Anterior Tibial Myoperiosteal Flap for Post-traumatic Tibial Osteomyelitis

Chieh-Chi Huang, Hao-Chih Tai*, Shuye-Yih Horng, Ming-Ting Chen

Division of Plastic Surgery, Department of Surgery,
National Taiwan University Hospital, Taipei, Taiwan
*Department of Surgery, Provincial Tao-Yuan General Hospital, Tao-Yuan, Taiwan

A patient of a 77-year-old male with a history of left femoral fracture and open tibio-fibular comminuted fracture (Gustilo type IIIB) had chronic osteomyelitis and non-union of upper-third tibial bone for 9 months. Due to the poor local conditions, the medial gastrocnemius myocutaneous flap was performed previously in vain. The size of the soft-tissue defect was 6.0×6.0×5.0 cm and severe scarring around the defect was noted. The angiography of the left lower leg revealed patent picture of the three main arteries, with moderate arteriosclerotic changes. The anterior tibial myoperiosteal flap based on the anterior tibial artery was designed for the coverage of the defect. After the aggressive debridement and sequestrectomy, the flap was elevated and turned over to tamponade the soft-tissue defect and therefore to accelerate osteogenesis. Complete survival of the flap was achieved. The roentgenography and bone scan revealed satisfactory reunion of the tibial bone after eight months' follow-up. This flap has both the advantages of the muscle and the periosteal flap. This myoperiosteal flap may be applied in the salvage operation for simultaneously treating osteomyelitis, soft-tissue defect and bony non-union following open tibial fracture. (J Plast & Reconsr Surg Asso R.O.C. 1999;8:197～203)

Key words: anterior tibial myoperiosteal flap, salvage of open tibial fracture

Introduction

Osteomyelitis of the lower extremity is a difficult problem because it is associated with greater tissue damage than the osteomyelitis of other locations.1-3 In general, the most consistently successful method treating osteomyelitis is radical debridement and muscle flap coverage.1-3 The combination of the original trauma and the subsequent debridement may result in problems in bony healing, ranging from an infected nonunion to segmental bone loss.4-6

The anterior tibialis muscle is a type IV muscle and supplied by anterior tibial artery.4 The periosteum of the lower lateral aspect of tibial bone is supplied by the periosteal branches of the anterior tibial artery. Pedicled or free periosteum flap had been designed for coverage
of the exposed bone. We designed the pedicled anterior tibialis muscle flap carrying the anterior tibial artery and adjacent periosteum for the coverage of the soft-tissue defect and bony nonunion of the upper third tibial osteomyelitis. The advantages of the muscle and the periosteal flap were achieved in a single-stage flap transfer.

Case Report

A case of 77-year-old man had a history of traffic-accident trauma, resulting in left femoral fracture and open tibio-fibular comminuted fracture (Gustilo type IIIb), and had undergone external skeletal fixation which was complicated with chronic osteomyelitis of methicillin-resistant staphylococcus aureus, non-union of the upper third tibial bone and large soft-tissue defect for 9 months. The medial gastrocnemius myocutaneous flap was used to manage the above problem but in vain. There was a 6×6×5 cm soft-tissue defect and a 4×3 cm bony defect left in upper-third tibia. (Fig. 1 and 2) The angiography of his left leg revealed patent three tributaries but moderate arteriosclerosis was also shown in the picture. The anterior tibial myoperiosteal flap based on the anterior tibial artery was designed and elevated after radical debridement. (Fig. 3) The longitudinal incision was made lateral to the tibial bone. The tibialis anterior muscle was dissected from distal to proximal and elevated with the accompanying anterior tibial artery, periosteal perforators, and interosseous membrane as an en bloc flap. The periosteum of the lower-third tibia was sharply dissected of 8×4 cm in size with the flap. The distal tendon end of the anterior tibial muscle was transferred to the tendon of the extensor hallucis longus to reduce the donor site morbidity. The flap was turned over to tamponade the soft-tissue defect and the periosteum was inset to cover the bony defect to accelerate osteogenesis. The donor site was closed directly and the muscle flap was resurfaced with the skin graft. (Fig. 4) The post-operative course was smooth. The flap survived completely without complication. (Fig. 5) The X-ray film of the lower leg and the bone scan study revealed the increased osteogenesis over the upper-third tibia after 5 months' follow-up. (Fig. 6 and 7) The level of the erythrocyte sedimentation rate and C-reactive protein were within normal limits. The foot could be kept in neutral position but weak in dorsiflexion.

