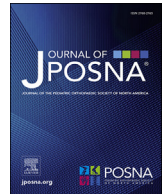




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## Surgical/Technical Tips

# Alternative Methods of Fixation for Anterior Tibialis Transfer in Residual Clubfoot Deformity

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## ABSTRACT

The preferred treatment for congenital clubfoot is the Ponseti method, which involves weekly manipulation and casting followed by tendoachilles tenotomy and abduction bracing. Depending on patient age and deformity location, 5%–35% of patients experience recurrent deformities and require additional treatment, including casting or surgery. Dynamic supination during the swing phase of gait represents a common sequela; it can be managed with anterior tibialis transfer to the lateral foot. Variations in this technique include how much tendon is transferred, the use of 2 or 3 incisions, the recipient location of the transferred tendon, and fixation methods. Ponseti preferred the transfer of the entire anterior tibialis tendon into the ossified 3rd cuneiform and securing the transferred tendon with absorbable stitches tied over a plantar button and sterile felt. With this method, the senior author has had soft tissue complications, namely skin maceration and, on one occasion, full-thickness necrosis down to the plantar fascia. As a result, variations on this technique have evolved with resultant mitigation of these complications. These methods are described here.

### Key Concepts:

- (1) Anterior tibialis transfer (ATT) is a commonly utilized method of addressing residual deformity following the Ponseti method
- (2) The classic fixation method includes using an absorbable suture tied over felt and a plantar button under the cast. While uncommon, this method can lead to significant pressure sores.
- (3) For patients who undergo isolated ATT, we now tie the button on the outside of the cast to avoid a pressure sore.
- (4) In patients who undergo ATT with additional treatment of posterior contracture, one can secure the anterior tibialis into the recipient site by tying it to a K-wire used to maintain the hindfoot correction.

## Introduction

The preferred treatment for congenital clubfoot deformity is the Ponseti method, whereby weekly manipulation and casting are followed by heel cord tenotomy and abduction bracing for three years. Despite being the standard initial approach for all clubfeet, approximately 1/3 years of patients treated with the Ponseti method will have some residual deformity and require further treatment [1]. A common residual deformity includes dynamic supination during the swing phase of gait; Ponseti hypothesized this to result from residual

medial displacement of the navicular on the head of the talus [2] (Fig. 1). This would preposition the forefoot into adductus and turn the anterior tibialis into a forefoot supinator as it dorsiflexes the foot. Other research has hypothesized that recurrent clubfoot deformity results from dysfunction of the peroneal nerve, and the resultant imbalance of the foot muscles leads to resistant/recurrent deformity [3–8] (Fig. 2).

Dynamic supination via the anterior tibialis tendon in swing phase is a common residual foot deformity and can be more problematic when the foot also has concurrent equinus deformity; in this case, the hind foot can

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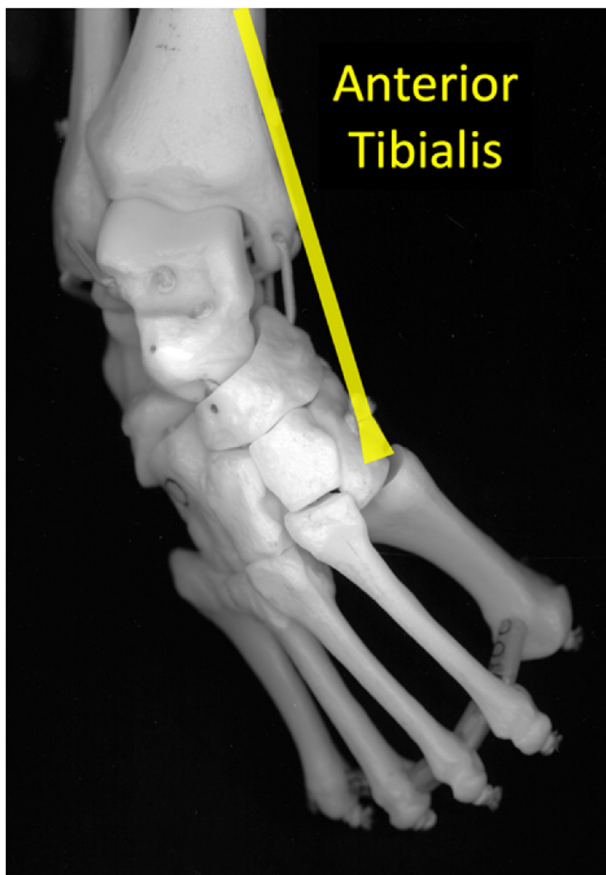
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**Figure 1.** According to Ponseti, medial deviation of the navicular promotes forefoot supination.



