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Cadaveric Limb Analysis of Tendon Length Discrepancy of Posterior Tibial Tendon Transfer through the Interosseous Membrane

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ABSTRACT

The posterior tibial tendon transfer through the interosseous membrane, as popularized by Watkins in 1954, is a procedure for treating reducible eversion and dorsiflexory paresis used by lower extremity foot and ankle surgeons. The posterior tibial tendon has been transferred to various locations on the midfoot for equinus and equinovarus deformities. Dorsiflexory paresis is a common symptom in equinovarus deformity, clubfoot deformity, Charcot-Marie-Tooth disease, leprosy, mononeuropathy, trauma to the common peroneal nerve, cerebrovascular accident, and Duchenne's muscular dystrophy. The main difficulty with this procedure, often discussed by surgeons, is inadequate tendon length, making anchoring to the cuneiforms or cuboid difficult. The goal of our cadaveric study was threefold. First, we sought to determine whether the tendon length is sufficient when transferring the posterior tibial tendon to the dorsum of the foot through the interosseous membrane for a dynamic or a static transfer. Second, we wished to describe the surgical technique designed to obtain the maximal length. Finally, we sought to discuss the strategies used when the tendon length for transfer is insufficient.

The anterior transfer of the posterior tibial tendon, using a circumferential route, was first reported by Ober in 1933 (1). Putti is credited with transferring the posterior tendon through the interosseous membrane to the dorsum of the foot in 1937 (1). Watkins popularized this procedure in 1955 (1,2). Dorsiflexory paresis is a common symptom in equinovarus deformity secondary to clubfoot deformity (3), Charcot-Marie-Tooth disease (1,4), leprosy (1,5), mononeuropathy, trauma to the common peroneal nerve (5–7), cerebrovascular accident (1,8), and Duchenne's muscular dystrophy (3,9).

Before performing this tendon transfer, several factors must be evaluated for a successful outcome. First, one must determine whether the etiology of the deformity is static or progressive (1,10). In some instances, when arthrosis or rigidity exists, osteotomies and/or arthrodesis procedures could be needed in conjunction with the posterior tibial tendon transfer (1,11). In a longstanding equinus contracture, the surgeon must also address the tight heel cord with Achilles tendon lengthening and/or a posterior release. Next, a thorough evaluation of the strength of lower extremity muscles through clinical examination and electromyography should be performed (1,4,10,12). The posterior tibial muscle strength must be graded as 4 or greater because 1 grade will be lost after transfer (10). The surgeon must also inform the patient of the surgical expectations and limitations of the procedure.

A common difficulty of this procedure, well documented by surgeons, is an inadequate tendon length, making anchoring to the cuneiforms or cuboid difficult (1,2,13,14). The tendon can be attached to the dorsum of the foot using 3 different techniques: the tendon through bone and then back on itself, tendon to bone, and tendon to other tendinous structures. The goal of our cadaveric study was threefold. Our first goal was to determine whether the tendon length is sufficient when transferring the posterior tibial tendon to the dorsum of the foot through the interosseous membrane for a dynamic or static transfer and to describe the surgical techniques designed to obtain the maximal length. In a dynamic tendon transfer, the donor muscle is strong enough to perform or augment the function of the muscle that is partially paralyzed. In a static tendon transfer, the tendon serves as an arthroereisis to prevent undesired motion, in our case, the undesired plantarflexion. All methods of attachment were explored; however, our standard method of fixation was a suture anchor. The second goal was to describe the surgical technique designed to obtain the maximal length. The third and final goal was to discuss the strategies used when there is insufficient tendon length for transfer.

