HEMISOLEUS MUSCLE FLAP, A BETTER OPTION FOR COVERAGE OF OPEN FRACTURES INVOLVING MIDDLE THIRD OF TIBIA

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Background: Local reconstructive options for middle third of leg make good use of Soleus muscle flap. Soleus being the prime ankle planter flexor and stabiliser of the ankle in ambulation cannot be sacrificed without significant morbidity. Soleus is a bipennate muscle with independent blood supply of each half. Using one half retains its important function, increases arc of rotation, and makes it easy to orientate for coverage of defect of any shape thus obviating the need for use of whole Soleus muscle flap. Due to this geometrical advantage, it is a superior option than the whole Soleus. We conducted a study to evaluate the reliability of the medial hemisoleus muscle flap for coverage of middle third tibial defects. **Methods**: This descriptive study was conducted at department of plastic surgery, Jinnah Hospital, Lahore from August 2008 to May 2009. Ten patients with middle third tibial defects were included in the study. All the patients were provided soft tissue coverage with proximally based medial hemisoleus muscle flap with split thickness skin graft on it. **Results**: All the flaps survived with primary healing of the wound except one patient who developed wound infection which settled after wound drainage and irrigation. **Conclusion**: Hemisoleus muscle flap is a valuable local option for soft tissue coverage of middle third of lower leg. It does not sacrifice the whole function of the Soleus muscle. Due to its longer arc of rotation, this flap can cover the defects of different size and shape in middle third of leg.

Keywords: Hemisoleus muscle flap, soft tissue coverage, lower extremity reconstruction.

INTRODUCTION

All major trauma centres around the world have developed standard operative procedures (SOPs) for the management of open fractures of lower extremity. In order to reduce the risk of non union and osteomyelitis, early vascularised soft tissue coverage is mandatory in these injuries.[1,2,3] Plastic surgeons are involved from the outset.

Local flaps or free Microvascular tissue transfer may be used for coverage of open tibial fractures of middle third of leg depending upon the complexity of the defect. Amongst the local options, the Soleus muscle flap is still a widely used option for coverage of defects of the middle third of the leg.[4] However, sacrificing the prime ankle flexor along with its limited arc of rotation[5], this option has always been a source of concern amongst the plastic surgeons.[5,6] Reconstructive surgeons have been searching the possibility of using part of the muscle in order to overcome the above mentioned shortcomings of using entire Soleus muscle.

The use of hemisoleus muscle flap was first described by Tobin and then by others.[7] The usefulness and reliability of hemisoleus muscle flap is debated amongst plastic surgeons.[8] As medial hemisoleus has a greater arc of rotation and only partially sacrifices the major ankle flexor,[7] it is a better option for coverage of suitable defects of middle third of leg. Due to its longer arc of rotation, the insetting of medial hemisoleus muscle flap is easier than complete Soleus. Due to this property, it can easily cover geometrically difficult defects especially the longitudinal defects thus making it a superior option than whole slues for coverage of middle third tibial defects. In this study, our preliminary experience with proximally based hemisoleus muscle flaps for coverage of middle third of tibia is presented.

PATIENTS AND METHODS

This study was conducted in plastic surgery department, Jinnah Hospital, Lahore from August 2008 to May 2009. It was a descriptive study including 10 patients (8 males and 2 females with the age ranging between 18 and 70 years). All these patients were referred to our department from orthopedic department after bony fixation. These patients had small to medium sized defects involving middle third of the leg. Defect size ranged from 4×2 cm to 12×8 cm (Table-1). Soft tissue coverage was provided with proximally based medial hemisoleus muscle flap. All the patients were followed up for a minimum of six weeks.

All the patients were operated in supine position with external rotation and abduction at hip joint and slight flexion at knee joint. Tourniquet was applied in all the patients. Skin incision was made 2 cm posterior and parallel to the medial border of the tibia (Figure-1). Existing open wound was extended into the incision both proximally and distally. Soleus muscle was identified and dissected from medial gastrocnemius muscle. Medial half of the muscle was elevated from the underlying deep flexors and all the

perforators entering into the muscle identified. Medially, only those perforators were divided which were limiting the arc of rotation of the flap thus saving as much perforators as possible. After dividing distally, the medial half of muscle was split longitudinally from lateral half at the level of midline raphe (Figure-2). Flap was transferred to the defect (Figure-3) and split thickness skin graft was applied over it after insetting (Figure-4). Donor site was closed over a suction drain. Above knee POP slab was applied for one week in every patient to avoid skin graft loss because of underlying muscle movements. Post operatively patients were kept in the bed with elevation of the operated limb for 7 days to reduce pain and swelling First dressing change was done on 4th postoperative day. Patients were discharged on 6th post operative day. First follow up visit was one week after the discharge and then fortnightly. Patients were evaluated for flap outcome in terms of flap survival.

