MASTERCLASS SERIES

Tibialis Posterior Tendon Transfer for the Management of Foot Drop

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Abstract

The transfer of a normal tibialis posterior through the interosseous membrane to the dorsum of the foot can restore active ankle dorsiflexion where this has been lost from common peroneal injury, anterior compartment muscle loss, or in some neurological conditions. An appraisal of the indications, planning, and a step-by-step description is provided.

Keywords: Ankle, Compartment syndromes, Peroneal neuropathies, Tendon transfer.

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Indications

This procedure is indicated in the field of limb reconstruction surgery for the following problems:

- Common peroneal or deep peroneal nerve injury (traumatic or iatrogenic) without recovery,
- Compartment syndrome with loss of anterior compartment function but with retention of normal power of deep posterior compartment muscles,
- Neuromuscular conditions leading to isolated weakness of ankle dorsiflexion.

The procedure was used historically for common peroneal nerve palsy associated with leprosy. Today, this procedure can address the weakness of ankle dorsiflexion from various aetiologies that produce a 'foot drop'. The impact of this problem varies according to the activity demands and other functional statuses of the patient. An assessment will often show the absence of a heel strike with a foot slap on landing and difficulty with clearance in the swing phase of gait (high stepping). The gait pattern, overall, is unattractive.

The requisites for tendon transfers must be met:

- The joints across which the tendon transfer is meant to act must be supple (or made so).
- The donor tendon should have sufficient strength and be expendable (one grade of motor power is lost in the transfer).
- The line of pull of the tendon should be straight.
- The new route taken by the tendon should be free of scars and adhesions (or made so).
- The chosen tendon should work in synergy with other musculotendinous units.
- The tendon transfer should aim to perform a single function.

Contraindications

An ankle in equinus that is not passively correctible should not be managed with a tendon transfer until passive joint motion into dorsiflexion has been restored. The examination to establish if the ankle has this passive range of movement, or if not, whether preoperative physiotherapy or a surgical release will enable this to be achieved is essential. Soft tissue releases to achieve at least 15 degrees of ankle dorsiflexion can be performed simultaneously with the tendon transfer. This scenario is more likely if there has been no previous trauma or surgery to the posterior aspect of the ankle. Scarring over the posterior ankle makes it unlikely to achieve the requisite amount of dorsiflexion by open soft tissue surgery alone. In this scenario, alternative solutions should be considered, such as gradual correction in a circular fixator, the combination of open soft tissue surgery, and dorsiflexion osteotomy.

> **Pitfall**
>
> A tibialis posterior tendon transfer in a patient with an equinus contracture is contraindicated. Full resolution of the equinus posture is an essential prerequisite.

The loss of one grade of motor power in the transfer indicates that the strength of the donor's tendon should be of medical research council (MRC) grade IV+ or V. In the event of transferring a tendon of grade IV, the result achieved is likely to be a tenodesis in ankle dorsiflexion and still provides the patient with the functional improvement required (addressing the foot drop, foot slap and high-stepping gait). Tibialis posterior strength can be assessed by

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the single heel raise test or by passively resisting foot inversion when in the plantarflexed and everted position, whilst palpating the tendon structure to confirm actual tautness within.

Alternatives

Successful non-operative management of this problem is with an ankle-foot orthosis (AFO). In addition to holding the ankle stable in a neutral position, variants of posterior leaf designs of the AFO can produce some return of power on push-off. Patients waiting for surgery placed into an AFO at the earliest opportunity have the advantage of preventing the equinus contracture from developing. Some patients may even decline surgery if they find that the splint provides a satisfactory return of function without exposure to surgical risk.

The circumtibial route of tibialis posterior tendon transfer (avoiding the re-routing through the interosseous membrane) has been described but fails to meet an important principle of tendon transfer – that of creating a straight line of pull in the transfer.

An ankle arthrodesis can be considered if a tendon transfer fails or the indications for the transfer are not met. It is a much more invasive surgical procedure, even if done arthroscopically. Many patients may choose to use an AFO over this option unless the ankle is also degenerated and is a source of symptoms.

