Combination of Evans Calcaneal Osteotomy and STA-Peg Arthrodesis for Correction of the Severe Pes Valgo Planus Deformity

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Twenty patients with 25 symptomatic severe flexible pes valgo planus were treated with a combined surgical technique. All patients underwent an Evans calcaneal osteotomy with allogenic bone graft and subtalar joint arthrodesis (STA-Peg) procedure. Adjunctive procedures as deemed necessary included Achilles tendon lengthening, navicular-cuneiform fusion, Lapidus first metatarsal cuneiform fusion, Cotton medial cuneiform plantarflexory wedge osteotomy with allogenic bone graft, plantarflexory medial cuneiform osteotomy, and excision of os tibiale externum. A retrospective pre- and postoperative radiographic evaluation revealed the following mean changes: lateral talo-first metatarsal angle, 16.9° to −0.6°; calcaneal cuboid abduction angle, 24.8°−2.8°; anterior posterior talocalcaneal angle, 25.3°−15.4°; talonavicular coverage angle, 22.7°−5.2°; calcaneal inclination angle, 10.6°−18.6°; talar declination angle, 32.4°−16.4°; lateral talocalcaneal angle, 18.3°−5.2°. A subjective questionnaire revealed that 100% of the patients stated they were satisfied or very satisfied with the surgery and achieved an average score of 93 based on a 100-point scale. (The Journal of Foot & Ankle Surgery 38(5):339−346, 1999)

Key words: calcaneus, Evans osteotomy, pes valgo planus, subtalar joint arthrodesis

The severe symptomatic flexible flatfoot that is unresponsive to conservative treatment can create a perplexing dilemma when considering surgical intervention. Numerous osseous and soft-tissue procedures have been described in the literature to correct the painful flexible flatfoot with no one procedure or combination of procedures emerging as the “gold standard” (1−7). The purpose of this paper is to present the authors’ experience with a combined surgical technique of Evans calcaneal osteotomy with allogenic bone graft and subtalar joint arthrodesis (STA-Peg)2 with adjunctive procedures for the treatment of the severe flexible flatfoot. The combination procedure was developed specifically to address those patients who present with a combined rearfoot pathology. It is reserved for those individuals who demonstrate excessive foot abduction indicated by an increase in the calcaneal cuboid abductus angle along with an increase in the talocalcaneal divergence angle and medial talus ptosis.

In those individuals exhibiting a severe flexible pes valgo planus deformity, the combined Evans calcaneal osteotomy with STA-Peg arthrodesis procedure can produce significant improvement over the preoperative lifestyle with significant reduction in pain. This is accomplished by stabilization of the rearfoot complex and limiting excessive midtarsal joint motion. The combined procedure not only addresses the exogenous subtalar joint pronation but also the transverse plane forefoot pathology associated with excessive abduction of the forefoot, resulting from a functionally short lateral column. Excessive subtalar joint motion is reduced while continuing to allow normal motion of the joint. A mechanical locking of the midtarsal joint is accomplished resulting in an improved fulcrum for the peroneus longus to plantarflex the first ray. Triplanar rearfoot control re-establishes the windlass mechanism with stabilization of forefoot hypermobility resulting in significance enhancement of medial column correction (8).

As with all other flatfoot reconstructions, the combination procedure also may incorporate adjunctive procedures such as gastrocnemius recession, Achilles tendon lengthening, Cotton opening medial cuneiform osteotomy, Lapidus first metatarsal cuneiform arthrodesis, navicular-cuneiform arthrodesis, excision of os tibiale externum, or plantarflexory wedge medial cuneiform osteotomy.

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Historical Perspective

The STA-Peg arthrodesis procedure has been found to be an effective means of surgically treating the hypermobile flatfoot in the pediatric population (8–10). Smith and Millar originally described the STA-Peg arthrodesis procedure in 1983 (9). The Smith STA-Peg implant is an endoprosthesis made of ultra-high-density polyethylene which has demonstrated excellent long-term success and biocompatibility in the pediatric and adolescent population (8–10). The use of an endoprosthesis was a modification based on Chambers’s original procedure where limitation of subtalar joint pronation was achieved by elevating the calcaneal sulcus utilizing a bone graft (8). The premise of arthrodesis is to restrict anterior migration and plantar subluxation of the talus by the elevation of the floor of the sinus tarsi by a mechanical block of motion. Historically, the subtalar joint arthrodesis was intended for the symptomatic pediatric flexible pes valgo planus deformity and the skeletally immature foot. The intent was to preserve normal subtalar motion while limiting exogenous subtalar and midtarsal motion in the painful pediatric flatfoot. This in turn improved, if not corrected, the underlying pathomechanics and restored normal anatomical function (9).

