

Technical Tips

Talocalcaneal coalition resection and bone block subtalar joint arthrodesis: a technical tip

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Abstract

In this technical tip, we present the case of an obese 17-year-old female diagnosed with a severe, rigid, and symptomatic flatfoot on a background of exuberant talocalcaneal and residual calcaneonavicular coalition. Through a technical modification of the fusion resection, both coalitions were quickly and safely removed with two single cuts of an oscillating saw, resecting a medial wedge through a medial approach, without the need for “peel-off” tarsal coalition resection. To protect and guide the resection osteotomy, one Freer elevator was inserted under direct visualization on the patent posterolateral aspect of the subtalar joint posterior facet and a second elevator was positioned underneath the talar neck. Under fluoroscopic guidance, an osteotomy was performed connecting these two points. The patient also received a bone-block subtalar joint arthrodesis and a Cotton osteotomy. Good short-term alignment correction and functional outcome were achieved.

Level of Evidence V; Therapeutic Studies; Expert Opinion.

Keywords: Tarsal coalition; Talocalcaneal coalition; Calcaneonavicular coalition; Cotton osteotomy; Subtalar fusion.

Introduction

Tarsal coalitions are a well-known cause of pain and disability in the foot and ankle, especially in the pediatric population^(1,2). These problems often lead to inability to participate in activities of daily living and sports, decrease quality of life, and are often associated with foot deformities, most commonly flatfoot⁽³⁾. The most common types of tarsal coalitions are calcaneonavicular (CNC) and talocalcaneal (TCC) coalitions⁽³⁻⁶⁾.

Many of these coalitions are asymptomatic, diagnosed only after trauma or incidentally during investigation of the limb⁽⁷⁾. Nevertheless, some cases present with quite exuberant signs and symptoms, as well as pronounced hindfoot deformity, abnormal bone growth, and dysplasia⁽⁸⁾. In severe cases with dysplastic talar formation, a ball-and-socket mortise joint may be found⁽⁹⁾.

There are osseous, fibrous, and cartilaginous subtypes of coalitions⁽³⁻⁶⁾. Differentiation between subtypes is primarily radiographic, but magnetic resonance imaging (MRI) and

computed tomography (CT) scans can also be used in diagnosis and treatment planning⁽¹⁰⁾. Most mild and early cases are successfully treated with nonoperative measures, such as physical therapy and insoles, but failure of these modalities usually leads patients to surgical intervention^(3-6,11).

A joint-sparing procedure with adequate coalition resection is the cornerstone of surgical treatment and, in several cases, the only required technique for treatment, especially when less than 50% of the mediolateral extension of the subtalar joint is involved⁽³⁾. Even when deformity is present, removal of the bone bridge is essential to correct foot alignment and relieve pain⁽¹²⁾. Different surgical techniques have been described for this purpose; all share the intention of safely removing the coalition as easily and quickly as possible⁽¹³⁻¹⁶⁾.

This article describes the treatment of a 17-year-old female with a symptomatic severe flatfoot deformity and obesity on a background of massive TCC and residual CNC, with history of a prior failed attempt at CNC resection. The patient

Study performed at the University of Iowa, Carver College of Medicine, Iowa City, USA.

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underwent resection of the coalitions through a novel medial approach (the subject of this technical tip) consisting of an osteotomy line connecting two fluoroscopic landmarks, followed by a medial wedge resection for hindfoot valgus correction and corrective lateral-wedge bone-block allograft arthrodesis and Cotton osteotomy for residual forefoot supination.

Case description

A 17-year-old (BMI 36) presented to an outside orthopedic service with a complaint of chronic right medial foot and ankle pain since childhood. The patient reported a history of rigid symptomatic flatfoot in childhood, which had been treated with physical therapy and insoles. She also had a history of an attempt at surgical CNC resection 18 months earlier, with only partial resolution of her symptoms (Figure 1). Following a recent minor injury, she had experienced a flare-up of symptoms. On physical examination at the time, a severe flatfoot deformity was observed, with significant hindfoot valgus of approximately 20-25° and a supinated forefoot. There was evidence of a healed sinus tarsi approach, with painful, rigid passive hindfoot inversion and eversion. She was also tender to palpation along the medial side of the foot and ankle, where a bony prominence could be palpated at the level of the sustentaculum talus, and had moderate tenderness on the sinus tarsi area. Conventional radiographs showed possible residual CNC, with indirect signs of a TCC (talar beaking and

C-sign) in the right foot, and a mild valgus talar tilt of the talar dome (Figure 2). Initial treatment plans included a walking cast for 6 weeks and brace immobilization; however, there was no significant improvement in the symptoms. MRI and weightbearing CT (WBCT) images were obtained to elucidate the extent of the coalition, assess the subtalar joint, and, possibly, assist in surgical planning.

