ABSTRACT

Background: Soft tissue coverage around the knee and a proximal third leg can be done using a medial Gastrocnemius Muscle Pedicle Flap (GMPF). There are variable results in the literature about its outcome and such study is lacking in our country. The present study was undertaken to evaluate the outcome of the medial GMPF to reconstruct the defect around the knee and proximal 3rd leg.

Methods: It was a retrospective study of 21 cases of medial GMPF reconstruction to cover the defect around the knee and proximal third leg over 2 years in tertiary care hospital. The outcome variables measured were flap and graft take up, fracture union, knee range of motion, and complications. Data was analyzed using SPSS software version 20.0 with descriptive statistics for categorical and discrete variables.

Results: The mean age of the patient was 37.19 years (range 21-65). Out of a total of 21 cases, 20 (95.2%) were traumatic wound defects, whereas 1 case was complications of necrotizing fasciitis. Flap and graft take-up was good in all the cases. The mean time for union of tibia fracture was 24.57 weeks (range 16-36). The mean knee range of motion was 125 degrees (range 90-145). Two cases had a superficial infection and one had a deep infection.

Conclusions: Medial GMPF gives satisfactory results in soft tissue reconstruction about knee and proximal 3rd leg and it can be performed well by trained orthopedic surgeons also with consistently good results.
Inclusion criteria were patients operated with medial gastrocnemius muscle pedicle flap for different reasons between the age group of 18 to 65 years for the soft tissue defect around the knee and proximal leg amenable to reconstruction with medial GMPF. Exclusion criteria were patients with incomplete data or lost to follow-up, patients operated outside with the same procedure, and patients <18 and >65 years of age.

**Anatomy and Vascularity of the pedicle**

Gastrocnemius muscles are bipennate large bulky muscles of the superficial compartment of the posterior leg. It has got larger and longer medial part and shorter and smaller lateral part, both of them confluence with each other and with soleus muscle to form tendoachilles distally and insert in the posterior part of the calcaneus. Each muscle is supplied by the sural artery (medial sural artery for medial head and lateral sural artery for lateral head of gastrocnemius muscle), a branch of the popliteal artery just above the level of knee joint posteriorly. Each artery descends in the muscle belly and provides good vascularity with a good arc of rotation and robust pedicle for the reconstruction of the knee and proximal third leg. The blood supply is consistent and flow is adequate for the survival of the flap.

**Operative Details:**

The patient was operated on in the supine position under spinal or general anaesthesia with the knee flexed and the hip slightly externally rotated. Cases were operated by a single surgeon at the single center without a tourniquet for the ease of taking a partial thickness skin graft from the same thigh. Prepping and draping were done following standard protocol. Wound debridement was done and defect size was assessed. For cases with Gustilo IIIB open fracture, either a temporary fixator with a simple unilateral external fixator was used if the patient is unstable or as part of damage control orthopedics. Definitive fixation with Ilizarov ring fixators was used to stabilize the fracture along with flap reconstruction after 5-7 days of primary operation in such cases. Definitive fixation with Ilizarov and flap reconstruction in the single seating was done for the rest of the patients. For defects without fracture (traumatic and infective soft tissue loss), meticulous debridement was done and flap coverage was done in the same seating.

Medial gastrocnemius proximal-based muscle pedicle flap was used in all the cases. A medial longitudinal incision from the popliteal fossa to the middle and distal third junction of the leg, 2cm posterior to the posterior border of the tibia, was made. Skin, subcutaneous tissue, and fascia were cut. The medial belly of the gastrocnemius muscle was identified. It was separated from the underlying soleus muscle through a relatively avascular plane of muscle fascia and from lateral gastrocnemius from proximal to distal with the help of midline raphe, direction of fibers, and location of the sural nerve and plantaris underneath the gastrocnemius muscle in the midline of the calf as identifying landmarks. The distal tendinous part of the medial half was divided keeping 2-3 cm of tendinous portion in the muscle belly for the ease of grasping and handling. The flap was transferred to the defect either through the continuous wound defect or subcutaneous tunnel depending upon the nature and location of the soft tissue defect. Length and breadth of the muscle flap were increased with multiple parallel pie crusting of the muscle fascia if needed as shown in figure 1. The muscle flap was sutured at its margin and tip with the recipient site skin margin with subcutaneous tissue with vicryl and a partial thickness skin graft taken from the ipsilateral thigh was applied over the muscle pedicle. Non-adhesive dressing with adequate padding and gentle compression bandage was applied over the flap and graft. A negative suction drain was used at the flap donor site and the wound was closed. A long knee brace was used for 1 week in case of the absence of Ilizarov fixation.

Dressing and drain out were done on the 4th postoperative day. Skin graft donor site was inspected on the 10th post-operative day and left open thereafter. Muscle strengthening and range of motion exercises were started on the 5th postoperative day. Weight-bearing and mobilization were decided as per the nature of fracture and fixation stability. Flap and graft survival and any wound-related complications were assessed and noted during ward stay. The patient was discharged once the wound and graft were healthy and taken up. Follow-up was done in OPD for suture removal, wound assessment, and evaluation of fracture union in 4 weekly follow up.