The STA-Peg procedure, as initially described, was not intended for adult flatfoot deformity as an isolated procedure. It has since been utilized in our practice in conjunction with medial column procedures in limited adult cases, with satisfactory outcomes. The STA-Peg implant, when used as an independent procedure in the late adolescent or the adult, may deliver more mechanical load to the calcaneus and lateral process of the talus than they are able to withstand. Literature has reported cystic degeneration of the lateral process of the talus and absorption of the implant into the calcaneus and/or talus (9).

Evans first described the calcaneal osteotomy in 1959 as a procedure to compensate for an overcorrection of clubfoot deformity (4). The effects of calcaneal lengthening on the relationship of the hindfoot, midfoot, and forefoot have been documented by a multitude of authors (11–15). Consistent findings in literature state that by realigning or restoring the length of the lateral column, the forefoot is displaced in front of the talus, thereby locking the midtarsal joint. This phenomenon provides a stabilizing effect on the peroneus longus by advancing the cuboid distally. The oblique midtarsal joint axis assumes a more perpendicular orientation resulting in decreased abduction of the forefoot on the rearfoot and maintenance of medial column stability (16).

The amount of correction achieved in the transverse plane typically is limited by the graft thickness. Graft thickness in excess of 10 mm has demonstrated excessive retrograde compression forces with in vitro studies, which may result in calcaneocuboid joint arthropathy (17). In this study, graft thicknesses in the adult were limited to 10 mm or less. Variations in grafting techniques have included both autogenous and allogenic tricortical iliac crest graft, with or without fixation often carved into either “T” or trapezoidal shapes. All have reported consistent good to excellent results with low morbidity, resolution of preoperative symptoms, and osseous structural radiographic and clinical improvement (11, 15, 16).

Methods

Twenty patients (25 feet) underwent an Evans calcaneal osteotomy with allogenic bone graft, subtalar joint arthrodesis (STA-Peg), and adjunctive procedures between March 1994 and June 1998 with an average follow-up of 25.6 months with a range of 6–54 months. Adjunctive procedures as deemed necessary included Achilles tendon lengthening, navicular-cuneiform fusion, Lapidus first metatarsal, medial cuneiform fusion, Cotton medial cuneiform opening-wedge osteotomy with allogenic bone graft, plantarflexory medial cuneiform osteotomy, and excision of os tibiale externum with reattachment of the posterior tibial tendon (Table 1). The average patient age was 20.4 years with a range of 9–71. There were 13 females and 7 males. A retrospective quantitative radiographic analysis was performed on the most recent radiographs. Radiographs were taken at 2 weeks, 6 weeks, 3 months, 6 months, and 1 year or longer (Figs. 1–4). The following angles were measured preoperatively and postoperatively (16, 18):

- **Anterior posterior radiographic angles**: Meary’s talo-first metatarsal angle, calcaneocuboid abduction angle, Kite’s talocalcaneal angle, and talonavicular coverage angle.
- **Lateral radiographic angles**: Calcaneal inclination angle, talar declination angle, talocalcaneal angle, and Simon’s talo-first metatarsal angle.

All 20 patients agreed to complete the subjective questionnaire originally described by Mahan and McGlannery (19) (Table 2) by phone interview or mail. Five patients requested surgical intervention on the contralateral foot with minimum time of 5 months between surgeries. All patients had previously failed a conservative treatment regimen consisting of orthotic therapy, oral nonsteroidal anti-inflammatory medication, surgical postoperative shoe, and cast immobilization.