Fig. 1. The soft-tissue and bony defect of the upper-third tibia was shown. Severe scarring around the defect was noted. Fig. 2. The X-ray film revealed the osteolytic lesions of the upper-third tibia, which was compatible with the diagnosis of the chronic osteomyelitis.

中華重建整形外科醫誌：民國88年／8卷／3期
Fig. 3. The anterior tibial myoperiosteal flap was designed and elevated for the coverage of the defect after radical debridement. The periosteum of the lower-third tibia, 8×4 cm in size, anterior tibial artery and interosseous membrane were elevated en bloc.

Fig. 4. The flap was turned over to cover the soft-tissue and bony defect. The donor site was closed primarily.

Fig. 5. The flap survived completely. The follow-up picture revealed satisfactory results 8 months after operation.

Fig. 6. The bone scan revealed the strong uptake of the upper-third tibia indicating active new bone formation after operation.

Fig. 7. The X-ray film showed callous formation 5 months after operation.
Discussion

Compound fractures of the tibia involving extensive bony and soft-tissue devascularization result in a high percentage of complications and amputation.\textsuperscript{4,17} Osteomyelitis of the lower extremity usually develops after severe local trauma, especially open fracture, and therefore leads to a chronic, fibrotic, relatively ischemic wound.\textsuperscript{5} Successful management of the osteomyelitis depends on providing vascularized soft-tissue coverage over the exposed bone, obliteration of dead space and removal of devitalized tissue.\textsuperscript{2,4,6-8}

Using local muscle flaps, free flap or a combination of both, the success rate of treating osteomyelitis of the leg was 80-100%.\textsuperscript{8} Muscle is preferred to cutaneous flaps because the muscle increases blood supply for the ischemic tissues around the fracture site, resists the infection and promotes bone healing.\textsuperscript{4,9} The vascularity of muscle flap enhance functional recovery by speeding fracture healing, healing rate of non-union and providing an excellent recipient bed for later cancellous bone grafting.\textsuperscript{7,10,11}

Muscle flap coverage is provided by either a free or local muscle flap depending on local muscle availability. Gastrocnemius flaps are preferred for wound on the upper third of the leg.\textsuperscript{3} In decreasing order of preference, the muscle flaps available for covering defects of the upper third of the tibia are as follows, medial head of the gastrocnemius, lateral head of the gastrocnemius, proximally based soleus and tibialis anterior flap.\textsuperscript{12} The medial gastrocnemius flap is the first choice based on its proximal and reliable pedicle.\textsuperscript{12,14} The flap is dissected upto the origin from the femoral condyle and will serve to cover the upper third tibia.\textsuperscript{12-14} The arc of rotation of the lateral gastrocnemius flap is less than that of the medial head because the muscle is shorter and further away from the anterior tibial lesion.\textsuperscript{15} Soleus flaps are more preferred for the middle third of the leg.\textsuperscript{12,15} The tibialis anterior usually used as a bipedicled flap and muscle function is preserved. To cover the upper tibia, the muscle origin of the tibialis anterior muscle may need to be detached and reinserted further anteriorly. External longitudinal muscle-splitting are used medially or laterally but is still difficult to reach the upper tibia.\textsuperscript{16,17} However, distally based muscle flaps should be used carefully due to the poor flap vascularity.\textsuperscript{3,15} If the lesions are in more extensive or distal-third tibial injuries, microvascular free-muscle flap are indicated.\textsuperscript{6-8}

In our patient, the medial gastrocnemius flap had been used and failed due to the vascular problems and poor local conditions. Lateral gastrocnemius and soleus are not considered due to the location of the lesion and the arc of the rotation of the flap. The tibialis anterior muscle is only used as a last resort because of its functional significance in the dorsiflexion of the foot.\textsuperscript{12,15}

The tibialis anterior muscle is a type IV muscle and supplied by the anterior tibial artery and its segmental perforators. (Fig. 8) The designs of tibialis anterior muscle flap are classified into standard, separation segment and longitudinal splitting flaps according to its blood supply.\textsuperscript{3,16,17} We modified the standard design of flap and turned over the flap to cover the upper third tibial defect and tamponade the dead space. The modification also included the carrying anterior tibial artery with the flap to increase the blood flow of the muscle and carrying the peristeme to enhance the bony healing.\textsuperscript{15} The distal tendon stump of the tibialis anterior muscle was transferred to the extensor hallucis longus to minimize the morbidity of the drop-foot.

