

## Intraoperative Three-Dimensional Navigation for Talocalcaneal Coalition Resection



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### ABSTRACT

Talocalcaneal tarsal coalitions are a common source of foot pain, stiffness, and deformity. These coalitions are treated symptomatically with rest and periods of immobilization. When those measures fail, surgical resection is attempted. This procedure is an anatomic challenge with the consequence of leaving residual coalition. The residual coalition primarily results from difficulty with intraoperative imaging because fluoroscopy does not provide adequate detail of this area. Some investigators have recommended intraoperative computed tomography after resection with reasonable results. We describe the combination of an intraoperative computed tomography with a navigated instrument system for resection of talocalcaneal coalitions. The use of a navigated probe and burr aids in defining the most anterior, posterior, and medial extents of the coalition. This technique reduces the morbidity, with less bone removed and preservation of intact subtalar articulations and allows for an efficient, thorough, and controlled resection.

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Tarsal coalitions are a common cause of foot pain and stiffness in pediatric and young adult foot and ankle practices (1). The talocalcaneal joint is commonly involved, comprising 25% to 40% of tarsal coalitions (2,3). Treatment options include observation, hindfoot fusion (1,4–7), and coalition resection (8–16). Recent studies have favored resection owing to preservation of motion, improved outcome scores, and fewer complications, in particular, in those patients with no degenerative changes (12,17,18).

Most surgeons agree that calcaneonavicular coalition resection is a simpler procedure, which has often been attributed to easier visualization of the joint using oblique fluoroscopic imaging. In contrast, talocalcaneal coalitions are more challenging owing to difficulty in visualizing the medial facet intraoperatively. A Harris axial view can be useful but is difficult to obtain using traditional fluoroscopy (19). Three-dimensional imaging, such as computed tomography (CT), is a standard tool in the diagnosis and preoperative planning for resection of talocalcaneal coalitions (20–22). It allows for assessment of the subtalar joint and the extent and size of the coalition. The use of an intraoperative CT scanner can improve the outcomes of talocalcaneal coalition resection and decrease the need for reoperation (23). Incomplete resection can be

determined intraoperatively and allow for the removal of any residual coalition.

Intraoperative imaging has been combined with computer-navigated technology to assist with several other pediatric orthopedic procedures. Most notably these advancements have been used in pedicle screw placement (24,25); however, these have also been applied for in situ cannulated screw fixation of a slipped capital femoral epiphysis (26,27) and physal bar resection (28).

We present a technique of intraoperative CT-guided navigation for talocalcaneal coalition resection.

### Surgical Technique

The patient is positioned supine on the operating room table with a bump under the contralateral hip. The baseline hindfoot motion is assessed. The patient is covered circumferentially with a lead apron. A thyroid shield is also used. A nonsterile thigh tourniquet is applied to the operative extremity. All bony prominences are padded. General endotracheal anesthesia is administered, and the operative lower extremity is prepared and draped in sterile fashion.

The operating room should be organized to ensure the navigated infrared optical sensor can visualize the reference frame and the instruments in the surgeon's hands (Fig. 1). The limb is exsanguinated and the tourniquet inflated.

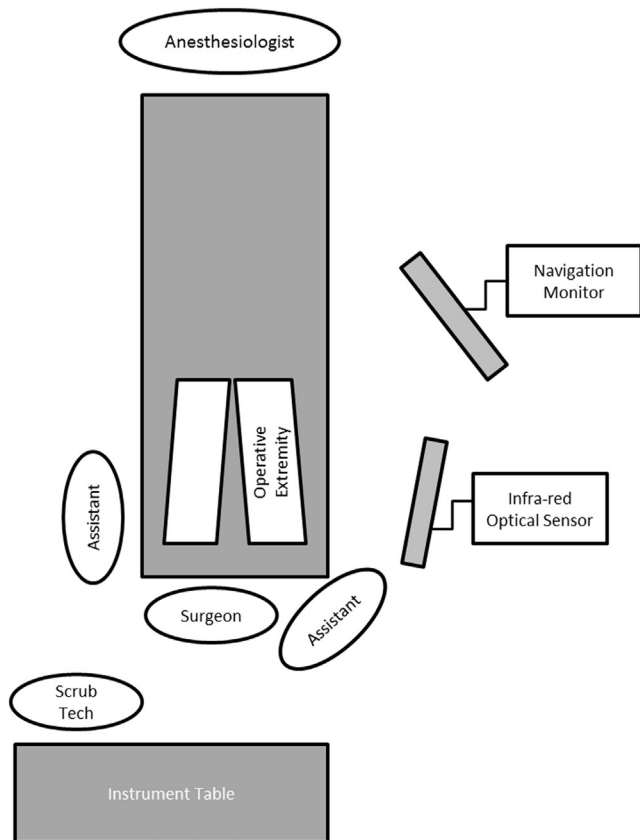
The Medtronic StealthStation Navigation System (Medtronic, Minneapolis, MN) was used. The reference frame is secured to the