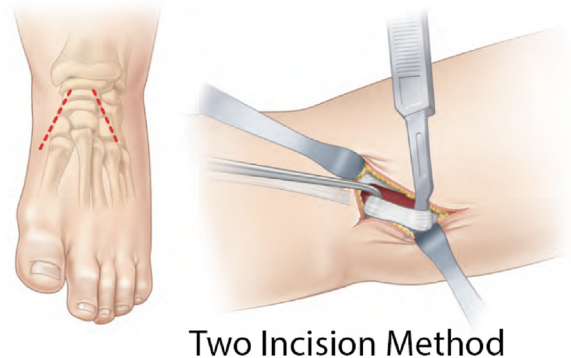
**Figure 2.** This 18-month-old child with residual clubfoot deformity has congenital peroneal nerve dysfunction. There is no active toe extension.

be driven into further varus deformity in stance phase. Complete anterior tibialis transfer was described by Garceau, who utilized a three-incision method where the tendon is transected from its insertion through a dorsomedial insertion and drawn into the leg through an anterior distal leg incision, which provides a direct line of pull into the third dorsolateral incision over the third cuneiform [9]. Ponseti preferred a two-incision method (Fig. 3), where the tendon is transferred into the dorsolateral foot incision [10]. In both methods, suture is woven through the tendon stump, then passed from dorsal to plantar through a drill hole in the cuneiform (Fig. 4). Classically, the sutures are threaded through straight Keith needles and passed through the skin of the plantar foot. The tendon stump is pulled into the bone tunnel while tensioning the sutures before passing them through sterile felt and tying them over a plantar button (Fig. 5).

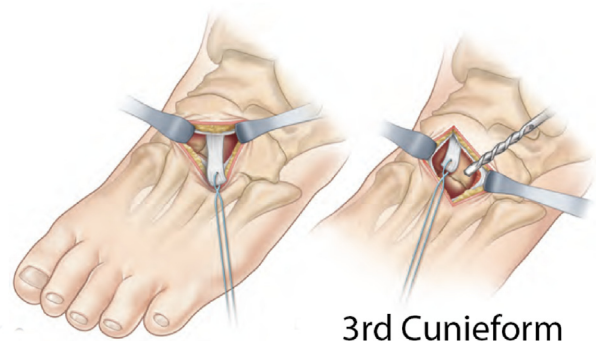
As time and technology have evolved, other methods to secure the anterior tibialis have been proposed and include suture (metallic or non) fixation and interference screw fixation [11–14]. In each of these articles, the authors cite the occurrence of skin complications from a plantar button as a motivation to develop better fixation methods.

There are several technical pearls for the Garceau/Ponseti method:

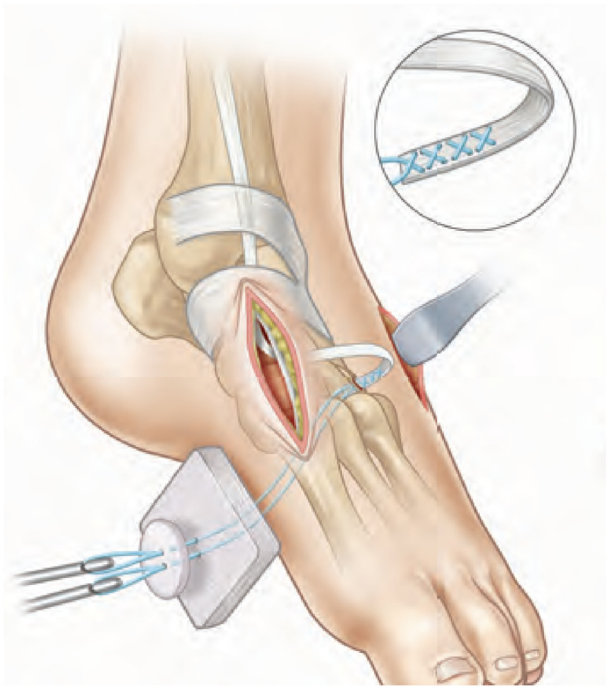
- During the procedure, one must be certain that the maximum tendon length is gained during the harvest.
- The cut end must be secured appropriately with a suture to allow an appropriate fit within the tunnel with appropriate tension.
- We use #1 Vicryl suture (Ethicon, Raritan NJ) as it is sufficiently strong and dissolves in 6 weeks.



