Extra-osseous Talotarsal Stabilization: An Overview

This procedure is used when an arch support isn't sufficient and reconstructive surgery is too aggressive.

BY MICHAEL E. GRAHAM, DPM

Foot specialists globally, both orthopedic and podiatric, have found extra-osseous talotarsal stabilization (EOTTS) to be a very powerful solution, when indicated. Yet, EOTTS still remains one of the most under-utilized procedures. The purpose of this article is to increase the foot specialist's knowledge on EOTTS so that more patients can benefit from this minimally invasive option.

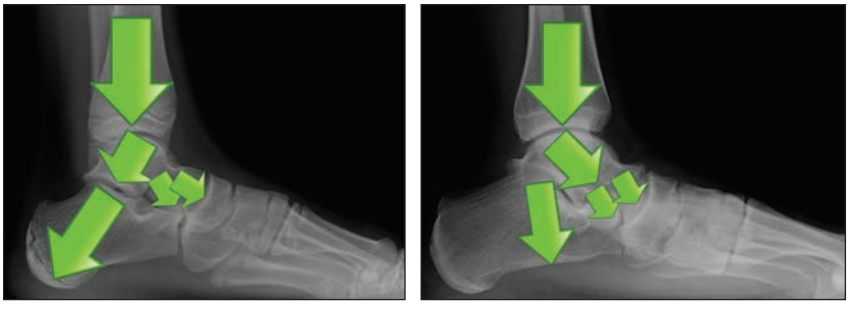

Figure 1-A: Weight-bearing lateral radiograph showing an aligned talotarsal joint. Arrows indicate the normal force distribution. 1-B shows talotarsal joint displacement with arrows showing abnormal force distribution anteriorly.

Evolution of Sinus Tarsi Implants

The birth of the "arthroereisis" procedure has been credited to Wollenberg, who in 1912 first performed a joint-blocking procedure for genu recurvatum.[1] Toupet, in 1920, published his results for a posterior block of the ankle joint for foot drop.[2] There is little doubt that these attempts to physiologically restore joint motion without anatomic interference of a joint influenced E.F.S. Chambers, MD, who published his paper on the insertion of a bone graft into the floor of the calcaneus.[3] This "conservative" osseous procedure was the first extra-articular attempt to prevent the partial anteriomedial dislocation of the talus on the calcaneus.

Conversion of a non-metallic into a titanium sinus tarsi implant created a re-energized excitement to a new generation of foot surgeons.[4] The use of titanium made more sense, but there remained two significant problems, patient tolerance and device displacement. The removal rates of the first generation metallic arthroereisis devices have ranged from 38% to 100%.[5,6] A second generation EOTTS device emerged with reduced tolerance issues and lower removal rates.

Anatomy Review and Function of the Sinus Tarsi

The sinus tarsi is a naturally occurring space between the talus and calcaneus. It serves as a fulcrum point for the transfer of forces obliquely between the talus onto the

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New Concepts and Studies

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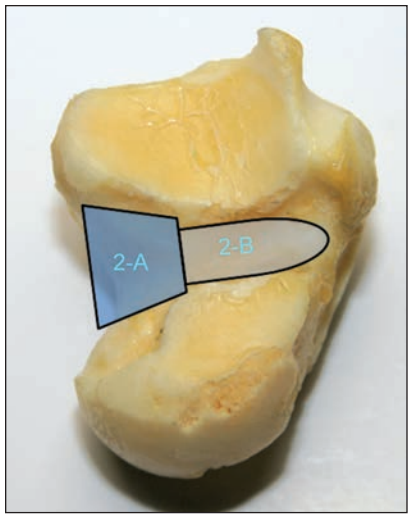

Figure 2: Plantar surface of the talus shows the lateral "sinus" portion (A) and medial canalis (B) portion of the sinus tarsi.

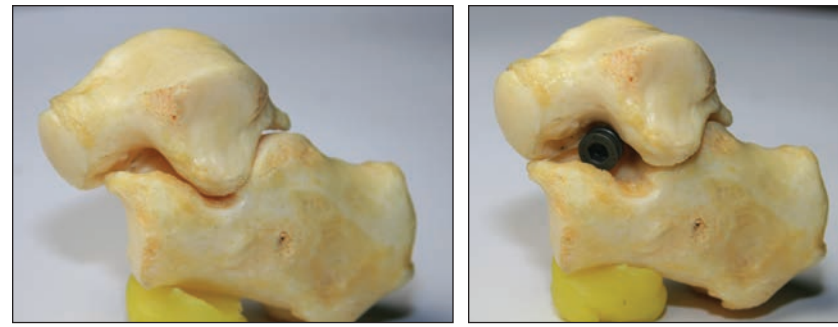

Figure 3-A: Shows partial dislocation of the talus on the calcaneus resulting in the obliteration of the sinus tarsi. 3-B shows the placement of a sinus tarsi implant with re-opening of the sinus tarsi.

