

Original Article

The split tibialis anterior muscle flap – A simple solution for longitudinal middle third tibial defects

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ABSTRACT

Background: The tibialis anterior flap is an underused flap, mainly because it is not an expendable muscle and is small in size. **Aim:** To study the use of the tibialis anterior muscle flap for longitudinal middle third tibial defects. **Materials and Methods:** We have analysed the use of tibialis anterior flap in five patients by the function preservation technique. **Results and Conclusion:** Function preservation techniques used in the harvesting of this flap will be able to cover narrow and linear defects on middle third of tibia comfortably. Size and pliability of the muscle must be assessed before initiation of harvesting of the flap. Flap harvesting is initiated by a sagittal split incision to preserve maximum blood supply to the muscle. Transverse incisions may be employed to obtain the desired reach of the flap. This flap is a simple alternative for linear wounds with small transverse dimensions on middle third of the leg, where the tibialis anterior muscle is uninjured.

KEY WORDS

Longitudinal tibial defect; tibialis anterior function preservation; tibialis anterior flap

INTRODUCTION

Middle third tibial wounds are commonly encountered in clinical practice. Many times, these defects are small in size but need a definite vascular cover. Local fasciocutaneous flaps, gastrocnemius and soleus flaps can be an option in some of these patients. Use of fasciocutaneous flaps or posterior group muscle flaps may not be an option in case of associated contusion injury.^[1,2] For very long and linear wounds, gastrocnemius

or soleus alone may not be able to cover the defect, and they may need a combination of these flaps. Other minor leg muscles may then be valuable options. Generally they have been relegated to a secondary role because of their limited reach, small potential surface area, and risk of devascularisation as they have only a segmental blood supply.^[3,4] The tibialis anterior muscle specifically has an additional contraindication in that its function of dorsiflexion and inversion of the foot is indispensable.^[2,4,5] Nevertheless, this muscle can still be valuable for middle third tibial coverage if function preservation techniques are used, as in a rotation flap,^[2,3,5] or after a lateral^[1,6-8] or medial longitudinal split.^[2,9]

MATERIALS AND METHODS

Surgical anatomy of tibialis anterior muscle

The tibialis anterior muscle lies superficially in the anterior

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	DOI: 10.4103/0970-0358.96585

compartment of the leg, just lateral to the tibia and medial to the extensor hallucis longus and extensor digitorum longus muscles.^[7] Its origin is from the lateral condyle of the tibia, upper lateral surface of the adjacent tibia, interosseous membrane and crural fascia, and it inserts into the medial cuneiform and base of the first metatarsal of the foot.^[2,7] On the basis of its vascular supply from the anterior tibial or anterior recurrent vessels, this is a type IV muscle with 8–12 pedicles of similar size entering the muscle in a segmental fashion.^[2,10]

This is a type III muscle according to its neurovascular supply as classified by Taylor and colleagues.^[11] Hirshowitz *et al.*^[7] have shown that the microcirculation to the muscle is predominantly in a transverse fashion from each segmental pedicle in the pattern of a horseshoe going around the central tendon to reach the anterior side of the muscle. Multiple small longitudinal branches interconnect the territories from one pedicle to the next within the muscle.

Surgical technique

The tibialis anterior muscle flap was used in five patients for coverage of middle third tibial wounds. The surgical technique used was as follows.

After debridement, the tibialis anterior muscle is most often exposed. The muscle is then assessed for its thickness and pliability in comparison to the defect to be covered, and for any trauma and contusion which might preclude its use for the particular defect. If the muscle is thick and fleshy, and pliable enough to cover the defect comfortably, we proceed with the harvesting of the tibialis anterior flap. A parallel incision is made at the subfascial level on the lateral border of the tibialis anterior muscle in a sagittal direction, and the muscle is mobilised [Figures 1 and 2]. The incision over the muscle is extended proximal and distal to the exposed bone to a level where the flap can easily cover the bone without undue tension. The tibialis anterior muscle can then be stretched over the tibia. If the muscle remains tethered, the longitudinal sagittal split can be extended in a vertical direction, proximally or distally to permit more stretch. Multiple segmental perforators can easily be identified entering the muscle [Figure 2]. Due care must be taken so as not to damage the segmental pedicles. Horizontal partial thickness incisions over the muscle can be used as and when necessary to improve the mobility of the muscle [Figure 2]. Due care must be taken so as not to expose the central tendon because

