skin tension lines. The midline of the incision is usually about 1 to 1.5 cm proximal to the calcaneocuboid joint where the osteotomy will be performed. The incision should end just plantar to the inferior edge of the calcaneus. This landmark is typically more superior then expected and it is common to continue the incision too far plantarly. The author recommends drawing anatomic landmarks and the incision itself for accuracy. This incision is advantageous because it is placed within the relaxed skin tension lines; therefore minimizing scar formation. This incision also provides good visualization of the surgical site but one should be aware of the surrounding vital structures. The intermediate dorsal cutaneous nerve is sometimes encountered in the most superior aspect of the incision and the peroneal tendons and sural nerve are in the most inferior aspect. Also, occasionally a communicating branch from the intermediate dorsal cutaneous nerve is encountered and may need to be sacrificed if it inhibits appropriate exposure of the surgical site.

A longitudinal, lateral incision can also be utilized, and although it parallels the peroneal tendons and sural nerve and there is less risk for injury to these structures, the author does not prefer this incision because it is against the relaxed skin tension lines and with the lengthening of the lateral column, thick scarring can result.

Blunt dissection is performed through the subcutaneous tissues until the extensor digitorum brevis muscle belly with its overlying deep fascia is encountered. The peroneal tendons are identified just inferior to the muscle belly. An incision is made along the inferior edge of the extensor

Figure 1. An oblique incision is drawn over the anterior calcaneus. Note the incision in relation to the calcaneocuboid joint and the peroneal tendons. The intermediate dorsal cutaneous and sural nerves are indicated with the dotted lines.

digitorum brevis muscle belly to allow retraction of the peroneal tendons plantarly. Care should be taken not to violate the peroneal tendons or their tendon sheath. A vertical incision is then made along the proximal edge of the muscle belly at about the level of the sinus tarsi. The extensor digitorum brevis muscle belly and its overlying deep fascia are then tagged with suture and reflected as one layer off of the underlying bone and retracted distally to expose the anterior calcaneus.

The calcaneocuboid joint is identified, but aggressive dissection should be avoided. The ligaments must remain intact so the joint is not destabilized. The calcaneocuboid joint is bluntly identified with a Freer elevator and then an 18 gauge needle is placed into the joint as a reference point. Next, a key elevator is utilized to reflect the soft tissues on the anterior, lateral calcaneus along the proposed osteotomy site and proximal to the calcaneocubiod joint. Retraction is then placed along the superior and inferior borders of the calcaneus to adequately expose the lateral surface of bone and protect the peroneal tendons.

Correct osteotomy placement is crucial for success of this procedure and the author will draw the osteotomy prior to execution to ensure accuracy. The osteotomy is performed 11 to 15 mm proximal to the calcaneocuboid joint. If the osteotomy is too distal or too close to the calcaneocuboid joint, the anterior fragment of the calcaneus will be too small and unstable and can dislocate dorsally. A small anterior fragment could also become dysvascular resulting in healing difficulties. Finally, it may violate the anterior facet of the subtalar joint. If the osteotomy is too proximal, it can violate the middle facet of the subtalar joint and subsequent pain and arthritis could result.

Hyer et al, in a cadaver study found that the majority of calcanei (56%) had a conjoined anterior and middle talocalcaneal facet, 3% had an absent anterior facet, and 41% had separate facets. They also found that the mean distance from the anterior border of the calcaneus to the proximal edge of the anterior facet was 11.04 mm and the mean separation between the anterior and middle facets, when present, was 3.85 mm (8). Therefore, they concluded that the ideal placement of the Evans calcaneal osteotomy is 11-15 mm proximal to the calcaneocuboid joint. Traditionally, the angle of the osteotomy has been performed perpendicular to the lateral wall of the calcaneus and weight-bearing surface and parallel to the calcaneocuboid joint. A follow-up cadaver study by Bussewitz et al, confirmed placement of the osteotomy as previously described but recommends that the osteotomy be angled slightly from posterolateral to anteromedial to avoid penetrating the arm of the sustentaculum tali, a vital load-bearing structure and the apex of the longitudinal arch (9).

The osteotomy is made from lateral to medial with a sagittal saw. An osteotome is then utilized to complete the cut through the medial cortex. This should be done very carefully to avoid violation of the medial neurovascular bundle and tendons. Next, the osteotomy is opened. The author utilizes a lamina spreader without teeth, however a mini distractor can be utilized if desired. If the osteotomy is resistant to distraction, then it is probably incomplete. The most common place of osseous continuance is the plantarmedial aspect. An osteotome can be gingerly used to transect any points of osseous connection.