Images demonstrated a recurrent/residual CNC, mostly plantar, and a massive TCC affecting both the middle and the posterior facets of the subtalar joint, compounded by with severe hindfoot valgus (tibicalcaneal angle of approximately 45°) and a mild valgus tilting of the talar dome (Figures 3 and 4).

The patient and her family decided to proceed with surgical treatment. Coalition resection followed by a bone block arthrodesis and a Cotton osteotomy were proposed to the patient and her family. Once the participants had agreed, surgery was formally indicated and performed.

Surgical technique and technical tip

The operation began with aspiration of bone marrow from the right iliac crest for concentration and later injection into the subtalar joint fusion mass.

An extensive medial foot approach was selected and performed along the trajectory of the posterior tibial tendon (PTT), from the medial malleolus down to the navicular tuberosity. The tendon was exposed and found to be intact pro-



Figure 1. Intraoperative fluoroscopic views of prior surgical treatment of calcaneonavicular coalition, (A) before and (B) after resection.

ximally, but with some insertional tendinopathy. The PTT was partially detached from the navicular tuberosity and retracted plantarly. The flexor digitorum longus (FDL) and flexor hallucis longus (FHL) tendons were identified by periosteal dissection, isolated, and retracted plantarly with the PTT, thus protecting the neurovascular bundle and exposing the medial aspect of the subtalar joint (SJ). A large bony prominence at the level of the sustentaculum tali, middle, and anteromedial aspect of the SJ posterior facet was identified, consistent with a talocalcaneal bony coalition.

Instead of using a “peel-off” coalition resection technique with resection of multiple slices of bone or a small wedge resection technique, both usually used to identify a line of fibrotic tissue where the articular line was supposed to be positioned, we performed a modified technique that can be

applied in cases where a coalition resection or a SJ fusion is planned. The technique modification consists of using two Freer elevators as fluoroscopic markers to guide a single-cut osteotomy to separate the talus and the calcaneus. To achieve that, the deep dissection is carried posterolaterally along the posterior aspect of the SJ and ankle to identify the posterolateral and patent aspect of the SJ posterior facet. The first Freer elevator is inserted into the joint under direct visualization. The second Freer elevator is positioned under the talar neck, to ensure that no talar neck bone is resected or osteotomized (Figure 5).

Under fluoroscopic guidance, an oscillating saw was used to perform the osteotomy connecting the two markers. In this specific case, as a severe hindfoot valgus existed and a SJ fusion was planned, once the talus and calcaneus were separated



Figure 2. (A) AP bilateral foot radiographs and (B) lateral view of the right foot demonstrating severe flatfoot, forefoot abduction, dysplastic talar head/neck, and indirect signs of tarsal coalition (C-sign and dorsal talar beak). (C) AP view of the right ankle demonstrating mild valgus talar tilt.



Figure 3. (A) Weightbearing CT (sagittal view). Talocalcaneal and calcaneonavicular (residual) coalitions. (B) Weightbearing CT (coronal view). Subtalar joint middle facet coalition. (C) Weightbearing CT (coronal view). Severe hindfoot valgus (approximately 45°). (D) Weightbearing CT (axial view). Residual calcaneonavicular.



Figure 4. (A) Posterior, (B) medial, and (C) anterior weightbearing CT 3D reconstructions of patient's foot and ankle surface anatomy, demonstrating severe hindfoot valgus and flatfoot. (D, E, and F) Weightbearing CT 3D bony reconstruction showing extensive SJ middle (MF) and posterior facet (PF) coalitions, as well as the residual plantar calcaneonavicular coalition (CN).