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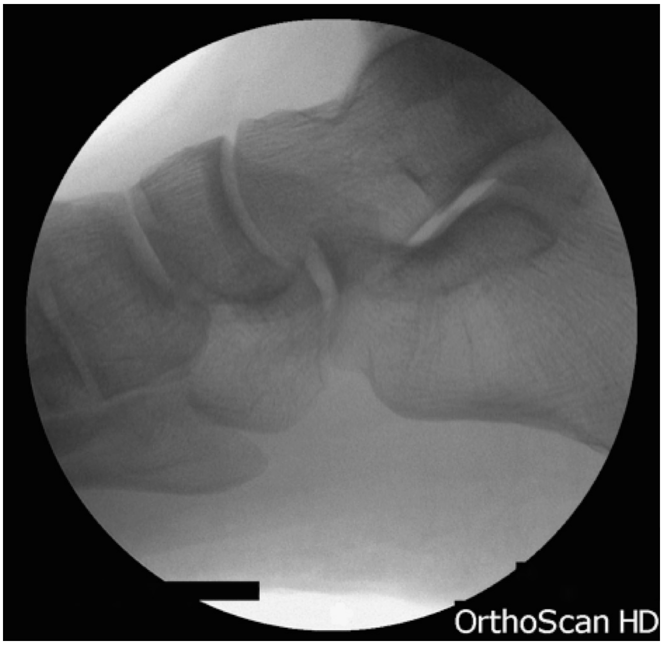

Fig. 1. Radiographic view of rectus foot.

Materials and Methods

The study was performed on 6 unpaired cadaveric limbs, aged 28 to 85 years, with the proximal origin of the posterior tibialis muscle intact. All the limbs were categorized into a rectus, pes cavus, or pes planus group through clinical and radiographic analysis (Fig. 1). We used the calcaneal inclination angle, cyma line position, and talocalcaneal angle (on anteroposterior and lateral views) for our radiographic analysis.

A modified version of Myerson's 4-incision technique was used for our transfer (10). The first incision is made medially 2 cm distal and proximal to the main insertion of the posterior tibial tendon at the navicular tuberosity. The posterior tibial tendon is then dissected off the navicular, preserving as much tendon distally and inferiorly to the navicular as possible (Fig. 2). A Krackow suture technique is then used to aid tendon transfer. We prefer size 2 fiber wire. The second incision, 4 cm in length, is made medially along the calf, 15 cm proximal to the distal tip of the medial malleolus and just posterior to the medial aspect of the tibial crest. The first tendon usually encountered is the flexor digitorum longus. Dissection is then made down to the posterior tibial tendon (Fig. 3). Using a large hemostat (i.e., a serrot), the distal tendon stump is then pulled out of the second incision (Fig. 4). Next, a tunnel is made with the serrot posterior to the tibia in a distal and lateral direction. Blunt and careful dissection is used in this step, because the neurovascular bundle is located in this area. The serrot is then used to penetrate the interroseous membrane and tent the skin distal and lateral to the second incision (Fig. 5). A 4-cm incision is then made at the point of tenting. After the third incision is made, the serrot is widely opened to provide a large interosseous window. The tendon is then passed from the second incision to the third incision (Figs. 6 and 7). The fourth incision, 4 cm in length, is the made over the midline of the lateral cuneiform. The position for the incision is confirmed by fluoroscopy. The tendon stump is then passed from the third incision deep to the extensor retinacula and out of the fourth incision.

The ankle is then positioned halfway between maximal dorsiflexion and maximal plantarflexion. This position has served as our dynamic transfer. If the tendon length is adequate, a suture anchor was driven into the lateral cuneiform (Figs. 8 and 9). If the limb is able to reach the lateral cuneiform in the plantarflexed position, the limb is considered to having sufficient length for the dynamic and static transfer. If the tendon length is insufficient, the discrepancy is measured by sewing a length of nonelastic cord to the distal aspect of the tendon in a Kessler fashion and measuring any deficiency in tendon length for both static and dynamic transfer.