Pre-op Planning and Work-up

Clinical examination is crucial to the requirements of the surgical plan. The key features that need to be established are:

- The signs of a high-stepping gait, foot slap, and drop foot posture.
- The loss of active ankle dorsiflexion (in some cases where only tibialis anterior is affected, the extensor muscles of the toes can act to produce some dorsiflexion of the ankle).
- The passive range of movement of the ankle and the ability to reach at least 15 degrees of dorsiflexion.
- The action and strength of tibialis posterior muscle.
- The strength of flexor digitorum longus (FDL) (this is needed to replace the tibialis posterior at its insertion in the navicular in order to prevent the development of a flatfoot). In the event this is not possible, a fusion of the talonavicular joint can be considered with the harvest of the tibialis posterior tendon.

A detailed assessment of the sensory and motor function of the common peroneal nerve is needed and should be documented. If the reason for the tendon transfer was either a common peroneal or deep peroneal nerve injury, the absence of recovery should be shown through nerve conduction studies.

Plain X-rays are used to rule out significant co-existing arthritis in the ankle which, if present, may suggest an alternative primary procedure such as arthrodesis.

Consent Issues

The expected successful outcome is the tendon transfer holding the ankle near the plantigrade position. Physiotherapy may enable a 're-education' of tibialis posterior to produce active ankle dorsiflexion. If this is not achieved, the tendon should function as a tenodesis of the ankle in a neutral position or in slight dorsiflexion.

General Risks: bleeding, infection, scarring, damage to nerves and blood vessels, pain, stiffness, blood clots in legs or lungs.

Specific Risks: failure to improve symptoms, further surgery, compartment syndrome.

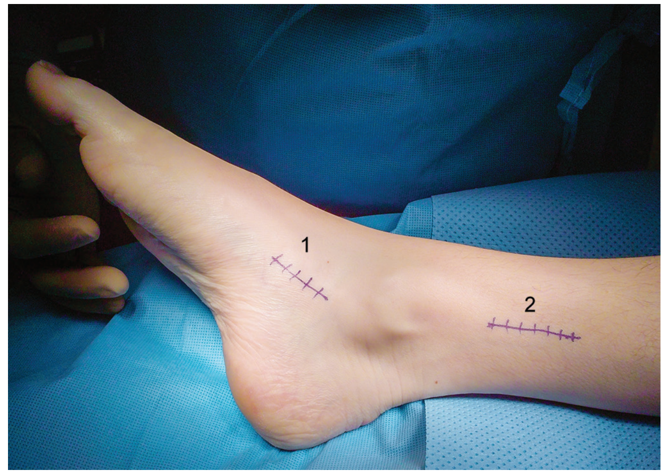

Fig. 1: Medial view of the foot and ankle. (1) A 5-cm incision over navicular. (2) A 5-cm incision in line with the posterior border of tibia, centred a hand's-breadth above the medial malleolus

Equipment and Other Requirements

Fluoroscopy, tourniquet, basic orthopaedic set, tendon passer or a retriever, tendon fixation (interference screw or bone anchors), and plaster slabs for post-surgical immobilisation.

Set-up in Theatre

General or regional anaesthesia is suitable. The patient is placed in a supine position, a contralateral sandbag is used (to enable easier access to the medial side of the leg to be operated on), a tourniquet is applied and inflated throughout, with skin preparation and draping to above the knee.

Procedural Steps

The first step is to mark the incisions on the medial side (Fig. 1). The relevant surface anatomy is the tuberosity of the navicular, the medial malleolus, and the posteromedial border of the distal tibia on the medial side. Anteriorly, the lateral or intermediate cuneiform is identified by being in line with the third and second metatarsals respectively and the crest of the tibia in the distal third forms the final landmark.

A 5-cm incision over the palpable prominence of the navicular extending towards the medial malleolus and a second 5-cm incision, centred a hand's-breadth above the medial malleolus in line with the posterior border of the tibia are made. The incision over the navicular may need extending if a transfer of FDL to the navicular is planned. Be careful not to damage the saphenous vein or nerve.

