

COMPLICATIONS OF THE EVANS CALCANEAL OSTEOTOMY

Kieran T. Mahan, DPM

The Evans calcaneal osteotomy was first described by Dillwyn Evans. He had noticed that lengthening the lateral column in an over corrected clubfoot could reduce the amount of valgus deformity present. He therefore applied this technique to treatment of rigid flatfeet, mostly post-polio. He used a longitudinal incision along the lateral side of the calcaneus and performed an osteotomy proximal to the calcaneal cuboid joint. He inserted a tibial bone graft. He described very good results with this and a follow-up study performed on long-term observations of his patients demonstrated only small amounts of degenerative joint disease.

The technique became popular in this country through a teaching film by Dr. James Ganley. Many members of The Podiatry Institute adopted this procedure as a technique for the treatment of the collapsing pes valgus deformity. The procedure was modified in terms of the graft material, and the incisional approach. The incisional approach was modified to an oblique incision in order to follow the relaxed skin intension lines. The bone graft material was modified to use allogeneic bone bank bone. Initially, cortical tibial struts were used; subsequently allogeneic iliac crest has been utilized.

A number of studies have demonstrated significant positive radiographic indicators for correction of deformity following the Evans calcaneal osteotomy. The procedure has been used for treatment of both the adolescent and the adult flatfoot. Some questions have been raised about the procedure in the adult flatfoot, particularly related to the possible promotion of degenerative joint disease at the calcaneal cuboid joint in these patients. Most commonly, the procedure is accompanied by additional procedures. This author most commonly utilizes a medial column suspension with or without a Cotton osteotomy as well as a tendo achillis lengthening or gastrocnemius recession. The author has found that the results from this particular combination of procedures have been successful and predictable. Nonetheless, as with all procedures, there is the potential for complications. There are very limited studies that document complications with this procedure. The purpose of this article is to categorize some of the complications that do occur with this procedure based upon the author's experience with hundreds of these procedures over twenty years.

SOFT TISSUE COMPLICATIONS

Some soft tissue complications can relate to the incision design. The longitudinal incision first developed by Evans, did not follow the relaxed skin tension lines and tended to produce scars that were somewhat thicker because of the tension on the incision line. The oblique incisional approach produces a very fine line scar. However, the oblique incision also makes it much more likely that the incision may entrap either the intermediate dorsal cutaneous nerve on the superior margin of the incision or the sural nerve on the inferior margin of the incision. The intermediate dorsal cutaneous nerve is much less frequently violated. This may be because its location is usually just above where the incision needs to end superiorly and also because it is easier to retract and protect from the saw blade. The sural nerve on the other hand is right at the inferior margin of the incision is more likely to be interrupted. Entrapment of the sural nerve can create significant problems. Initial treatment with physical therapy and corticosteroid injections may prove successful, but if there is significant neuroma as a result of damage to the nerve, then surgical resection of the neuroma may be necessary. Some patients do experience numbness in the sural nerve distribution but actual entrapment of the sural nerve is more rare. However when it does occur, it can create quite significant symptoms.

The peroneal tendons also lie on the inferior margin of the incision. The tendon sheath is not infrequently violated during the sub periosteal dissection inferior to the calcaneus. In addition inadequate retraction may allow the saw blades to damage the tendons. Symptoms along the peroneals are usually transitory. In addition to acute damage occurring at the time of surgery, symptoms may be initiated by the increased tension placed on the peroneals by the addition of the graft length to the lateral column. In the author's experience this has been infrequent and transitory. No additional surgical procedures have been necessary to treat peroneal tendonitis.

The other important soft tissue structures in the vicinity are the ligaments surrounding the calcaneal cuboid joint. If the dorsal calcaneal cuboid ligament is violated, then the anterior beak of the calcaneus may

become unstable and dislocate superiorly. In this situation pinning of the osteotomy from the cuboid to the body of the calcaneus is necessary. During the course of the Evans procedure, meticulous care is taken to avoid incising ligaments at the calcaneal cuboid joint (Figure 1).

OSTEOTOMY

The placement of the osteotomy for the Evans procedure is critical. The factors that are involved in the design of the location include; 1) the location of the anterior and middle facets of the subtalar joint, 2) the circulation of the calcaneus and, 3) placement with respect to other vital structures in the area. Raines and Brage did a study looking at critical structures in this area and determined that the cut should ideally be placed 1cm proximal to the calcaneal cuboid joint and indeed this is the area that is most commonly utilized for this procedure.

Errors that can occur include the following. If the osteotomy is placed too distal, then the anterior beak of the calcaneus becomes a relatively small fragment with minimal blood supply. This can result in avascular neurosis of the distal fragment and degenerative disease. The osteotomy also needs to be performed perpendicular to the lateral wall of the calcaneus. If the osteotomy is angulated too far distally, the lateral portion of the anterior beak becomes too small. If the osteotomy is cut too far proximal, then the middle facet can be violated, creating the possibility of the development of arthritis within the subtalar joint. The location of the middle facet can be identified with a freer elevator prior to the bone cut. Keeping the cut approximately 1cm proximal to the calcaneal cuboid joint is another technique for avoiding these complications.