Table-1

Patient	Age/Sex	Mode of injury	Co morbidity	Wound size (cm)	Wound location[c] (cm)	Flap outcome	Complication
1	50 yr/M	MVA[a]	Nil	6×5	13	Successful	Nil
2	25 yr/M	MVA	Nil	12×08	20	Successful	Nil
3	35 yr/F	MVA	Nil	8×6	15	Successful	Nil
4	25 yr/M	MVA	Nil	12×08	20	Successful	Nil
5	70 yr/M	MVA	Nil	6×5	19	Successful	Nil
6	50 yr/M	MVA	Diabetes	6.5×6.5	14	Successful	Wound infection
7	30 yr/M	FAI[b]	Nil	4×2	21	Successful	Nil
8	35 yr/F	MVA	Nil	7×5	16	Successful	Nil
9	30 yr/M	MVA	Nil	10×6	13	Successful	Nil
10	18 yr/M	MVA	Nil	8×5	14	Successful	Nil

a. MVA= Motor vehicle accident, b. FAI= Fire arm injury, c. Distance from tip of medial maleolus

RESULTS

In this study all the ten patients (8 male and 2 females) with open tibial fractures in the middle third of leg underwent successful soft tissue reconstruction with medial hemisoleus muscle flap covered with split thickness skin graft. Nine patients (90%) achieved primary healing and only one (10%) patient developed wound infection. This patient with wound infection was treated with wound drainage and intravenous antibiotics, and infection settled in 1 week. Ultimately all the patients achieved wound healing with good cosmesis because of lesser bulk of hemisoleus as compared to whole Soleus muscle flap.

CASE REPORTS

Case-1 (Figure-5)

A 50-year-old diabetic male presented to us two weeks after sustaining right sided open tibial fracture as a result of motor vehicle accident. He had 6.5×6.5 cm wound with exposed fracture site in middle third of leg. After debridement, new external fixator was applied. Soft tissue cover was provided with proximally based medial hemisoleus muscle flap and skin graft. He developed post operative wound infection which settled after wound drainage and intravenous antibiotics.

Case-2 (Figure-6)

A 25-year-old male presented 3 weeks after road traffic accident resulting in open tibial fracture of right side. He had 12×8 cm wound with exposed fracture site. Exposed tibia was covered with medial hemisoleus muscle flap. He achieved primary wound healing.

Case-3 (Figure-7)

A 30-year-old male presented with one month history of left sided open tibial fracture as a result of fire arm injury. Fracture site was exposed. After thorough wound debridement, soft tissue coverage was provided with proximally based medial hemisoleus muscle flap. Primary wound healing was achieved.

Figure-1: Skin incision is made 2 cm posterior and parallel to medial border of tibia.

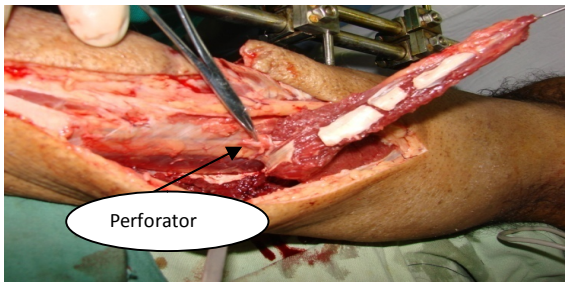

Figure-2: Medial hemisoleus muscle flap is elevated after division from lateral half at midline raphe. The perforator at 15 cm from medial malleolus was identified and preserved (forceps pointing at the perforator).

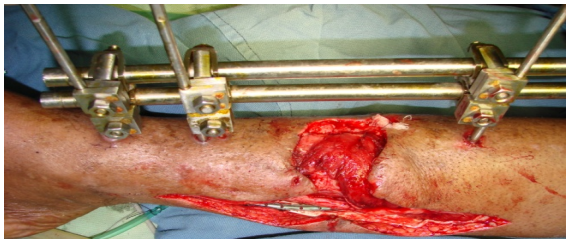

Figure-3: Medial hemisoleus muscle flap after transfer and inset

Figure-4: Skin graft is applied on the muscle flap and donor site is closed

Figure-5(A): Pre operative picture of a 50 years old diabetic male with 6.5×6.5 cm post traumatic wound on right leg and exposed fracture site.