Once through skin and fascia, tibialis posterior can be seen inserted broadly into the navicular (Fig. 2). The tendon is released with sharp dissection from its insertion into and over the substance of the tuberosity. This latter release provides an important extra 1 cm of the distal expansion.

Tip

Ensure that you take as much of the distal tendinous expansion as possible when harvesting tibialis posterior. The 1 cm of extra length helps ensure sufficient reach is attained when re-implantation is done anteriorly.

Fig. 2: (1) Insertion of the tendon of tibialis posterior in its native position

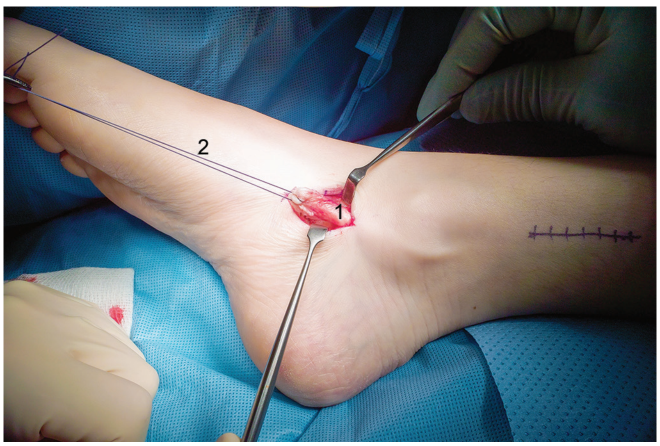

Fig. 3: (1) Tibialis posterior tendon. (2) Whip stitch

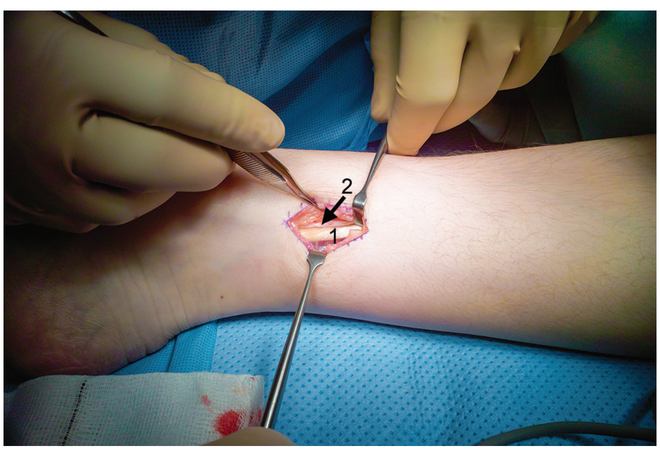

Fig. 4: (1) The tendon seen just after incising the fascia is flexor digitorum longus. (2) Tibialis posterior is the tendon seen deeper in this proximal medial wound

A whip stitch is placed into the tibialis posterior tendon to facilitate tendon passing during the procedure (Fig. 3). Any strong (0 grade) suture suffices.

The proximal posteromedial incision (shown in Fig. 1) is used to find the same tendon. The first muscle seen after incising the fascia is usually FDL. Retracting FDL posteriorly reveals the tibialis posterior tendon (Fig. 4). Tug on the tendon distally and look for corresponding movement to ensure the correct tendon is identified.

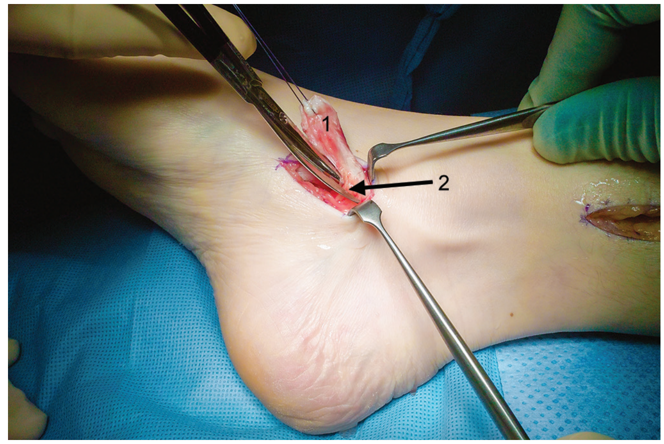

Fig. 5: (1) Tibialis posterior tendon under tension with the whip stitch. (2) Vinculae being divided by fine dissecting scissors