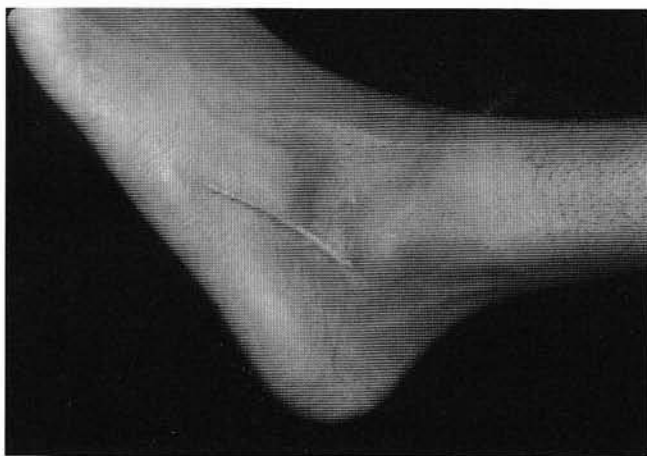


Figure 1. Lateral view showing wide scar after longitudinal approach to Evans. This approach is opposite to the relaxed skin tension lines (RSTL). The oblique incisional approach parallels the RSTL.

CORRECTION

The Evans calcaneal osteotomy produces correction in multiple planes. When the procedure was first popularized, it was known primarily as a procedure that produces correction in the transverse plane. The correction in the transverse plane is indeed quite profound. However correction also occurs in the sagittal plane to quite a significant degree and the frontal plane as well. If the graft is too large or the resulting tension on the inferior calcaneal ligaments is too great, then an excessive amount of plantarflexion of the lateral column can occur. This creates an excessive amount of anterior equinus deformity. If the graft really is too large, this may create excessive pressures on the calcaneal cuboid joint. Cooper and others have examined this problem regarding pressures at the calcaneal cuboid joint. In my experience, this has rarely been a problem in the adolescent flexible flatfoot. The few times when it has been a problem have been those times when the Evans was used to treat a more rigid flatfoot deformity. In these cases degenerative joint disease at the calcaneal cuboid joint did result. In the adult patients with acquired flatfoot, grafts of 1cm or more can create degenerative joint disease at the calcaneal cuboid joint. In adult patients, I typically utilize grafts that are approximately 7mm or so, 3 – 4mm smaller than those that are used adolescent patients.

Under correction is less likely with this procedure than in many procedures that we utilize. Risk factors that may be associated with under correction include a high talar calcaneal divergence on the AP radiograph and a high degree of heel valgus. Graft size must be adequate for correction and in many cases correction must rely on the addition of significant procedures for the medial column, release of equinus, and perhaps other osteotomies and limited fusions (Figure 2).

GRAFT MATERIAL

The graft material utilized by Evans and subsequently by Ganley was autogenous cortical tibial bone. Subsequently allogeneic bone bank bone has been used by many authors. This has the advantage of avoiding the procurement of autogenous bone from the patient, which carries with it significant complication risks, particularly at the iliac crest. Allogeneic bone has performed quite well for this procedure because of the excellent vascularity of the calcaneus, which has numerous sources of blood supply.

In a study by Mahan and Hillstrom (1998), we identified 127 calcaneal osteotomies, of which 126 were allogeneic bone. Only one of these went on to a delayed



Figure 2A. Lateral radiographs showing good correction. Pre-operative view - note declination of talus, low calcaneal inclination angle.

union. Nonetheless whether the patient is young or old, delayed or non-union can occur. In my experience, this has been more likely to occur in adult patients with larger size bone grafts. To date, I have not had to re-operate on any of these patients for non-union. Each of them has responded to addition immobilization time and use of a non-invasive bone stimulator (Figure 3).

AUTHOR'S RECOMMENDATIONS

There are a number of recommendations that I would make based on observations of the procedures over the years.

I use grafts up to 1.2 or 1.4cm in diameter in adolescent patients that are tapered 3 or 4mm more narrowly on the medial side. In adult patients the lateral dimension is usually no greater than 7mm. If additional correction is necessary for a particular foot, then other procedures may need to be performed. In addition, I will usually place a supplemental piece of bone graft below the primary piece of bone graft in order to simply increase the healing potential and support the distraction of the osteotomy.

Ancillary procedures are almost always necessary with the Evans calcaneal osteotomy in any type of significant flexible flatfoot. Most commonly I perform a medial column suspension with or without a Cotton osteotomy. The medial suspension consists of a Young's suspension, an advancement of the tibialis posterior, and shortening or tightening of the spring ligament. In the Young's suspension, half of tibialis anterior is translocated into a keyhole slot in the navicular. The other half is utilized as a strut along the medial aspect of the foot for ligamentous reinforcement. This procedure allows peroneus longus to pull down on the first ray without



Figure 2B. Postoperative view at 6 months with the Evans graft fully healed, Cotton graft healed but, still radio dense in first cuneiform, with good correction of talar declination and calcaneal inclination.