A sinus tarsi implant is used to stabilize the talus without surgically altering the articular facets of the TTJ.

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tarsal mechanism (calcaneus and navicular) both posteriorly and anteriorly (Figures 1A, 1B).

Of importance is its anterior-lateral-distal-plantar to posterior-medial-proximal-dorsal orientation. The weight-bearing forces, at heel strike, pass posteriolaterally through the back of the heel, and at full-plantar-foot contact the forces shift anteriomedially.

There are two anatomic regions of the sinus tarsi. The lateral, superficial portion is conically shaped and referred to as the "sinus" portion. The deeper, medial cylindrical space is the canalis tarsi region. The majority of motion occurs within the sinus over the canalis portion, making the canalis portion the most stable area and the outer sinus the least stable. There are many ligamentous attachments between the talus and calcaneus, including the interosseous talocalcaneal (Figure 2).[7,8]

Function of Sinus Tarsi Implants

A sinus tarsi implant is used to stabilize the talus without surgically altering the articular facets of the TTJ. The sinus tarsi device acts as a "stent" to internally prevent the obliteration of the sinus tarsi. This re-establishes the axis point at the entrance to the canalis tarsi. Instantly, the forces passing posteriorly are normalized with decreased forces acting anteriomedially on the osseous and soft tissues on the medial column of the foot.[9] It is important to note that a sinus tarsi device is not implanted into a joint. There is no articular cartilage within the sinus tarsi (Figure 3A, 3B).

Classification of Sinus Tarsi Implants

There are joint-blocking or limiting arthroereisis devices and non-joint blocking devices.[10] Additionally, there are intra-osseous devices that are partially inserted into either the talus or calcaneus.[11,12] These devices are used with less frequency compared to extra-osseous devices that do not involve the penetration of the device into bone (Figures 4A,4B).

The overall success rate is determined by the type of device used. Type I arthroereisis joint-blocking devices have a significantly higher removal rate over non-joint blocking Type II devices.[13,14] Arthroereisis devices are inserted into the lateral half of the sinus tarsi, the least stable area. They act as a door-jam to block the anteriomedial rotation of the lateral process of the talus. These devices are also placed from lateral to medial within the sinus

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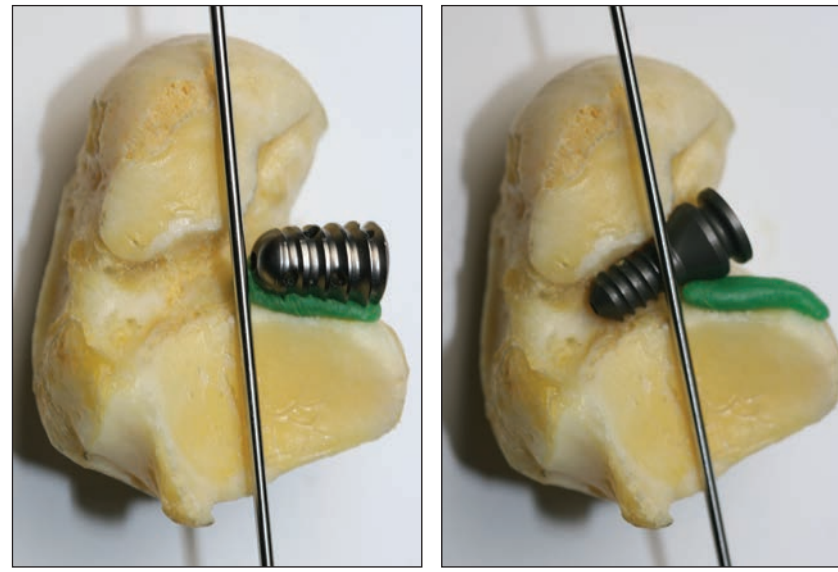

Figure 4-A: Plantar view of the talus showing a type I arthroereisis device. 4-B: shows the placement of a Type II non-joint blocking sinus tarsi implant.

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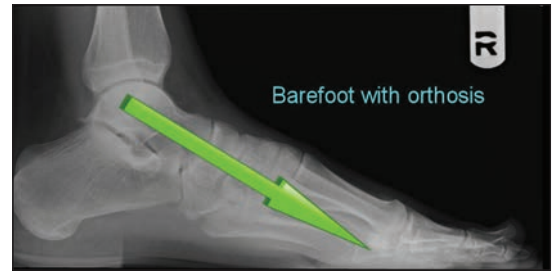
portion of the sinus tarsi, not in alignment with the oblique orientation of the sinus tarsi. These arthroereisis devices function against the normal talotarsal range of motion. The combination of these design limitations has led to a higher degree of removal.