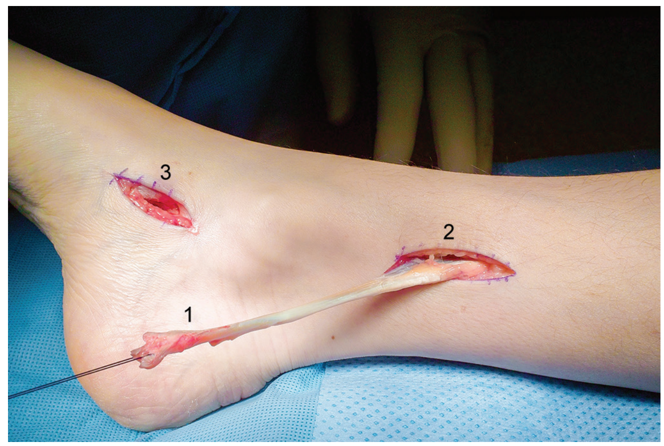

Fig. 6: (1) Tibialis posterior tendon has been retrieved proximally. (2) Proximal medial wound. (3) Distal medial wound

Before the tendon can be retrieved from the proximal incision, the vinculae anchoring it to its fibro-osseous tunnel need to be divided (Fig. 5). Fine-curved dissecting scissors are ideal for this step. The vinculae can tether the tendon anywhere along its course between the two incisions so the scissors need to be passed along this course adjacent to the tendon on all its sides in retrograde and antegrade directions.

Once all the vinculae have been divided, tibialis posterior tendon can now be withdrawn from the distal wound and delivered out of the proximal incision (Fig. 6). The tendon is wrapped in a moist saline-soaked swab to avoid desiccation. Through the same proximal incision, the musculotendinous portion of tibialis posterior is mobilised sharply in a proximal direction. This is to facilitate the straight line of pull of the tendon (Fig. 7). After mobilising the distal portion of the muscle belly, the scissors are used to open the plane, deep to the tibialis posterior but superficial to the periosteum of the tibia, towards the fibula.

The sandbag can now be removed from the contralateral buttock, which has the effect of allowing the operative limb to roll back towards neutral, giving better access to the lateral side. A

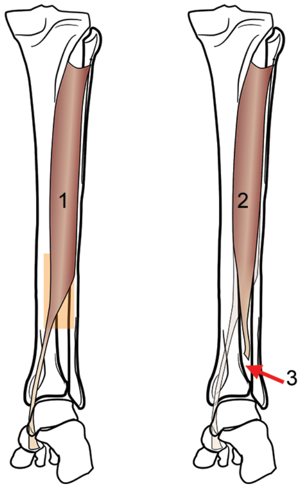

Fig. 7: Diagram of the posterior view of the tibialis posterior muscle in its native position (1) and after the tendon has been transposed (2), through the interosseous membrane (3). This shows how mobilising the distal portion of the muscle belly maintains a straight line of pull. The orange rectangle highlights to distal portion of the musculotendinous portion that needs to be mobilised in order to realign the pull of the tendon so that it is straight

5-cm proximal anterior incision is made about 1 cm lateral to the crest of the tibia (Fig. 8). This is centred slightly distal to the centre of the corresponding incision on the posteromedial side. The second anterior incision can be positioned either by X-ray guidance or by palpation along the metatarsals. This 4-cm incision is placed over the intended target for implantation of the tendon transfer (usually the lateral cuneiform). The proximal anterior incision is deepened through fat and fascia. The plane between the tibialis anterior and the lateral wall of the tibia is then developed sharply and this leads all the way down to the interosseous membrane. The anterior tibial artery and the deep peroneal nerve lie either on the interosseous membrane in the depths of this wound, or more distally, it may lie between the tendons of tibialis anterior on one side and extensor hallucis longus (EHL) and extensor digitorum longus (EDL) on the other. These important structures should be identified, mobilised and retracted to safety. An incision is made in the interosseous membrane at the posterolateral corner of the tibia and bluntly widened to create a defect under direct vision.