Results

The procedure was performed on 6 cadaveric limbs, 4 right and 2 left. Through radiographic and clinical analysis, 4 rectus limbs and

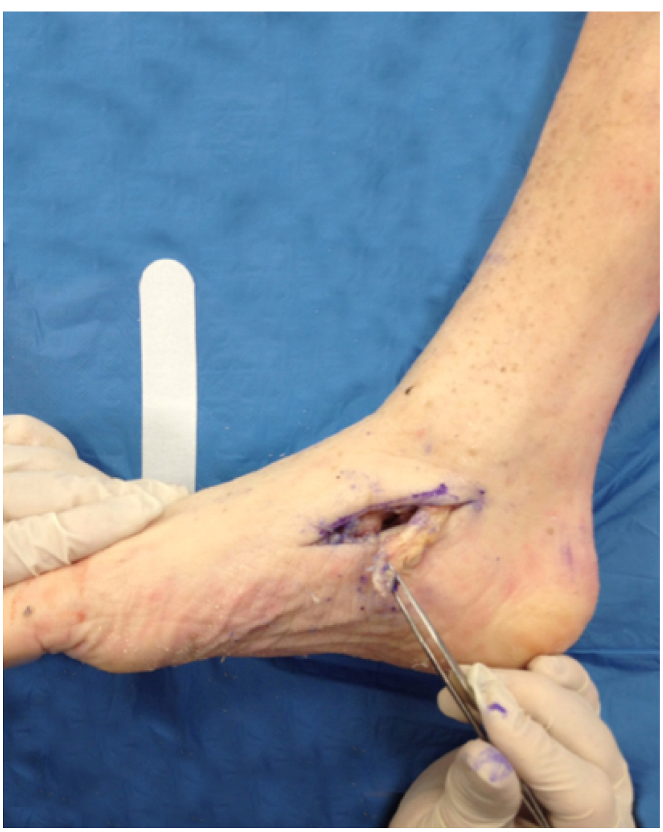

Fig. 2. Longitudinal incision (4 cm) with medial navicular dissection and exposed posterior tibial tendon.

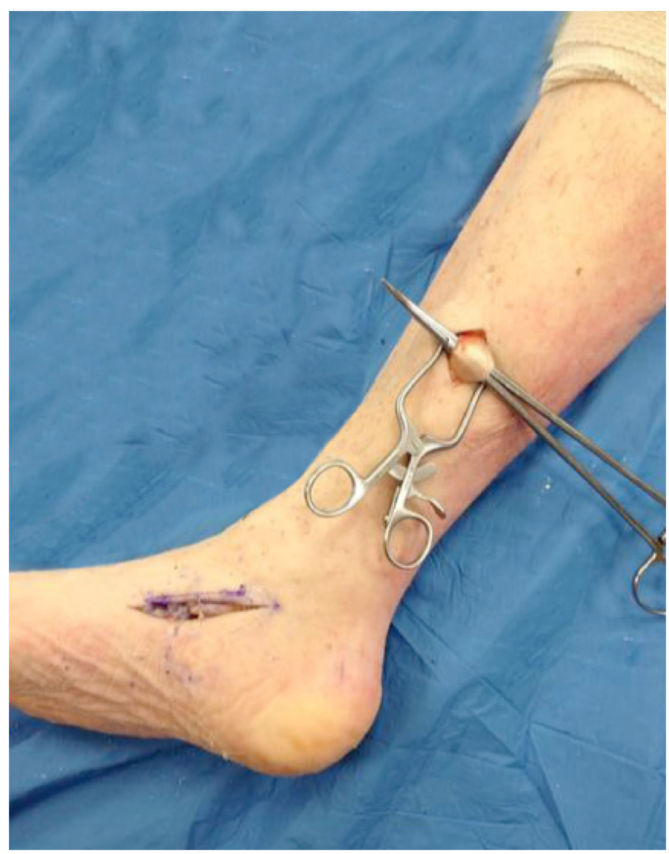

Fig. 3. Second incision, isolating posterior tibial tendon.