Surgical criteria for this procedure combination was based on the exhibition of all three of the following
TABLE 2  Patient questionnaire

<table>
<thead>
<tr>
<th>Why did you have flatfoot surgery?</th>
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<tr>
<td>Pain</td>
</tr>
<tr>
<td>Pain and Deformity</td>
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<tr>
<td>Deformity</td>
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<tr>
<td>Other</td>
</tr>
</tbody>
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Does anyone else in your family have a flatfoot?

What improvement have you had on scale of 0 (no improvement) to 100 (complete improvement)?

Were special devices such as orthotics prescribed to wear in your shoes after surgery?

If yes, do you wear them regularly?

How long after surgery (in weeks) did it take before you could resume your daily activities?

Would you recommend the operation that you had to others with a problem similar to yours?

In terms of satisfaction are you:

- Very satisfied?
- Satisfied?
- Neither?
- Other?

findings: 1) increased calcaneocuboid abductus angle, 2) increased talocalcaneal divergence angle, and 3) an unmasking of the talonavicular joint of greater than 40%. X-rays and clinical exam demonstrated the absence of degenerative joint disease in the subtalar, talonavicular, and calcaneocuboid joints. All patients had flexible and reducible deformities. Adjunctive procedures that address first ray hypermobility and equinus were commonly included in the surgical correction. First ray hypermobility was assessed clinically and radiographically. Excessive motion of the first ray (greater than 10 mm) was used as an inclusive criterion for hypermobility. The length of the first ray dictated procedure selection. A long first metatarsal relative to the second metatarsal was corrected with a Lapidus first metatarsal cuneiform fusion or plantarflexory medial cuneiform osteotomy. A short first ray had a Cotton medial cuneiform opening osteotomy with allogenic bone graft performed. The Cotton maintained first ray length while stabilizing and plantarflexing the first ray. In one instance, a navicular cuneiform fusion was used to stabilize a medial column breach at this joint. During this study, patients with equinus (limited dorsiflexion less than 90°) were treated with a sagittal Z Achilles tendon lengthening or a gastrocnemius recession.

Surgical Procedure

The patient was placed upon the operating table in a position consistent with the procedure. In the event there was an underlying equinus, either a gastrocnemius recession or Achilles tendon lengthening was done in the prone position prior to the Evans STA-Peg procedure. The patient was then rotated on the operating table to a lateral decubitus position and maintained with a vacuum pack Bean Bag and landmarks for the Evans STA-Peg procedure were identified. A thigh tourniquet was typically utilized for the procedure and was released after the initial tendon lengthening and then reinflated after repositioning the patient. The subtalar joint arthroereisis procedure was performed first in the fashion described by Smith (9). The initial skin incision was modified from the original technique described by Dwilly Evans (4) and later modified by Mahan and McGlamry (19) to incorporate an inverted lazy L approach. The most distal aspect of the incision begins at the anterior process of the calcaneus at the calcaneocuboid joint and continued proximally and plantarly to the base of the calcaneus. It was approximately 14–2 cm proximal from the calcaneocuboid joint articulation. This allowed access to the anterior process of the calcaneus and for evacuation of the contents of the sinus tarsi which would facilitate the calcaneal osteotomy. Dissection was deepened down to the level of the extensor digitorum brevis muscle belly. Careful attention was given to preserving the integrity of the peroneal tendons and the sural nerve, although the latter was seldom encountered. A linear fascial incision was then made parallel to the peroneal tendons just superior to the inferior border of the extensor digitorum muscle belly. The extensor digitorum muscle belly was then reflected anteriorly and superiorly and access to the sinus tarsi was gained. The contents of the sinus tarsi were evacuated and the interosseous ligament was severed. Remodeling of the floor of the sinus tarsi peg was performed utilizing a side-cutting burr to accept the subtalar joint arthroereisis. Implant sizers were then introduced into the floor of the sinus tarsi and, typically, 1–2 mm of the leading edge of the posterior facet was resected perpendicular to the floor of the sinus tarsi. Once the sizer had been introduced beneath the lateral process of the talus, a single 3/16-inch drill hole was placed corresponding to the peg of the implant. The channel was underdrilled in order to preclude the use of cement. The lateral aspect of the implant should be even with the lateral wall of the calcaneus and the posterior portion of the implant should abut directly on the posterior
facet. It is important to realize that an anterior placement of the peg may compromise ability to perform the Evans calcaneal osteotomy.