Pitfall

Some sources advocate piercing the interosseous membrane blindly from the medial side using an instrument such as a Roberts artery forceps. This technique carries a risk of injury to either anterior tibial artery, deep peroneal nerve or both. We recommend the creation of a defect in the interosseous membrane under direct vision with the neurovascular bundle protected.

A plane can be developed bluntly from the aperture made in the interosseous membrane from lateral to medial, establishing continuity to the plane established earlier from the medial side. A clip or artery forceps is then passed from lateral to medial to pick up the end of the whip stitch (Fig. 9).

The tibialis posterior tendon is delivered out of the proximal anterolateral wound and pulled in the direction of the midfoot (Fig. 10). The tendon has to run straight and untethered to function

Fig. 8: Anterolateral view of the foot and ankle. A 5-cm proximal incision on the anterior aspect of the distal tibia. A 4-cm incision on the dorsum of foot centred over the chosen target for the tendon transfer (usually lateral cuneiform)

Fig. 9: Anterior view of the lower leg with medial on the right of the image and lateral on the left. An artery forceps is passed from the proximal lateral to the proximal medial wound and grasps the whip stitch at the end of tibialis posterior tendon. (1) A fasciotomy scar secondary to traumatic compartment syndrome is visible. The proximal anterior incision, normally placed 1 cm lateral to the crest of the tibia, was made using the lower end of this fasciotomy scar to prevent a second wound in close vicinity

Fig. 10: Tibialis posterior tendon is now drawn out of the proximal anterior incision

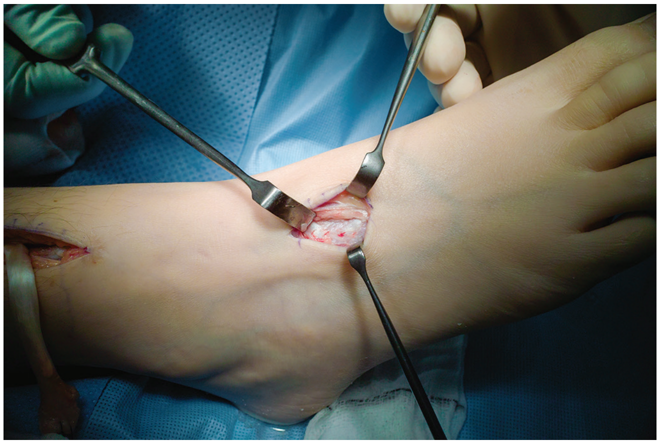

Fig. 11: Dorsum of the foot with exposure of the lateral cuneiform. This target for insertion is approached carefully to avoid injury to the superficial peroneal nerve

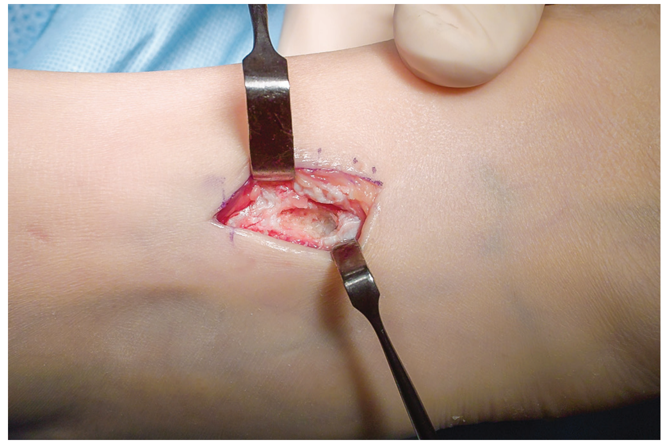

Fig. 13: Detail of the target bone once it has been decorticated with the awl and curettes. Note the exposed cancellous bone