The non-blocking sinus tarsi stent is placed deeper into the sinus tarsi. A Type II device stabilizes the talus at the axis point and it allows triplane talotarsal joint motion. There have been numerous scientific papers published on the positive results of the type II sinus tarsi stent.[14-23]

Utilization of Sinus Tarsi Implants

The leading reason a patient is told to obtain arch supports is to correct a foot over-pronation condition. Displacement of the talus on the tarsal mechanism is the cause of over-pronation. This unlocks the mid-tarsal joint, creating instability primarily on the medial column of the foot. Subsequently, excessive strain is placed on the supporting soft tissue structures and joints. Eventually, the repeated exposure of excessive force leads to secondary symptoms such as "growing pains", heel pain, plantar fasciitis, posterior tibial tendon dysfunction, 1st ray disorders, hallux limitus, hallux valgus, metatarsalgia, and flexor stabilization hammertoes (Figures 5 A-F).

Displacement of the talus on the tarsal mechanism is the cause of over-pronation.



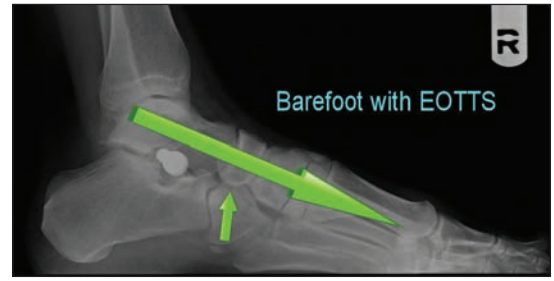


Figure 5-A: Weight-bearing dorsoplantar radiograph showing the anteriomedial talotarsal joint displacement. 5-B same patient standing on a custom-molded orthosis. 5-C is same patient with the placement of a type II sinus tarsi implant. 5-D is same patient lateral weight-bearing x-ray barefoot. 5-E x-ray is with the patient standing on their orthosis. 5-F is after the placement of a type II sinus tarsi implant.

There are many benefits that are derived from a foot orthosis, except for stabilizing the talotarsal joint. The effectiveness of an arch support to realign and stabilize the TTJ has never been clearly established.[24] How exactly does something placed on the plantar aspect of the foot realign and stabilize the talus or the TTJ? A foot orthosis has minimal to no positive effect on the TTJ.[25] Actually, an orthosis can lead to an increase of the TTJ displacement deformity.[31] Think about the number of patients daily, monthly, or annually who are told to buy arch supports to re-align their feet. The majority of these patients should be considered as potential candidates for an EOTTS procedure.

EOTTS as a Superior Option for "Fixing" Over-pronation

The partial dislocation of the talus on the tarsal mechanism is the leading etiologic factor to many foot and ankle deformities.[26] The goal of any treatment is to eliminate the

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underlying etiologic factor along with ameliorating associated symptoms. Addressing the symptoms without removing the underlying etiology will result in a chronic re-occurring condition.

Most conservative treatments serve as temporary measures. It gives the patient a "false sense of treatment." Patients think that their foot mis-alignment is "cured" with an arch support; unfortunately, this simply isn't the case. Excessive abnormal forces continue to take their negative toll on the osseous and soft tissues within the foot and ankle and, most times, these conditions progress from bad to worse.

The use of osseous and soft tissue reconstructive surgery such as talocalcaneal arthrodesis, medial displacing calcaneal osteotomy, lateral column lengthening (Evan's calcaneal osteotomy with insertion of bone graft), mid-foot osteotomies combined with tendon balancing procedures may be another option to consider. There are significant risks and potential complications associated with these procedures and long-term risks of disease to the adjoining joints (Figure 6).[3]

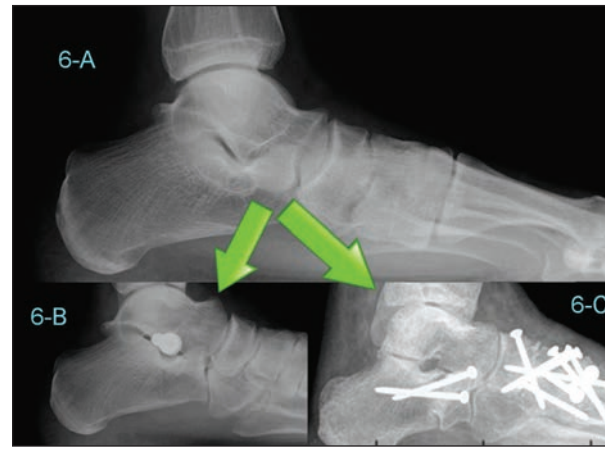

Figure 6: Weight-bearing lateral radiograph show a talotarsal joint displacement. 6-B shows the placement of sinus tarsi stent. 6-C shows the option of traditional rearfoot reconstructive surgery.