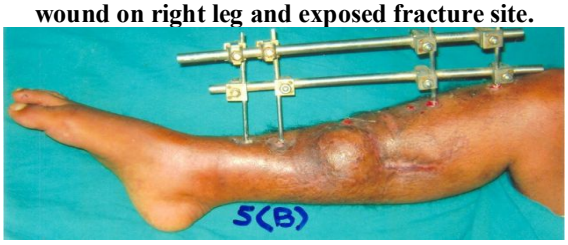

Figure-5(B): Post operative picture 3 months after coverage with medial hemisoleus muscle flap and skin graft (new external fixator was also applied). He developed wound infection which settled after wound drainage and intravenous antibiotics.

Figure-6(A): Pre operative picture of a 25 years old male with 12×8 cm post traumatic wound involving right leg with exposed fracture site.

Figure-6(B): post operative picture 3 months after flap coverage. Primary wound healing was achieved.

Figure-7(A): (A) Pre operative picture of 30 years old male with exposed fracture site after fire-arm injury to the left leg.

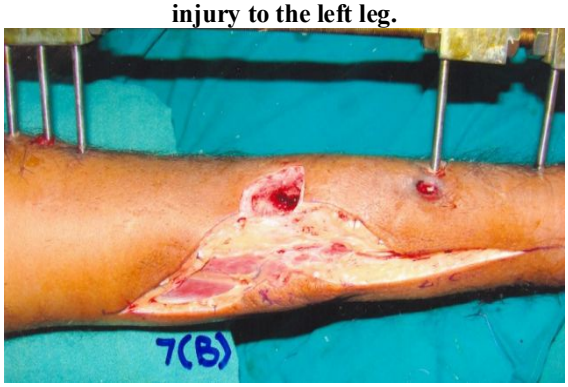

Figure-7(B): Per operative picture after wound Debridement and skin incision. Fracture site is exposed

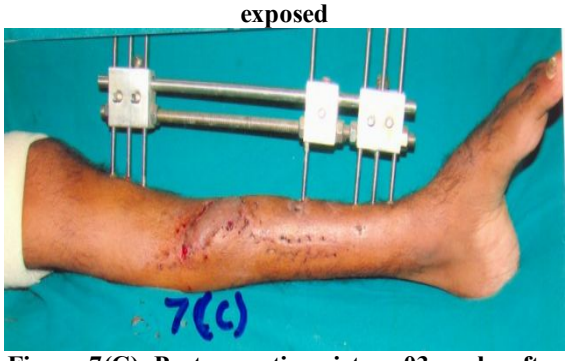

Figure-7(C): Post operative picture 03 weeks after coverage with medial hemisoleus muscle flap and skin grafting. Primary wound healing was achieved.

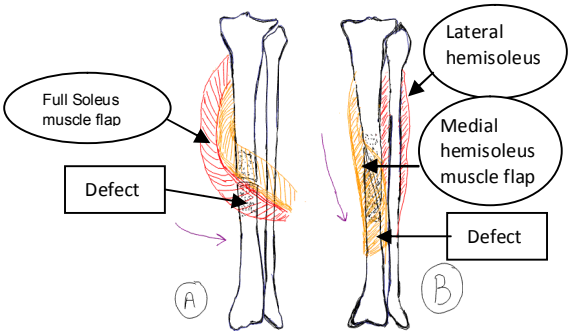

Figure-8: Illustration of flap orientation: (A) Whole Soleus muscle flap is oriented more transversely. (B) Hemisoleus muscle flap can be oriented more longitudinally/obliquely thus covering longitudinal defects more effectively.

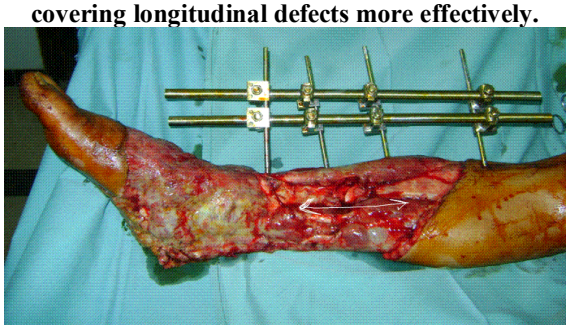

Figure-9(A*)*: Double head arrow indicating longitudinal orientation of middle third tibial defect

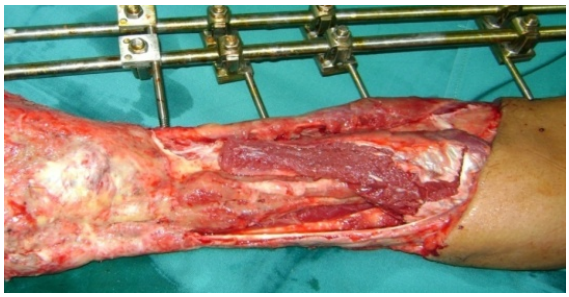

Figure-9(B): Black arrow indicates longitudinal orientation of hemisoleus muscle flap effectively covering the defect shown.