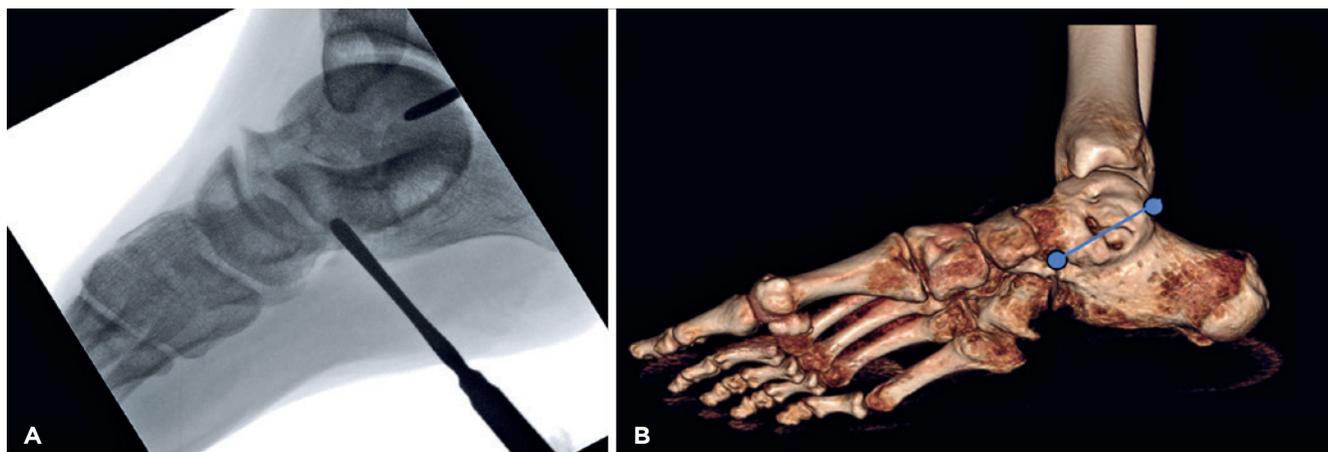


Figure 5. Technical tip. (A) Two Freer elevators are inserted under direct visualization to guide the orientation of the osteotomy: one in the posterolateral patent aspect of the posterior facet of the subtalar joint and one underneath the talar neck. (B) 3D Weightbearing CT bony reconstruction showing the dots representing the tip of the Freer elevators and a straight line connecting the dots, following a very similar path when considering a patent posterior facet.

by the first osteotomy, an additional osteotomy line was then performed in the calcaneus to resect a medial wedge of bone aiming to correct the valgus deformity. In cases where the posterior facet would be preserved and an isolated coalition would be performed, this second osteotomy line and wedge resection would not be performed. After removing the wedge and being able to correct the valgus deformity to some extent, the residual cartilage on the talar SJ facets was resected with curettes and osteotomes, and the extra bone on the medial surfaces of the talus and calcaneus, composing the bulky aspect of the talocalcaneal coalition, was resected with the oscillating saw and sharp osteotomes.

During a trial for a bone-block arthrodesis with a lateral wedged allograft (inserted from the same medial approach), no adequate correction was achieved secondary to residual stiffness for mobilization of the calcaneus. At that point, the osteotomy line created previously was extended distally in the calcaneus side aiming to separate the residual connection between the calcaneus and the navicular bone, aiming for the plantar aspect of the anterior process of the calcaneus, and avoiding injury to the calcaneocuboid joint. Following this step, adequate mobilization of the calcaneus was possible, and correction of the valgus deformity was achieved with medial displacement of the calcaneus and a lateral-based allograft bone-block trial wedge (12mm lateral base height) (Figure 6).