Important factors to consider prior to performing the Evans calcaneal osteotomy are the relative length of the lateral column of the calcaneus and age of the patient. Adequate length for calcaneal lengthening should be determined preoperatively by measuring the width of the anticipated endoprosthetic joint and calculating distance between the leading edge of the peg and remaining portion of the calcaneus to the calcaneocuboid joint. Typically, the large Smith STA-Peg measures 12 mm in length by 7.6 mm in width. In the adult, if less than 1 cm of bone is available, questionable instability or aseptic necrosis of the anterior portion may result. Attention is then directed to the lateral wall of the calcaneus utilizing a key elevator, and the soft-tissue structures are elevated, including the peroneal tendon complex which is retracted laterally and inferiorly. The through-and-through osteotomy is performed from lateral to medial with a slight bias of proximal to distal to avoid the sustentacular tali. The osteotomy is created just distal to the leading edge of the endoprosthesis to preserve the integrity of the subtalar joint arthrodesis. After the osteotomy is completed, a trapezoidal shaped, cortical tibial allogenic bone graft is fashioned based on the size and dimensions of the calcaneus. Typically in the adult flatfoot, graft thickness should approach 8–10 mm, and in the pediatric patient 5–7 mm is usually adequate. The graft is fenestrated with several 1.1-mm drill holes with careful attention not to over fenestrate, which could result in fracture of the graft. Graft is then delivered into the respective osteotomy site until the lateral aspect of the graft is on the anterior wall of the calcaneus. Fixation is achieved with threaded .062 K-wire driven from the anterior neck of the calcaneus, through the graft to the plantar proximal portion of the calcaneus. This affords stability of the anterior portion of the calcaneus and results in an earlier protected return to weightbearing status. Intraoperative fluoroscopic evaluation is performed for proper location and placement of graft and endoprosthesis. Soft-tissue structures are reapproximated followed by skin closure. If an equinus has been unmasked that was previously not corrected, appropriate tendo Achilles lengthening is performed. The medial column is then assessed for need of medial column procedure.

Postoperative Care

The patient was kept nonweightbearing for 2 weeks in a posterior splint. At the end of 2 weeks, the patient was placed either in a slipper cast or below-knee cast if Achilles lengthening is performed. For the next 2 weeks, partial weightbearing was allowed with crutches or walker. Full weightbearing in a cast was permitted at 4 weeks after surgery and continued for 4 more weeks. At 8 weeks postoperative, the cast was removed and a surgical shoe or removable walking cast was utilized. The walking cast was utilized if the Achilles tendon was lengthened. At 8 weeks postoperatively, a custom-made orthosis was fabricated, and the patient was allowed to return to normal shoe wear 12 weeks after surgery. We believe that the orthotic afforded protection of the graft site and medial column procedures without compromise of surgical results. Physical therapy was recommended for the next 4–6 weeks with gait training and muscle rehabilitation programs.

Results

The average follow-up time for this study was just over 2 years with a range from 1 to 4 years. Radiographic evaluation of the patients in this study was done at a minimum of 1 year postoperatively and revealed improvement in all measured angles. On the AP radiograph, the measured parameters showed an average decrease in Meary’s angle (talo-first metatarsal) from 16.9° to −0.6° and the mean calcaneocuboid abduction angle was reduced from 24.8° to 2.8° Kite’s angle decreased from 25.3° to 15.4°. The talonavicular coverage angle improved talar head coverage from 22.7° to 5.2°.

Lateral radiographic measurements resulted in the calcaneal inclination angle increasing from 10.6° to 18.6°. Talar declination angle decreased from 32.4° to 16.4° and the lateral talocalcaneal angle improved from 18.3° to 5.2° (see Table 1).

The subjective and mail patient questionnaire which was completed by all of the patients revealed that 100% of patients reported that they were satisfied or very satisfied with their surgical result. Sixty-six percent of patients stated they requested surgical intervention due to pain and deformity, while pain alone accounted for only 17% and deformity alone accounted for only 17%. Fifty-six percent stated they had family members with flat feet. On a scale of 0 (no improvement) to 100 (complete improvement), an average improvement rating of 93 with a range of 70–100 was achieved. Daily activities were able to be resumed at an average of 12.8 weeks. Ninety-five percent of patients were prescribed orthotics postoperatively, but only 67% wear them regularly. Ninety-four percent would recommend the operation to others with a similar problem.