DISCUSSION

We have unusually high incidence of open fractures of lower extremity. This is mainly due to unregulated traffic. Most of these injuries are sustained by motor bike riders and pedestrians because of lack of protection. Management of these high energy injuries requires multidisciplinary approach[9] and major brunt of responsibilities falls on soft tissue reconstructive surgeon.

The management of lower extremity trauma has evolved over the last two decades to the point that many extremities that would have required amputation are routinely salvaged.[9,10] This is mainly because of better understanding of anatomy and vascular patterns of the areas, resulting in expansion of available choices to cover a wider range of defects. Local options available for soft tissue coverage of leg include muscle, fasciocutaneous and adipofascial flaps.[9] Free tissue transfer has become a gold standard option for the large complex defects of the lower limb.[1,9]

All ten patients in our study had soft tissue defects in middle third of tibia and were referred to us in sub-acute phase (2 to 4 weeks after injury).[1,9] They were considered suitable candidates for local flap. Medial hemisoleus muscle flap was selected as an alternative to whole Soleus. All of our patients had underlying tibial fractures so a muscle flap was considered as a preferred method of coverage because of its potential to bring in a rich source of blood supply to the fracture site thus promoting the healing process.[6]

Medial hemisoleus muscle flap was given preference over the whole Soleus muscle because of its longer arc of rotation and minimal functional loss of foot plantar flexion.[7] when whole Soleus muscle flap is used, its lateral half is usually wasted to traverse the deep flexors where it is not needed. The lateral half also limits the arc of rotation thus hindering the reach of flap. Whole Soleus muscle flap has to be orientated transversely/obliquely whereas hemisoleus muscle flap can be orientated more obliquely/longitudinally because its pivot point lies nearer to the tibia (Figure-8 and 9). Due to this geometrical advantage medial hemisoleus muscle flap can cover equally long or sometimes even longer defects than complete Soleus muscle flap. As medial hemisoleus muscle flap is less bulky than the whole Soleus muscle flap, the reconstructive outcome is usually cosmetically better than the whole muscle.[5]

Anatomy of the Soleus muscle has been explored thoroughly,[7,11] providing the basis for the technically more comfortable and safe dissection of this flap. The bipennate nature of the Soleus and the independent neurovascular supply to both medial and lateral halves of the muscle[7] are the key anatomical features that allow splitting the muscle longitudinally along the raphe. The most significant advantage of hemisoleus muscle flap is preservation of foot plantar flexion power by the hemisoleus muscle belly left in situ.[7] The medial half of the muscle is supplied constantly throughout its length by the perforators from the posterior tibial artery. This feature makes medial hemisoleus muscle flap more reliable than the lateral half.[11]

The use of hemisoleus muscle flap was advocated first by Tobin.[7] But the reliability and the usefulness has been continuously debated among the plastic surgeons.[8] In recent past, the work of Lee on the refinements of surgical technique of this flap[5,6,12] encouraged us to use this flap as an alternative option in patients who were not suitable candidates for free tissue transfer. The key to success of this flap, after careful identification of all the medial perforators, lies in preserving maximum number of perforators by sacrificing only those which may hinder the longer arc of rotation of the flap.[5]

A large number of referrals to the plastic surgeons are made late when microsurgery has increased failure rate.[9] In our part of the world, organization of the trauma services are still in an early phase of development. Combined management of open tibial fractures is not usual practice because trained plastic surgeons are not available except for a few major centres where work load of soft tissue reconstruction far outweighs their capacity. Majority of trauma orthopaedic surgeons refer the patient with open tibial fracture after a few days. By the time they reach plastic surgery unit, a week has already passed, i.e., patients are in the sub acute phase with highest chances of failure of free flap[1,9] along with increased risk of non union and osteomyelitis, thus making local muscle flaps an important tool for reconstruction.

We did not comment on the bone healing because bony union is affected by many factors like age, nutritional status of the patient, quality of fixation and presence of infection etc.[13] Present study was not designed to cover all these variables. Also, the role of muscle flap in improving the bony union and control of osteomyelitis is already proven.[14] The purpose of this study was to assess the reliability of this flap in terms of its survival only.

CONCLUSION

Medial hemisoleus muscle flap is a reliable option for the reconstruction of soft tissue defects of the middle third of leg. Careful flap dissection with preservation of as many perforators as possible is the key to success. It has longer arc of rotation, is easier to inset for a variety of middle third tibial defects compared to the whole Soleus. Also, it is less bulky, so provides a better contour of reconstruction. Hence, with a few exceptions, this is a superior option than the whole Soleus to cover the middle third tibial defects.

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