The osteotomy is then distracted until desired correction is achieved (Figure 2). The ideal position of the rearfoot is with the heel in a rectus or slight valgus position. The gap at the osteotomy site is then measured and a bone graft is fashioned. The correction in most pediatric patients averages 10 mm and typically ranges from 8 to 12 mm. In an adult, however, the maximum bone graft size utilized is 8 mm. The author typically does not use bone grafts over these dimensions because it can cause increased pressure and secondary pain and arthritis at the calcaneocuboid joint. A large bone graft can also cause displacement of the anterior calcaneus. If further correction is needed, and the maximum bone graft size has been reached, the author will typically perform a medial displacement osteotomy in the posterior calcaneus, in addition to the Evans osteotomy instead of utilizing a larger bone graft.

The author utilizes allogeneic bone graft. Many authors have shown that due to the increased vascularity of the calcaneus, allogeneic bone graft incorporates very well and autogenous bone graft is not warranted for this

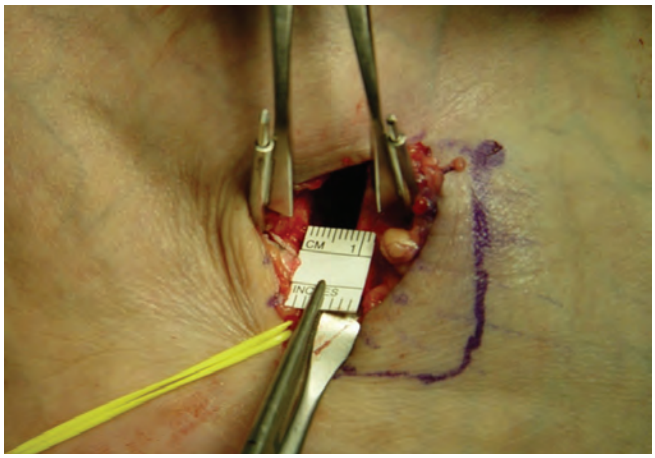

Figure 2. The osteotomy is opened with a distractor until desired correction is obtained. The gap is then measured to determine the size of bone graft needed, which in this case is 8 mm.

procedure (10-12). Also, a combined corticocancellous bone graft is the most advantageous graft for this procedure. The cancellous bone allows increased vascularity and aids in graft incorporation and healing and the cortical bone adds strength to the graft to combat the compressive forces within the osteotomy. The author prefers to use a tricortical iliac crest allogeneic bone graft, 15 to 18 mm in width. This width will typically allow enough bone graft for the Evans osteotomy and a Cotton osteotomy if also needed for further correction of the medial arch.

The bone graft is then fashioned into a trapezoidal shape (Figure 3). The cortical bone is going to be on the dorsal, lateral, and plantar aspects and the cancellous bone will be on the distal and proximal aspects of the osteotomy. The most lateral aspect of the bone graft is the widest and it tapers down to about 3 to 4 mm as it goes medially.

Precut allogeneic bone wedges are also available. The author has utilized some of these grafts with success however, it should be noted that these grafts are usually only bicortical. These grafts are also sometimes longer than desired, from lateral to medial, especially in pediatric patients, and need to be cut and shortened to fit properly. If these precut grafts are utilized, the author recommends minimal tamping and manipulation of these grafts to ensure their strength and integrity are maintained. Although other types of grafting/wedge material are available for the Evans calcaneal osteotomy, the author does not have any personal experience with these devices and will not report on them. The preferred choice of bone graft for the author, based on experience, success, and repeatability, is allogeneic, tricortical iliac crest bone graft, that is cut and fashioned individually.

Once the bone graft is appropriately fashioned, the osteotomy site is distracted slightly beyond the desired corrected position allowing the bone graft to easily be inserted and tamped into place. If the osteotomy is not opened wide enough, the bone graft could be compromised with excessive tamping and manipulation required for accurate placement, and ultimately loss of correction could result during insertion. The lateral edge of the bone graft should line up evenly with the lateral wall of the calcaneus without any osseous prominence (Figure 4). The surgeon should also ensure that the bone graft has not rotated dorsally or plantarly during insertion. The bone graft should be placed in the central portion of the osteotomy and avoid dorsal placement where it could enter into the subtalar joint. The bone graft usually does not fill the entire space of the osteotomy; however, the graft typically incorporates very well and these open spaces are not cause for concern. Additional bone graft can be added if desired but this is not standard for the author.