According to the literature, the osteogenesis of the free periosteum was first reported by Ollier in 1967. The rate of the osteogenesis of revascularized peristeum had been influenced
by the recipient-bed vascularity, and weight or stress on bony formation.\textsuperscript{14, 15} Osteogenic capacity increases proportionately to the vascularity and volume of the vascularized periosteal flap and enhanced by contact or proximity to the viable bone.\textsuperscript{21} While used in covering bony defect, the musculoperiosteal flap with ample blood circulation, has a greater osteogenic capacity than the fascioperiosteal flap.\textsuperscript{20, 22}

The combination of the original trauma and the subsequent debridement of the chronic tibial osteomyelitis may result in bone defects ranging from an infected nonunion to segmental bone loss.\textsuperscript{3, 4} It is also imperative to restore bone stability in order to allow early functional recovery.\textsuperscript{1, 11} Some author preferred to delay definitive treatment of the bony lesions until 3 to 6 months after the debridement and muscle flap procedure. Patients with bony nonunion or small (less than 6 cm in length) defects are treated by placing cancellous bone grafts. If the defect is large, a pedicled fibular flap, free vascularized bone transfer, or bone lengthening via the Ilizarov device are reasonable treatment.\textsuperscript{10, 11, 23, 24}

If the skeletal defect is more than 6 cm in length or the lesion is poor vascularized and infected, a vascularized bone graft is indicated.\textsuperscript{10, 11} Vascularized periosteal flaps have been suggested if the bony defect is small or unusual shape or nonunion. It is effective in promoting early bony union with a vascularized periosteum and bone graft, where conventional bone grafts are not reliable.\textsuperscript{10, 26} The periosteum on the lateral surface of the tibia is supplied by the segmental perforators of the anterior tibial artery and can be harvested 7 cm in width maximally.\textsuperscript{1} The interosseous membrane that lies between the edge of the periosteum and the anterior tibial artery is included in flap to support and protect the delicate periosteal branches.\textsuperscript{18} The vascular periosteal flap has been applied to treat the bony nonunion or traumatic bony defect.\textsuperscript{6}

In conclusion, improvements in the early treatment of the Gustilo type III tibial fractures, including radical debridement, rigid bone fixation, and early wound coverage, has led to a reduction in the incidence of osteomyelitis.\textsuperscript{4, 6, 7} Successful management of chronic osteomyelitis depends on providing vascularized soft-tissue coverage over the exposed bone, obliteration of dead space and removal of devitalized tissue and adequate management of the bony problem.\textsuperscript{1-8, 10, 11, 23, 24} The vascularized periosteal graft have the best indication in the lesion of nonunion without significant bony defect, where vascularized bone grafts are difficult to be applied due to large defect or irregular configuration.\textsuperscript{10, 20, 25} The disadvantage of utilizing the tibialis anterior muscle is sacrificing the muscle function which can be minimized by the tendon transfer of the distal stump of the extensor tendon of the foot. The tibialis anterior myoperiosteal flaps have dual roles in the treatment of the chronic osteomyelitis of upper third tibia including augmentation of osteogenesis and soft-tissue coverage, if other attempts have tried.

\textit{J.P.R.S.A.R.O.C. 1999. Vol 8 · No. 3}
References

使用前脛肌骨膜皮瓣解救脛骨慢性骨髄炎

黃介琦  戴浩志  洪學義  陳明庭

一位77歲男性，因車禍造成左大腿骨骨折併左側脛腓骨開放性粉碎骨折（Gustillo IIIB），九個月以來因慢性骨髄炎發作上三分之一脛骨骨折不癒與缺損，內側腓腸肌皮瓣已使用但不幸失敗，留下6×6×5cm的軟組織缺損併脛骨暴露缺損。血管攝影顯示下肢三條血管通暢，但有中等程度的動脈硬化。所以我們設計帶前脛動脈的前脛肌骨膜皮瓣，用來填塞軟組織缺損併加強脛骨骨折的癒合。術後皮瓣完全存活。術後八個月的追蹤，骨髄X光片和骨髄掃描檢查均顯示骨折處重新癒合。所以前脛肌骨膜皮瓣同時具備了肌腱皮瓣和骨皮瓣的優點，可運用於解救脛骨開放性骨折所造成的骨髄炎，軟組織缺損與骨折不癒。

J.P.R.S.A.R.O.C. 1999, Vol 8 · No. 3