Fig. 12: An awl is being used for the preparation of the target bone

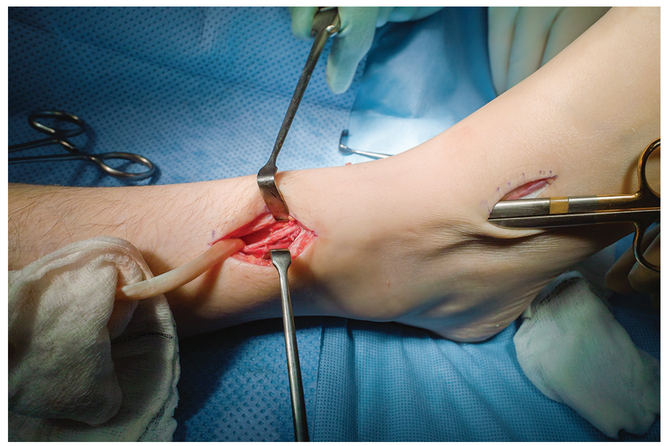

Fig. 14: A large curved (Mayo) scissors are being used to develop a track under the retinaculum from distal to proximal. The tips of the scissors should advance into the proximal lateral wound

optimally; judicious release of any fascial restraints can be done to facilitate this. At this point, an assessment can be made regarding the amount of length available. If the tendon has been harvested as described and the ankle dorsiflexed to at least 15 degrees, then there should be sufficient length to reach the cuneiform bones for anchorage.

The target in the midfoot is approached (Fig. 11), taking care not to injure the extensors or branches of the superficial peroneal nerve, which may be running directly across the operative field. A 1 x 1 cm area is exposed on the dorsal surface of the target bone (e.g., the lateral cuneiform).

The target bone is prepared to receive the tendon and anchor according to the operative technique appropriate for the specific method of implantation and fixation. In this case, a drill hole is made in the bone and then curettes and an awl (Fig. 12) or countersink are used to decorticate the dorsal surface of the bone to provide a wide area of cancellous bone onto which the tendon can heal (Fig. 13).

Large curved Mayo scissors are passed from distal to proximal underneath the extensor retinaculum (Fig. 14). The scissor blades are kept closed throughout to protect the neurovascular bundle. The tips of the scissors should be visible in the proximal wound. Once passed, the scissor blades are opened gently to create a track

Fig. 15: The whip stitch has been retrieved using a suture passer or similar and the tibialis posterior tendon has been delivered into the distal wound. Ensure the suture is passed deep into the retinaculum to prevent bowstringing

Fig. 16: The foot is held in maximum dorsiflexion and the tendon is pulled to confirm the sufficient length

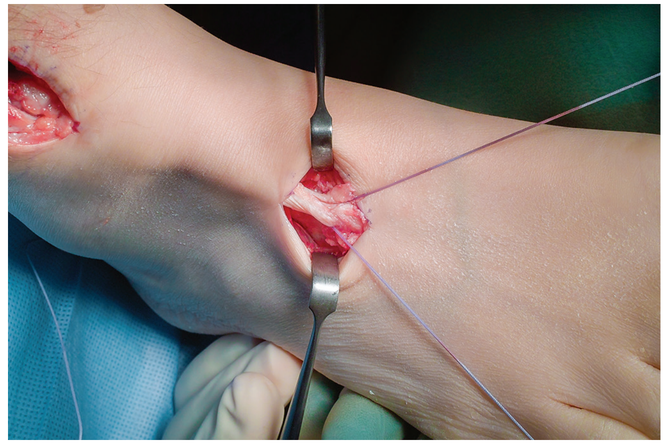

Fig. 18: The whip stitch is removed and the end of the tibialis posterior tendon is drawn deep into the target bony tunnel via the sutures of the anchor and secured