Complications

In no cases were we required to reoperate. There were two patients who were clinically considered to be
undercorrected; however, neither patient is having postoperative symptoms. One patient expresses displeasure with a cosmetically flattened arch presentation, but has no functional limitation of her foot or lifestyle. This patient presented with a severe deformity and had unrealistic postoperative expectations. There has been no graft compromise or failure of the graft to fully incorporate. We have observed transient cases of sinus tarsiitis which have resolved with one or two injections. There were no instances of detritic synovitis, talar cyst formation, or loosening of the implant which has been described in previous literature (10). All patients with bilateral deformities elected to undergo the procedure on their contralateral foot after recovery from their first extremity.

Discussion

Ideally, in most situations either the Evans calcaneal osteotomy or subtalar joint arthrodesis procedures will provide adequate correction for the moderate symptomatic flatfoot deformity independent of each other (8, 10, 11, 14, 15). It has been the authors’ experience that in severe pes valgo planus deformity in which a triplane deformity exists that neither procedure adequately corrects all components of the osseous malalignment or resolves symptoms when done in isolation. These observations were made even when done in combination with medial column stabilizing procedures and Achilles tendon lengthening.

In those individuals exhibiting a severe flexible pes valgo planus deformity, the combined Evans calcaneal osteotomy with STA-Peg arthrodesis procedure has demonstrated significant improvement over the preoperative lifestyle and activity with a significant reduction in pain. This is accomplished by stabilization of the rearfoot complex and limiting excessive midtarsal joint motion. In this study the AP calcaneal positional relationship improved an average 25.3°–15.4° when assessing Kite’s angle. It is felt that the majority of this improvement occurred secondary to the subtalar arthrodesis procedure. As a result of combining it with the Evans procedure, we see a significant improvement in calcaneocuboid abductus angle and the transverse plane forefoot pathology associated with excessive forefoot abduction. This correction was expressed as a 20° or greater reduction of the calcaneocuboid abduction angle in 16 of 25 feet and a reduction of mean preoperative talonavicular coverage from 22.7° to 5.2°.

The Evans calcaneal osteotomy has been traditionally described as a transverse plane correction procedure (11). In this study it was noted that the Evans osteotomy may have some sagittal plane correction capabilities as demonstrated by an average increase in calcaneal inclination angles have appeared in cases performed by the senior author where an isolated Evans calcaneal osteotomy was performed. Previous authors have felt this occurred as a result of the improved fulcrum for the peroneus longus to plantarflex the first ray (16).

It is not known how much contribution the combined procedure had on the improvements noted in the medial column measurements. This sagittal plane improvement of the talo-first metatarsal angle from 18.3° to 5.2° probably stems partially from the indexed procedures and from the medial column stabilizing procedures described earlier. In either instance, it is the authors’ belief that the appropriate adjunctive medial column hypermobility procedure be performed to enhance the likelihood of a successful outcome.

Conclusion

The combination Evans calcaneal osteotomy with allogenic bone graft and Smith’s STA-Peg arthrodesis procedure has demonstrated predictable reproducible results over the last 4 years. Patient satisfaction as well as radiographic evaluation has demonstrated excellent postoperative results with reduced morbidity. Preservation of subtalar joint and midtarsus joint function has allowed this patient population to continue with active ambulatory and athletic lifestyles. To this date, no revisional surgeries have been required for either implant removal or further stabilizing procedures such as hindfoot arthrodesis.

Ideally, the procedure is designed for those individuals with marked forefoot abduction while simultaneously demonstrating functional and radiographic evidence of excessive subtalar joint pronation. Although it has been performed on the elderly population without complications, it is ideally suited for the adolescent to mid-adult life individual with an intact posterior tibial tendon and absence of subtalar and midtarsal joint arthropathy.

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References

5. Myerson, M., Corrigan, J., Thompson, P. M. Tendon transfer combined with calcaneal osteotomy for treatment of posterior tibial tendon