Figure 3. The bone graft is fashioned into a trapezoidal shape. The widest portion of the graft will be the most lateral aspect.

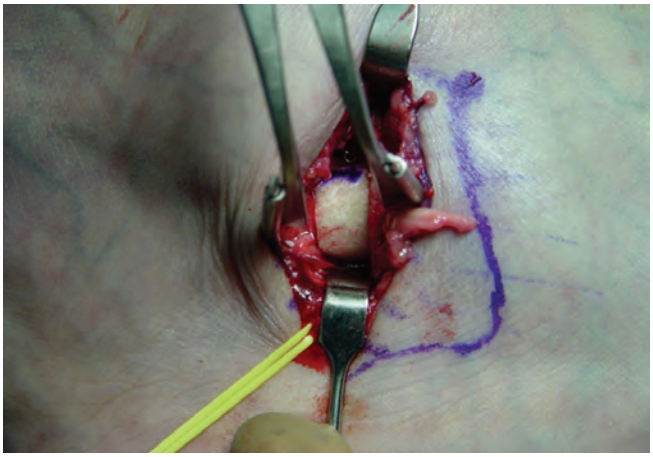

Figure 4. The bone graft has been successfully tamped into place in the central portion of the osteotomy and is flush with the lateral wall of the calcaneus.

Once the bone graft is placed, stability is assessed. Since the bone graft is under significant compression, it is usually very stable within the osteotomy, and fixation is not routinely utilized by the author. If the anterior fragment of the calcaneus is unstable, or if it appears dorsally dislocated, fixation can be obtained with a percutaneous Kirschner wire or Steinman pin, or plate and screw fixation may be utilized. The two main reasons for displacement of the anterior fragment are aggressive dissection of the calcaneocuboid ligaments creating instability or placement of too large of a bone graft. The surgeon may want to reassess the size of the bone graft if there is dorsal displacement of the anterior process of the calcaneus.

Standard tissue and skin closure is then performed and the foot is assessed for remaining deformities. Typically, a forefoot supinatus and equinus deformity is present, warranting additional procedures such as a Cotton

Figure 5A. Preoperative radiograph shows significant increase in the talocalcaneal, calcaneocuboid, and talar declination angles. Also with a decrease in the calcaneal inclination angle and significant talar head uncovering.

Figure 5B. Preoperative lateral radiograph.

Figure 5C. Postoperative radiographs of an Evans calcaneal osteotomy, Cotton medial cuneiform osteotomy, and an Achilles tendon lengthening. Note the triplanal correction achieved with good realignment of the joints and correction of the abnormal angles seen preoperatively.

Figure 5D. Postoperative lateral radiograph.

medial cuneiform osteotomy and appropriate posterior lengthening, in order to gain full correction of the pes planovalgus deformity.

Postoperatively, the patient is kept non-weightbearing in a cast for about 6 weeks or until osseous consolidation is achieved radiographically. The patient is then transitioned to a Cam walker and begins weightbearing and range of motion exercises over the next 3 weeks. Continuation to full weightbearing and normal shoegear then ensues as pain and swelling permit. Obviously, this postoperative course can be modified or changed as needed depending on other procedures performed.

The author has found the Evans calcaneal osteotomy to be a powerful procedure resulting in triplanal correction for flexible pes planovalgus deformities (Figure 5). It is the work horse for this deformity but it cannot stand alone. Additional procedures such as a Cotton osteotomy and gastrocnemius recession or Achilles tendon lengthening are typically performed in order to gain full correction of this complex deformity. The author has found that the described surgical technique is reliable and consistently renders successful results.

Surgical Pearls:

- Make an oblique incision in line with the relaxed skin tension lines and avoid the peroneal tendons and sural nerve.
- Avoid aggressive dissection of the calcaneocuboid joint.
- Osteotomy placement should be 11 to 15 mm proximal to the calcaneocuboid joint and angled slightly from posterolateral to anteromedial.
- Allogeneic, tricortical iliac crest bone graft fashioned individually, produces a custom fit and provides strength while aiding in bone graft incorporation.
- Fixation of the osteotomy is not utilized if the osteotomy is stable and there is no dislocation of the anterior process of the calcaneus.
- If a large bone graft is required to gain adequate correction with the Evans calcaneal osteotomy, consider performing a double calcaneal osteotomy instead. In this scenario, an Evans calcaneal osteotomy with a smaller bone graft can be used, avoiding potential complications, and a posterior medial displacement osteotomy can also be performed to gain further correction.
- Perform additional procedures in the medial column and posterior muscle group as warranted for full correction of the pes planovlagus deformity.

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