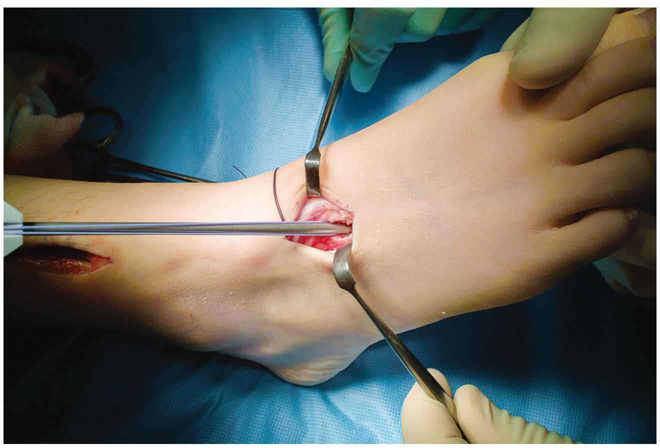

Fig. 17: The suture anchor is being introduced into the prepared tunnel

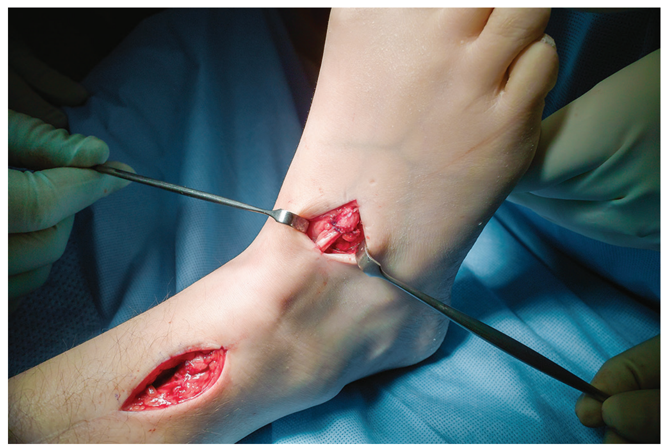

Fig. 19: The tendon is now locked within the tunnel and the procedure is then completed by layered closure of all wounds

for the tendon. The blades are kept open as these are withdrawn to ensure the track created is beneath the entire roof of the extensor retinaculum.

A tendon passer or similar instrument is passed from distal to proximal to grasp the sutures at the end of the tendon so that the tibialis posterior can be delivered into the distal wound (Fig. 15). Take care to follow the track made by the Mayo scissors in the previous step. Lack of care at this point could cause the tendon to pass superficial to the extensor retinaculum with resultant bow-stringing.

With the foot held in maximal dorsiflexion, the surgeon pulls on the sutures at the end of the tendon to confirm that the length is sufficient to reach the target (Fig. 16). The anchor system is then placed into the target bone (Fig. 17). The whip stitch at the end of the tendon is removed and the tendon is trimmed to ensure that it will fit into the bony tunnel. The anchor sutures are then passed into the tendon end and pulled tight, drawing the tendon down into the tunnel (Fig. 18). Note that there are variations in how different anchor systems work and the surgeon should be familiar with the mechanism of securing the tendon. The sutures are then tied with the foot held in maximal dorsiflexion (Fig. 19).

Closure is done in layers. The foot is then held in dorsiflexion whilst a plaster of Paris backslab is applied.

Post-op Plan

This would be targeted to reduce postoperative swelling initially, and subsequently, safe mobilisation with crutches is recommended. Chemoprophylaxis for venous thromboembolism prophylaxis for 6 weeks (e.g., daily low molecular weight heparin injections subcutaneously) is recommended. A clinic review in 2 weeks for wound inspection and suture or staple removal is arranged and for the application of a below-knee cast. As the ankle is dorsiflexed in the cast, the patient remains non-weight until 6 weeks post-op when a below-knee AFO ('walking boot' type) with a dorsiflexion wedge is substituted for a further 6 weeks. Active dorsi-plantarflexion and tibialis posterior recruitment exercises commence at 6 weeks. At no point in the rehabilitation pathway should the patient be subjected to passive plantarflexion of the ankle as this may risk detachment of the newly transferred tendon, or if instituted later, it may cause stretching of the tendon and loss of any tenodesis effect.

Pitfall

Passive plantarflexion of the ankle can lead to detachment of the transposed tendon in bone and MUST be avoided in the physiotherapy sessions. In time, the patient recovers the range of plantarflexion spontaneously.

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