Clinical evaluation (with the heel centered underneath the leg from a posterior view and the leg elevated) and fluoroscopic assessment demonstrated adequate correction of the deformity and apposition of the trial bone block with the calcaneal and talar surfaces. The trial was removed and both osseous surfaces were prepared with multiple drill holes to stimulate healing, using a 1.9-mm drill bit. The wedge-shaped allograft was soaked in the bone marrow aspirate for 5 minu-

tes and then inserted into the fusion site. Additional morselized cancellous bone allograft with demineralized bone matrix and viable cells (with osteoconductive, osteoinductive, and osteogenic potential) was also inserted in between the bone block and calcaneal and talar surfaces (Bonus Triad®, Zimmer-Biomet®). After adequate deformity correction under clinical and fluoroscopic guidance, two slightly divergent guidewires for 5.5-mm cannulated screws were inserted. Adequate deformity correction and positioning of the wires was confirmed, followed by insertion of the headed screws, one of them partially threaded (compression) and the second one fully threaded (position). Adequate compression between bone block and bone surfaces was noted under direct visualization, as was the stability of the construct. An additional amount of the same morselized cancellous bone graft was inserted in the sinus tarsi and around the bone block.

With the hindfoot corrected into neutral alignment, attention was turned to the forefoot. Palpation of the heads of the first and fifth metatarsals demonstrated residual fixed supination of the forefoot. We then proceeded with a Cotton osteotomy to reestablish the foot tripod and protect the fusion site and the ankle from a valgus thrust. A 6-mm trial wedge was inserted and was noted to correct the deformity. The trial was removed, and a 6-mm Cotton wedge allograft, soaked in bone marrow aspirate, was inserted into the osteotomy site. Insertion of the allograft provided adequate osteotomy stability and resulted in the correction of forefoot supination, bringing the heads of the first and lesser metatarsals to a more harmonic plantigrade position.

The patient was released with a non-weight-bearing splint. This was replaced with a boot at the 14-day visit, while the non-weight bearing regime gains momentum. During this period, physical therapy was introduced, and ankle range of motion exercises were slowly initiated. By the 7th week, pro-

gressive bearing was initiated, and the boot was removed by the 12th week. A good short-term alignment correction and functional result were achieved (Figure 7).

During evaluation, this study received approval from the Institutional Review Board and both patient and family provided written informed consent for participation.

Discussion

Tarsal coalitions are found in less than 1% of the population⁽¹⁷⁾. Though it is not an extremely common condition, its management remains challenging. The TCC in this case was drastic, involving a large fusion between the two bones. Presence of an adjunctive CNC and a severe hindfoot valgus and