eventually the muscle is to be skin grafted. Care must be taken not to strip off the periosteum on the tibial shin adjoining the tibialis anterior, more so if it is the only periosteum remaining on that particular part of the bone, as it may hamper the vascularity to the bone. The muscle flap is then sutured to the edge of the defect with multiple horizontal mattress sutures and then skin grafted [Figures 3 and 4]. Other case series of tibialis anterior flap being used as turnover flap are shown in Figures 5-7.

Progressive resistive exercises are started after 2 weeks. The exercises are initiated in an active assisted manner,



Figure 1: Post burn exposed shin of tibia

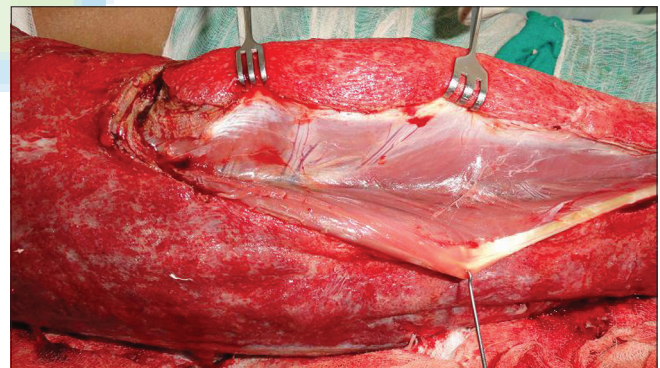


Figure 2: Segmental perforators entering the tibialis anterior muscle



Figure 3: Muscle sutured in place and skin grafted



Figure 4: Well-settled flap and graft



Figure 5: Exposed and fractured middle third tibia

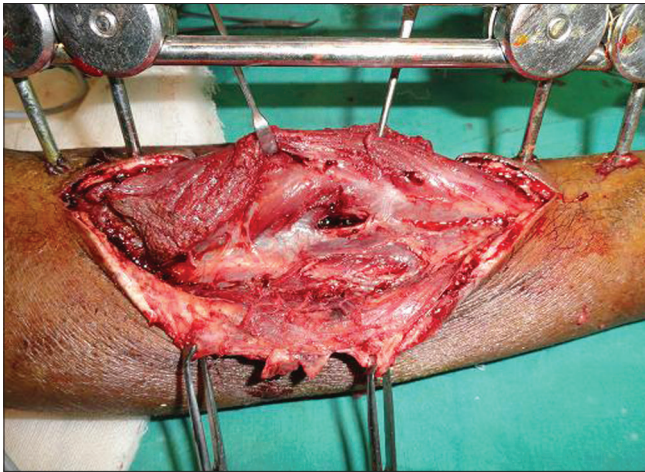


Figure 6: Tibialis anterior muscle being flipped over



Figure 7: Well-settled TA flap and graft



Figure 8: Plantar flexion after the TA flap



Figure 9: Complete dorsiflexion after the TA flap

which moves on to active movements and then to active movements with resistance to strengthen the tibialis anterior.

Table 1: Patient summary

Age	Se	Mode of injury	Defect size	Technique of tibialis anterior transfer
54	M	Burns	17 x 3 cms	Saggital split with transverse incision
33	M	Trauma	14 x 5 cms	Anterior turnover
42	M	Trauma	13 x 3 cms	Anterior turnover
63	F	Trauma	10 x 2 cms	Saggital split with transverse incision
30	M	Trauma	11 x 4 cms	Saggital split with transverse incision

RESULTS

The split tibialis anterior muscle flap was used successfully in five patients over a period of 3 years [Table 1]. The follow-up ranged from 4 weeks to 18 months. One of the patients had exposed bone because of full thickness burns, and rest of the patients had post-traumatic defects in middle third of the leg. The maximum width of the

defect in our series was 5 cm, and the maximum length of the defect was 17 cm. The tibialis anterior was already exposed in all the patients because of injury or debridement. Skin incisions had to be extended in two patients to optimise the exposure and arc of the tibialis anterior muscle to cover the bone. All the flaps settled uneventfully without further intervention. Function of the tibialis anterior was preserved in all the patients [Figures 8, 9 and video showing function of tibialis anterior].