**Figure 3.** The two-incision method as favored by Ponseti.



**Figure 4.** The anterior tibialis is pulled into the dorsolateral wound directly over the 3rd cuneiform where an appropriately sized drill bit is used to prepare a bony tunnel.



**Figure 5.** Classically described, the anterior tibialis is pulled into the tunnel by the sutured tendon and tied over sterile felt and a sterile button. The foot is held in dorsiflexion as the cast is applied.

- Closing the dorsolateral incision last with the foot maximally dorsiflexed allows one final visualization to ensure the tendon is in the bony tunnel.
- The foot is to be held in maximal dorsiflexion, and the suture is tied with just enough pressure to keep the tendon in the tunnel without undue pressure.
- This foot position must be maintained until the cast is applied in equal dorsiflexion.

Several pitfalls with this technique must also be noted:

- The senior author has seen some soft tissue pressure problems with the plantar button in children who do not comply with instructions to be nonweight bearing or when the surgeon pulls too hard to get a tendon into the bony tunnel. This would be more likely to happen in patients with concurrent posterior contracture.
- A recent biomechanical study explored soft tissue complications, finding that the pressure exerted on the bottom of a cadaveric foot is high enough to cause a plantar sore [15].
- While difficult to confirm, it is possible that the tendon withdraws from the bone as a result of inadvertent plantarflexion while casting or due to the creep of the plantar soft tissue.

This technical tip paper describes how we secure the anterior tibialis in patients with and without posterior ankle contracture. At our institution, these methods have mitigated the risks of plantar pressure sores. They are also cost-effective and have a lower financial impact than most surgical anchors.

## Method

### Technique 1

After the anterior tibialis tendon has been transferred into the bony tunnel, an assistant holds the suture with tension with a hemostat

(Fig. 6). One last look is taken into the dorsolateral incision, and the ability of the tendon to easily slide in and out of the tunnel with variable suture tension is confirmed. The wound is closed, and the foot is held in the position of the final casting. Sterile dressings and the cast are applied while the assistant holds the suture in tension. The soft tissue dressing and cast material must be applied while respecting the orientation of the suture pull. The person who applies the padding and cast material takes great care in ensuring the cast padding and fiberglass material do not wrap up the suture and restrict the suture's line of pull. An unencumbered line of pull allows tensioning to finally occur with a straight trajectory line. Failing to do this will make it hard to ensure the tendon can finally be tensioned into the tunnel without cast material resistance. (Video 1).

Once the cast has hardened, the Vicryl suture is tied over the button with a safe amount of tension, avoiding suture failure. One can safely increase the tension by wrapping an additional suture (Fig. 7) around the Vicryl suture between the button and cast (Video 1). Using this method, the button is displaced away from the cast, gradually increasing tension on the tendon (Fig. 8). Once the button is secured and tensioned, the cast can be anteriorly univalved to allow for postoperative swelling while maintaining the foot in dorsiflexion. Before discharge, the cast is over-wrapped, and the button is covered. Should the surgeon elect not to split the cast, the button can be covered with one final layer of cast material before leaving the operating room. When the cast is removed at 6 weeks,

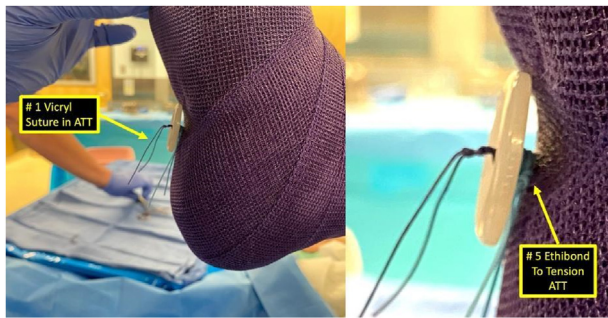


**Figure 6.** While the foot is held corrected, an assistant holds the suture in tension so that the dressings and cast material can be applied without getting the suture bound up in the cast, which could limit final tensioning.



**Figure 7.** A no. 5 Ethibond suture (Ethicon, Raritan NJ) is used to finally tension the ATT transfer. By winding around the Vicryl suture between the button and the cast, a gradual increase in tension can be applied as the button is displaced away from the cast.