Patient Selection Criteria for an EOTTS Procedure

There is a complex algorithm to determine who is or isn't a candidate, combined with stand-alone or combination of required treatment modalities or additional surgical procedures. If these factors are unidentified or under-addressed, there could be a compromised patient satisfaction outcome. The flexibility or reducibility of the TTJD deformity must be evaluated with the patient, both non-weight-bearing and weight-bearing. Failure to evaluate the weight-bearing stance and dynamic phases of gait could reveal unidentified co-existing deformities. A positive indication that the patient is a potential candidate for the EOTTS procedure is the ability to re-align the TTJ while standing.

Suspicion for the use of an EOTTS device should occur if the weight-bearing patient is unable to re-align the TTJ. The integrity of the posterior tibial tendon (PTT) must be taken into consideration because it is often severely weakened or even over-stretched due to the years or decades of excessive forces acting on it. Typically, a stage 1 posterior tibial tendon dysfunction (PTTD) does not require additional tendon repair. Stage 2 PTTD often requires the combination of procedures along with a tendon augmentation.

The alignment and stability of the first ray is also very important. Talotarsal joint displacement increases the forces acting on the medial column of the foot. This places excessive force on the 1st ray and can lead to weakening of the supporting ligaments and further misalignment dorsal-medially. Failure to identify and treat instability or structural misalignment of the 1st ray could compromise the success of an EOTTS procedure.

A positive indication that the patient is a potential candidate for the EOTTS procedure is the ability to re-align the TTJ while standing.

Limited 1st metatarsophalangeal joint MPJ motion can lead to a compensatory abduction of the forefoot. This would also lead to increased strain to the TTJ. Conservative or surgical options to restore 1st MPJ motion must be considered.

Talotarsal joint range of motion is an objective finding that is difficult to replicate from one observer to another. An "industry standard" is the use of weight-bearing radiographs. These images produce subjective data that is reproducible from clinician to clinician. The talar second metatarsal angle on the dorsoplantar (DP) im-

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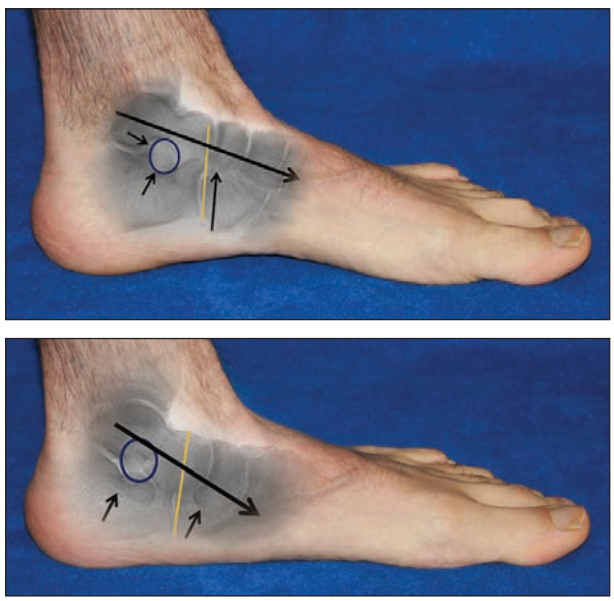
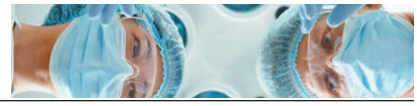


Figure 7-A: Shows an "x-ray" vision view of a talotarsal joint displacement deformity. 7-B shows the same foot with the talotarsal joint re-aligned.



ages provides the best transverse hindfoot-forefoot measurement.[27] The lateral talar declination angle provides a sagittal plane measurement.

"Dynamic" radiographic evaluation can be obtained by taking two sets of images; first, with the weight-bearing hindfoot in relaxed stance and a second set with the TTJ placed into alignment, neither pronated nor supinated. These comparative images document the reducibility of the talar dislocation deformity. There are many specific radiographic parameters to be evaluated. For instance, a coalition deformity could also be ruled out if there is a "re-opening" of the sinus tarsi. Weight-bearing fluoroscopy or CT images would also provide very valuable diagnostic information (Figures 7 A,B).