DISCUSSION

Literature has sparse reports on the use of the tibialis anterior flap. The tibialis anterior muscle flap has been underused because this muscle is not expendable and has the important function of dorsiflexion and foot inversion.^[2,10] Nevertheless, even when some form of function preservation technique has been possible, only a small number of cases have been reported. We present our experience with the tibialis anterior muscle flap in a series of five patients. Many function preservation techniques have been described. Technique using detachment of the muscle partially from the tendon to allow an inferior or superior based rotation flap has been described. However, the reach and size of the flap in this case is very small.^[2,3,5]

Any of the longitudinally split versions potentially will allow coverage of the entire middle third of the tibia because of its proximity, but caution must be observed because of chances of direct injury to the muscle due to its proximity to the bone. The posterior advancement form requires a medial incision at the level of the interosseous membrane to use the medial muscle for coverage.^[9] The medial muscle is dissected in a subperiosteal plane away from the tibia, and the muscle is mobilised to cover the defect.^[9] The anterior turnover version is less risky, but previous descriptions state that the lateral incision should then proceed posteromedially above the central tendon until only a narrow medial hinge remains.^[6,7] Thus, the thin flap of anterior muscle so turned over must rely on retrograde flow coming around the medial side of the central tendon. Unlike what has been described in literature for the anterior turnover versions, we have observed that lateral incisions extending only up to one-third of the muscle depth are sufficient to turn over the tibialis anterior comfortably. It is also important

to note that all our turnover versions of the flap were done in acute cases of trauma where the pliability of the muscle was good. Lateral incisions not deepened below one-third of the depth of the muscle also ensure a robust blood supply to the muscle. The converse situation would also be true for the lateral hinged version.^[12] Another technique of the saggital split of the tibialis anterior has been described.^[12] The advantage of this minor variation is that both the medial and the lateral vascular sources are preserved to some degree because there is a direct muscle incision only towards the central tendon, with no intent at undermining.^[12] A disadvantage exists, however, if the muscle is not pliable enough for advancement. In that event, the horizontal extension comparable with the anterior turnover version would be required.^[12]

We have used the anterior turn over modification of the tibialis anterior after a saggital split incision in two patients and a simple saggital split technique with transverse incision in three patients. All the techniques are beneficial, and a decision on how to mobilise the tibialis anterior muscle depends most importantly on the pliability and size of the tibialis muscle in comparison to the dimensions of the defect. We believe that harvesting of the tibialis anterior flap should be initiated by the saggital incision on the lateral border of the tibialis anterior as described by Hallock.^[12] This incision splits the muscle and preserves both the medial and lateral vascular sources to a great extent. After assessing the pliability of the muscle, consideration should be given on whether a transverse incision is necessary so as to mobilise the flap medially or turn it down like a book flap.

CONCLUSION

The patient selection for the use of the tibialis anterior muscle flap is important. The indications for the use of this muscle are very precise. The dimensions of the defect, and condition and pliability of the muscle are important factors which must be taken into consideration before considering the flap as a reconstructive option. We reinforce the idea of use of the tibialis anterior muscle for narrow and linear defects of the middle third of the tibia requiring flap cover. An already exposed tibialis anterior muscle in the wound further adds to the ease of dissection without any additional incisions.

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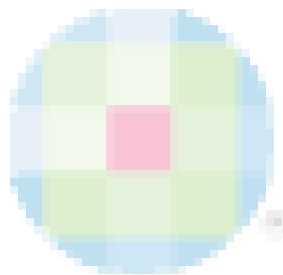
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How to cite this article: Panse N, Sahasrabudhe P, Pande G, Chandanwale A, Dhongde R, Rajpal L. The split tibialis anterior muscle flap - A simple solution for longitudinal middle third tibial defects. *Indian J Plast Surg* 2012;45:53-7.

Source of Support: Nil, **Conflict of Interest:** None declared.



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