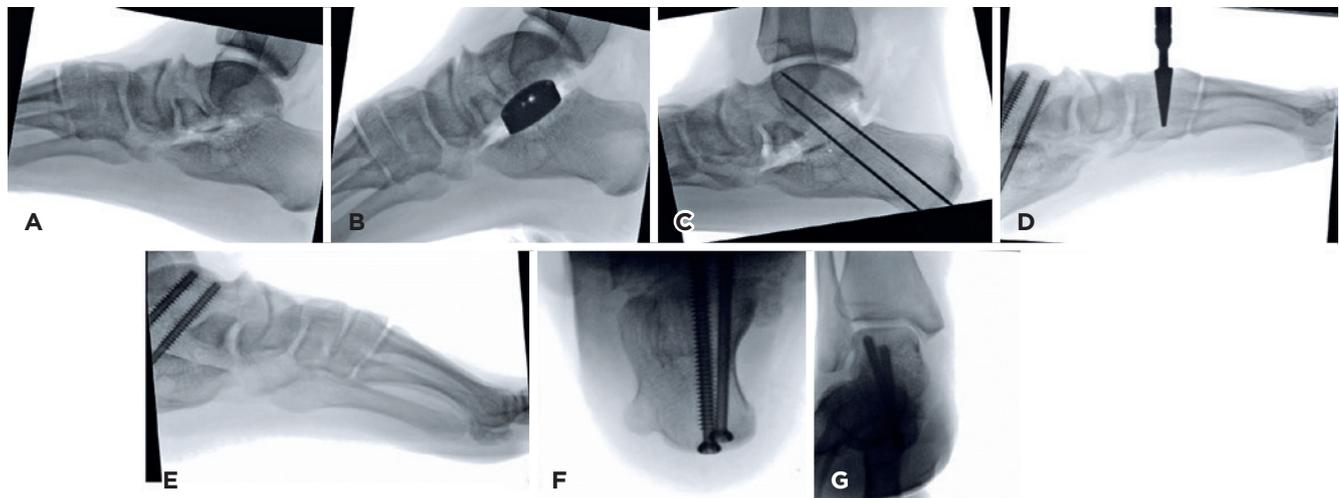


Figure 6. (A) The sagittal saw was used to connect the dots marked by the Freer elevators and, later, the osteotomy line in the calcaneus was extended distally to the plantar aspect of the calcaneocuboid joint to free up the residual calcaneonavicular coalition. (B) Fluoroscopic view. The bone block (12-mm lateral-based trial wedge) is inserted, and its alignment checked. (C) Fluoroscopic view of the bone block allograft in place and secured with two guidewires for 5.5-mm cannulated screws. (D) Fluoroscopic view of the 6-mm trial wedge for Cotton osteotomy correcting the residual forefoot supination. (E) Final lateral fluoroscopic view after insertion of the Cotton osteotomy wedge allograft. (F and G) Final fluoroscopic calcaneal axial and anterior ankle views demonstrating adequate hardware positioning.



Figure 7. (A and B) Postoperative non-weightbearing radiographs demonstrating the correction achieved on lateral and hindfoot alignment views, with adequate apposition of the bone-block arthrodesis and positioning of the hardware, as well as significant correction of the hindfoot and forefoot deformities.

residual forefoot supination, although not unprecedented, portended a complex scenario^(4,18,19).

Tarsal coalitions are commonly identified in pediatric patients. Although the coalition is already present at birth, negative effects are not normally observed until later growth stages. Pain during physical activity is the main symptom, with recurrent ankle sprain sometimes arising as another. Approximately 90% of tarsal coalitions are either TCC or CNC⁽¹⁾.

Surgery is an expected denouement to these patients, as non-operative treatment usually presents a certain fragility in maintaining a pain-free environment⁽²⁰⁾. Coalition resection is a well-established technique, often employed alone, especially in patients with small coalitions, focal pain/tenderness, and absence of associated deformities^(21,22). Removal of the correct amount of bone without harming good cartilage or neighboring structures is vital to the procedure success. This study presents a technical tip for middle TCC resection using landmarks easily identifiable under direct visualization that can also be used as fluoroscopic landmarks for a safe, rapid, and reliable separation of talus and calcaneus, allowing quicker access to the residual SJ posterior facet.

A subtalar arthrodesis is usually anticipated in severe cases, when more than half of the joint is affected and arthritic changes may be found, as well as in recurrences. It may be also the first line of treatment, as advocated by some authors who believe this is a more durable strategy^(23,24). In situ fusions are normally implemented, but vast deformities associated with dysplastic anatomical changes through the bones require hindfoot alignment correction and a bone-block arthrodesis⁽²⁵⁾. This is accomplished in order to regain alignment and

talar/hindfoot height, measures that may be lost due to the disease or its withdrawal. Indeed, this was the proposed tactic in this case, which required a medial wedge resection and insertion of an additional lateral-based bone wedge graft for adequate correction of the severe hindfoot valgus. In addition, the forefoot supination and medial column insufficiency was addressed by a medial cuneiform plantarflexion osteotomy (Cotton), reestablishing the foot tripod, correcting the forefoot supination and protecting the ankle joint, that already demonstrated mild valgus talar tilting preoperatively. Although largely performed in the flatfoot environment, the use of bone-block arthrodesis in the tarsal coalition patients remains anecdotal.

In summary, as nonsurgical measures had been exhausted, a prior attempt at surgical calcaneonavicular coalition had been unsuccessful, and pain was persistent, a comprehensive approach to addressing and treating the patient's severe hindfoot valgus, rigid flatfoot, and exceptional tarsal coalitions was employed. This approach involved a modification of surgical technique to expedite intraoperative resection time of the talocalcaneal coalition using two Freer elevators as fluoroscopic landmarks, positioned in the posterolateral aspect of the patent posterior facet of the subtalar joint and underneath the talar neck, allowing a single saw cut to separate the talus and calcaneus and providing access to the subtalar joint. This specific patient needed additional medial wedge resection and lateral wedge bone-block arthrodesis for adequate correction of severe hindfoot valgus, as well as a Cotton osteotomy to correct forefoot supination and reestablish the foot tripod. We would recommend this technical tip/technique modification for resection of TCC in an accelerated fashion intraoperatively.

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