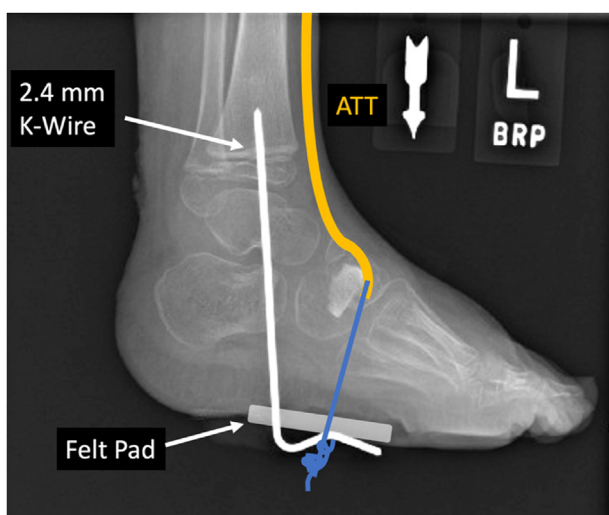


**Figure 8.** Once the Vicryl suture has been tied, the final tensioning is done by wrapping a #5 Ethibond suture around the Vicryl between the button and the cast, which incrementally tightens the ATT by displacing the button distally.

the button remains in the cast as the suture will dissolve under the skin. There is no increase in pain or difficulty with cast removal at 6 weeks; very rarely, a small portion of suture can extrude from the foot, and it can be trimmed at the level of the skin.

#### Technique 2

In many cases of residual clubfoot deformity, the child may have an equinus contracture that undergoes tendoachilles lengthening or posterior capsule release before ATT. In these cases, the surgeon may hold the corrected hindfoot in a dorsiflexed position with a 2.0 mm or 2.4 mm K-wire pin placed retrograde through the heel pad, crossing the subtalar and ankle joint in maximal dorsiflexion. The primary purpose of this pin is to maintain the hindfoot correction without relying on plantar cast pressure and potential pressure sores on the metatarsal heads. In these cases, the wire can be bent so that the #1 Vicryl suture ends (securing the ATT) can be secured to the wire with an appropriately placed felt pad between the skin and the pin (Fig. 9). The advantage of this method is that one can watch the tendon as it slides into the tunnel and confirm its location after it is tied over the pin. As a result of pinning the hindfoot, one can easily apply the cast without worrying about ATT fixation loss during immobilization. The pin and felt button are removed at six weeks, and as above, the #1 Vicryl suture will have dissolved (see Fig. 10).



**Figure 9.** This 4-year-old girl with recurrent clubfoot deformity was treated with posterior release and pinning. Through the medial incision, the ATT was harvested, and a first cuneiform osteotomy was performed to correct the metatarsus adductus. After transfer to the third cuneiform, the Vicryl is tied to the bent wire, and the cast is applied.



**Figure 10.** Six weeks after surgery, the cast was removed, and the pin was removed. The Vicryl suture had dissolved under the skin.

#### Discussion

Following the Ponseti treatment method for clubfoot deformity, some children may present with dynamic supination in the swing phase of gait. In these cases, Ponseti and others proposed the transfer of the entire AT tendon, secured with absorbable sutures through a sterile felt and button on the plantar surface. Due to the pressure of the button on the plantar surface, this method occasionally runs the risk of causing soft tissue complications in patients. We have modified the ATT by tying the suture to the button on the exterior of the cast, which spreads any pressure over the area of the plantar surface of the cast. The risks of resultant acute soft tissue pressure sores are eliminated. In addition, the tension on sutures can be more finely “tuned” through the described winding technique, reducing the likelihood of sudden suture failure from overtensioning. With this method, and in more than 2 decades of practice, the senior author has never encountered a plantar pressure sore or had a failed transfer.

Many patients with residual clubfoot deformity have posterior equinus and supination and thus require tendoachilles lengthening or posterior release before ATT. Surgical management of the equinus rarely results in immediate normal dorsiflexion of foot on the OR table. When we then perform the ATT, we note that these patients with baseline equinus often require more tension on the tendon and are at higher risk for plantar button pressure as opposed to an isolated ATT in a child with more normal dorsiflexion. In these cases, we will use a hindfoot transfixing K-wire to secure the ATT and have not had any complications with this method.

#### Consent for publication

The author(s) declare that no patient consent was necessary as no images or identifying information are included in the article.

#### Author contributions

**Spencer Wilson:** Writing – review & editing, Writing – original draft.  
**Laura L. Bellaire:** Writing – review & editing, Writing – original draft.  
**Kenneth J. Noonan:** Writing – review & editing, Writing – original draft, Methodology.

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#### Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jposna.2024.100126>.

View the video(s) on POSNAcademy here: <http://www.kaltura.com/tiny/t7gbi>.

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