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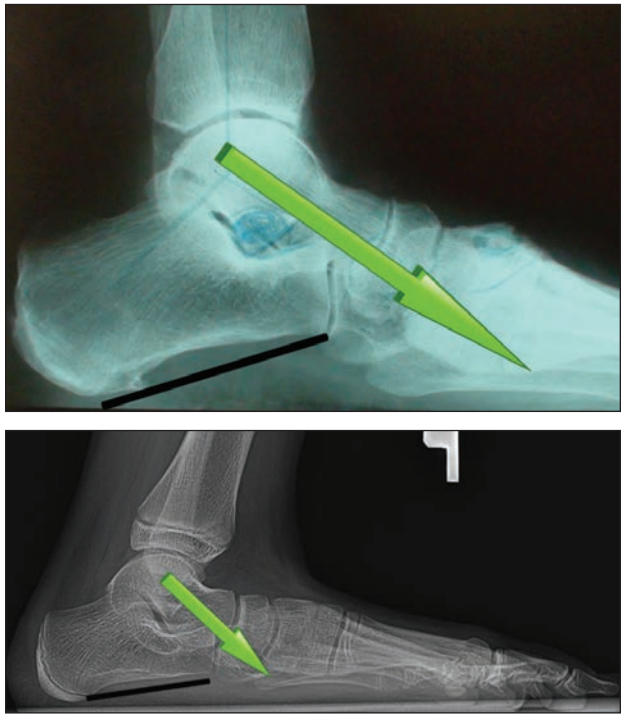

Figure 8-A: Weight-bearing radiograph showing a lower than normal calcaneal inclination angle along with a talotarsal joint displacement deformity. 8-B shows another foot with a normal calcaneal inclination angle but with a talotarsal joint displacement.

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The calcaneal inclination angle (CIA) must be evaluated. A lower than normal CIA will also contribute to an anterior shift of forces. EOTTS has not been shown to effectively correct a lower than normal CIA.[29] A tendo-Achilles lengthening (TAL) or gastrocnemius recession procedure could be required. A TAL or gastroc-recession procedure is not always needed or required for an EOTTS. The major deciding factor is the CIA (Figure 8).

Poor Patient Satisfaction Outcomes

There are foot specialists who don't perform or advocate the EOTTS procedure, but who may have had a patient present to them in pain after undergoing an EOTTS procedure. If such foot specialists see even a limited number of patients who experience pain or other complications from an EOTTS procedure, they will develop a negative impression of this form of treatment. There are many potential factors for a patient to have an unsatisfactory outcome.

It is very unfortunate that many foot specialists fail to treat these patients with conservative measures or to address the underlying cause of discomfort. The recommendation,

Figure 9: Shows worn-out shoe that could compromise the results of the EOTTS procedure.

from most, is to simply reverse or remove the sinus tarsi implant, which is an advantage of the EOTTS procedure, unlike traditional reconstruction. There are simply some patients who, regardless of their positive result, will remain "unhappy."

The shoes that patients wear post-EOTTS could have a negative impact. Shoes simply don't last as long as they used to. During the normal gait cycle, the majority of weight-bearing forces hit the posteriolateral aspect of the shoe. Eventually, this area on the shoe wears out, and this will lead to an over-supination of TTJ. Excessive strain is placed on the lateral TTJ supporting ligaments.

If an EOTTS patient complains of lateral soft tissue pain, one of the first considerations is to evaluate the shoes that the patient is and has been wearing, along with radiographic verification that there hasn't been

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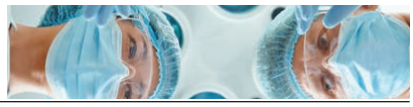

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displacement of the stent or loss of correction (Figure 9).

There have been many patients who have only had ETTOS performed unilaterally even though a TTJD condition was found in both feet. The issue here is that the uncorrected foot will continue to adversely affect the internally corrected foot. Patients must be told that both feet require re-alignment and that the first corrected foot will continue to have pain-soreness until the contra-lateral limb is stabilized.

Conclusion

EOTTS is one of the most under-utilized orthopedic procedures. The publication of many peer-reviewed scientific studies has helped to narrow the indications for this very powerful minimally invasive solution to recurrent talotarsal joint displacement. Surgeons considering the use of a sinus tarsi implant need to undergo training in order to understand patient selection, surgical technique, and how to prevent or handle post-op issues.

Foot specialists must consider that there is a segment of the population where an arch support isn't sufficient and reconstructive surgery is too aggressive. These patients could benefit from, and should be told about, the EOTTS option, regardless of insurance coverage limitations. **PM**

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