Figure 3. Lateral radiograph demonstrating healing area from pull off fracture off inferior aspect of anterior beak of the calcaneus. Most likely caused by excessive tension on the short plantar ligament by the lengthening effect of adding the Evans graft.

opposition from tibialis anterior. In addition it creates a strong plantar ligament at the navicular cuneiform joint where there is often some compensatory sag. The Cotton osteotomy is performed when there is structural elevation of the medial column. This consists of a vertical osteotomy in the medial cuneiform with a small triangular opening wedge graft to create plantarflexion. Usually the graft is only 4 or 5mm wide at the superior aspect of the cuneiform. The plantar aspect of the cuneiform is maintained without breaking the hinge. Frequently a posterior group lengthening is necessary. One of the profound effects of the Evans calcaneal osteotomy is to create significant plantarflexion of the forefoot on the rearfoot. This creates a pseudoequinus deformity that, when added to the patient's existing

equinus deformity, makes lengthening of the posterior group muscles critical.

Avoidance of the sural nerve is critical. The deep incision that is used to reflect the extensor digitorum brevis muscle belly is performed just above the peroneals. This usually allows the sural nerve to be retracted inferiorly along with the peroneals. They can be protected there with a Senn retractor or a curved Crego elevator, which is inserted around the calcaneus. Once the procedure has been completed, it continues to be important to be vigilant about the sural nerve. A suture looping around the sural nerve or a needle passing through it can create significant problems.

The location of the osteotomy is critical. The osteotomy is located 1cm or so proximal to the calcaneal cuboid joint and is then performed perpendicular to the lateral wall of the calcaneus. This location is best in terms of avoiding critical structures. The freer elevator can be utilized to identify the location of the middle facet and the location of the calcaneal cuboid joint to ensure that these are not violated.

There is no reason to believe that the benefits of autogenous bone would exceed their risks for this particular procedure. Allogeneic bone has historically performed exceptionally well in this location. Nonetheless it is important to use bone of sufficient density that it will resist the compressive forces caused by the distraction lengthening. It is also important to use a graft that is a composite of cortical and cancellous bone to facilitate the right balance between strength and healing. It is unknown whether supplemental materials such as bone graft substitutes or platelet gel products would accelerate this healing around the graft to any significant degree.

As indicated earlier, the effect of the Evans is to create an anterior equinus. Until the size of the graft has been determined, the decision about whether or not to perform a posterior group lengthening cannot be finalized. If the posterior group lengthening is necessary, then the gastrocnemius recession is performed if only the gastrocnemius muscle is tight. If both the gastrocnemius and soleus muscles are tight then a tendo achillis lengthening is performed. This can either be performed as an open tendo achillis lengthening from a medial approach or as a percutaneous tendo achillis lengthening.

The vast majority of time, I don't pin an Evans calcaneal osteotomy. However there are times when I have

regretted not pinning an Evans calcaneal osteotomy. Some instances are clear where pinning should be performed. If an Evans calcaneal osteotomy is performed in conjunction with resection of a calcaneal navicular bar for example, then a pin is very likely to be necessary because of the destabilization of the calcaneal cuboid joint. Also if a larger graft (1.2 cm or above) is utilized, then the risks of anterior superior subluxation of the anterior beak of the calcaneus is greater and placement of a .062 K wire or 5/64 Steinmann pin are helpful. This can prevent loss of correction as well as displacement of the graft.

Of primary importance is insuring that the procedure is performed for the right indications. The Evans calcaneal osteotomy is less likely to be effective in the presence of wide talo calcaneal divergence on the AP views of the foot. In addition, severe heel valgus might indicate an alternation of the spring ligament and deltoid ligament, which would require significant medial procedures to be performed if correction is to be maintained.

In my experience the Evans calcaneal osteotomy has not performed well on rigid feet. By rigid foot I don't just mean a foot with a coalition but a flexible flatfoot where there is just a much more limited amount of available range of motion. In these patients, full correction of the deformity has been less likely, displacement of the graft has been more likely, and the healing has generally taken longer. The Evans is a wonderful predictable procedure – most of the time. The above discussion is intended to remind the reader of the complications that can occur.

BIBLIOGRAPHY

- Cooper P, Nowak M, Shaer J. Calcaneocuboid joint pressures with lateral column lengthening (Evans) procedure. *Foot Ankle Int* 1997;18:199.
- Mahan KT, Flannigan P. Pes Valgus Deformity. In: Banks A, Downey M, Martin D, Miller S, *McGlamry's Textbook of Foot and Ankle Surgery*, Third Edition. Philadelphia:Lippincott Williams & Wilkins; 2001.
- Mahan KT, Hillstrom H. Bone grafting in foot and ankle surgery: a review of 300 cases. *J Am Podiatr Med Assoc* 1998;88:109-18.
- Mahan KT, McGlamry ED. Evans Calcaneal Osteotomy for Flexible Pes Valgus Deformity: a Preliminary Study. *Clin Pod Med Surg* 1987;4:137-51.
- Raines R, Brage M. Evans osteotomy in the adult foot: an anatomic study of structures at risk. *Foot Ankle Int* 1998;19:743.