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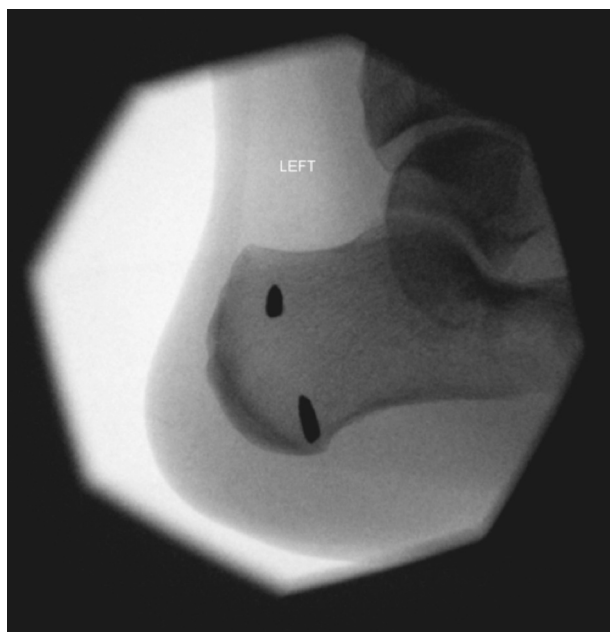
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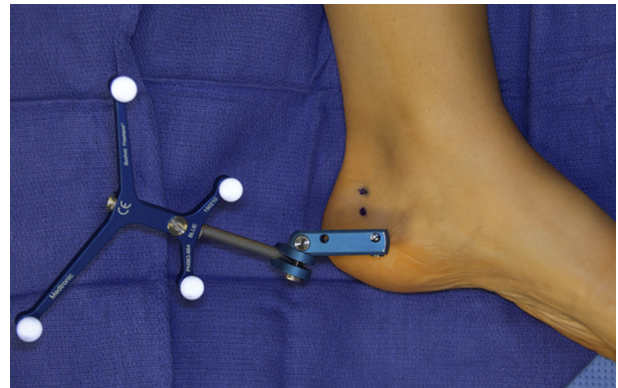


**Fig. 1.** Operating room setup for navigated left talocalcaneal coalition resection. In particular, note the location of the infrared optical sensor, operative extremity, surgeon, and assistance to ensure recognition of the reference frame and navigated instruments.

calcaneus using 1 or 2 partially threaded bicortical pins (Figs. 2 and 3). The frame should not be placed such that it interferes with the planned incision for the medial approach to the subtalar joint. In our experience, 1 pin will provide adequate fixation and security for the



**Fig. 2.** Intraoperative lateral fluoroscopic image demonstrating the position of the partially threaded reference frame pins in the calcaneus using 2 pins.



**Fig. 3.** Intraoperative fixation of the reference frame to the calcaneus using 1 partially threaded pin.

reference frame. The pins should be placed perpendicular to the calcaneus using fluoroscopic guidance.

Once this has been performed, a portable intraoperative O-Arm CT scanner (Medtronic) is brought into the room and the fluoroscopy machine is removed. Three-dimensional images are obtained. A navigated probe is used to mark the anterior and posterior extents of the coalition, and the medial incision is planned. Dissection is carried down through skin and subcutaneous tissue. Again, a navigated probe is used to define the boundaries of the talocalcaneal coalition (Fig. 4).

A navigated burr with a 4-mm round cutting tip is then used to resect the coalition (Fig. 5). The resection should be performed in a controlled manner, aiming directly at the preserved subtalar articulation. The depth of resection is gauged under direct visualization and with the assistance of the navigated system.

When normal articulation is visualized, the resection is completed from anteriorly to posteriorly (Fig. 6). Once it is believed that complete resection of the coalition has been accomplished, hindfoot motion is again assessed. It is important to perform complete resection before attempting any motion at the subtalar joint to preserve the accuracy of the reference frame if further resection is necessary. Bone wax is then placed on the exposed cancellous bone adjacent to the resection. Interposed tendon or a fat graft can be used as well, according to surgeon preference. A secondary intraoperative CT scan can be performed to confirm a complete resection has been performed (Fig. 7).

The tourniquet is then deflated and hemostasis obtained. The wound is closed in a standard layered fashion. The reference frame pins are removed, and a sterile dressing is applied. A well-padded weightbearing short leg cast is applied. This is removed at 10 to 14 days postoperatively. The wound is inspected, and physical therapy aimed at ankle and hindfoot range of motion, proprioception, and calf strengthening is initiated.

## Discussion

To the best of our knowledge, this is the first description of a surgical technique using 3-dimensional navigated resection of a talocalcaneal coalition. This technique allows for a controlled and efficient resection with a navigated burr. Although placing the reference frame and performing the initial intraoperative CT scan does increase the operative time, performance of a more efficient resection should negate the additional time.

Furthermore, the use of navigation to perform the resection avoids 2 potential events. First, the need for rongeurs and osteotomes is limited, which eliminates the challenge of identifying the coalition. Thus, this technique decreases the risk of overresection of the medial bone. Second, it helps avoid the risk of an incomplete resection by combining live 3-dimensional referencing and direct visualization.

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