The patient’s demographic data, injury and operative details, postoperative outcome, and possible complications were taken from the admission files and assessment during OPD visit. The outcome variables were flap and graft take up, infection, bony union, knee range of motion, and repeat operation due to flap-related reasons.

Data analysis was done using IBS SPSS version 20.0 software. Frequency and percentage were calculated for the categorical variables and mean and median for the continuous variables. Differences in the outcome between traumatic and non-traumatic cause and with fracture and without fracture were assessed in terms of flap take up and range of motion at the knee.

**RESULTS**

There was a total of 23 patients operated with medial gastrocnemius muscle pedicle flap for soft tissue defects about the knee and proximal third leg during the study period. Two patients lost to follow-up after discharge and only 21 were included for the final analysis. There was total of 19 (90.5%) male and 2 (9.5%) female. The mean age of the patients was 37.19 years (range 21-65) and the mean follow-up duration was 6.81 months (range 4-12). Out of total of 21 cases, 20 (95.2%) were traumatic wound defects, whereas 1 case was due to complications of infection (necrotizing fasciitis). The mean size of the wound defect after debridement was 22.24 cm².
square centimeter (range 12-40). The mean injury-intervention interval was 5.38 days (range 2-10) and the mean length of hospital stay was 15.95 days (range 9-32).

Characteristics of the wound, fracture and fixation mode have been presented in table 1.

**Table 1: Characteristics of the wound, defect site and fixation mode**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Percentage (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Knee</td>
<td>33.3% (7)</td>
</tr>
<tr>
<td>Knee and Proximal 3rd leg</td>
<td>4.8% (1)</td>
</tr>
<tr>
<td>Proximal 3rd leg</td>
<td>61.9% (13)</td>
</tr>
<tr>
<td>Exposed bone</td>
<td>100% (21)</td>
</tr>
<tr>
<td>Exposed joint</td>
<td>9.5% (2)</td>
</tr>
<tr>
<td>Exposed neurovascular</td>
<td>4.8% (1)</td>
</tr>
<tr>
<td>Preoperative infection</td>
<td>47.6% (10)</td>
</tr>
<tr>
<td>Presence of fracture</td>
<td>80.9% (17)</td>
</tr>
<tr>
<td>Tibial plateaue fracture</td>
<td>64.7% (11)</td>
</tr>
<tr>
<td>Extraarticular proximal tibia fracture</td>
<td>35.2% (6)</td>
</tr>
<tr>
<td>Definitive fixation with ilizarov</td>
<td>100% (17)</td>
</tr>
</tbody>
</table>

Note: n=number

All cases had excellent flap and graft take-up. Two cases had a superficial infection at the margin postoperatively which healed well with regular dressing and antibiotics without further operative intervention. One case of flap infection needed debridement in the operation theatre and healed well. All of these postoperative infected cases had preoperative infected wounds with an open fracture with external fixators in situ.

All the fractures (n=17) united well with a mean union time of 24.57 weeks (range 16-36). Secondary bone graft was applied in 4 (23.53%) cases of tibia fracture and 13 cases (76.4%) united well without bone graft. The mean knee range of motion was 125 degrees (range 90-145). The mean range of motion at the knee among cases with the presence of preoperative wound infection and without preoperative infection was 124.09±10.61 and 126±19 respectively. Similarly, the mean union time for the fracture among cases with preoperative wound infection and without infection was 25±6.41 weeks and 24.18±6.18 weeks respectively.

No case had postoperative neurovascular injury, seroma, haematoma. Restoration of the function was good and no patient had complained of a cosmetic issue.

**DISCUSSION**

Medial gastrocnemius muscle pedicle flap reconstruction for
the soft tissue defect about knee and proximal 3rd leg has shown excellent results in the present study with good flap and graft take up in all 21 cases. The procedure is technically simple and less demanding. In the context of a limited number of plastic surgeons in developing countries, this surgical technique can be learned and practiced by orthopaedic surgeons as well. As orthopaedic surgeons are well versed in addressing bony injury, knowledge, and practice of basic plastic surgery reconstruction techniques using rotation pedicle flap will be a great asset.

Open fracture or complication of trauma is the most common cause of exposed tibia, knee joint, and patellar tendon. Other common causes are complications of infection and ischaemic tissue necrosis which can give rise to exposure of bone, joints, prostheses, and implants. Early intervention to cover the exposed bone with soft tissue reconstruction significantly minimizes the complication rate.

Medial GMPF is a reliable option in dealing with soft tissue reconstruction around the knee and proximal 3rd leg. It is the workhorse for all plastic surgeons and orthopaedic surgeons in dealing with such defects. Other options are free flap, local fasciocutaneous flap, and skin graft. A skin graft is not suitable for exposed bone, joints, implants, and neurovascular structures. A free flap is technically demanding and is not practical in a constrained setup. Medial gastrocnemius flap is a relatively longer and broader muscle flap choice (average length 15-20 cm and breadth 8 cm). It has a longer arc of rotation and can cover the larger defect. Lateral gastrocnemius being smaller in size and at risk of peroneal nerve palsy is a less useful choice. In most centers in developed countries, flap reconstruction surgery is performed by a team of plastic surgeons. But, this facility is very limited in a country like ours where few plastic surgeons are available. They are also limited to some higher centers only. Because of the consistent vascular supply, robust nature of the muscle pedicle, and relatively easy surgical techniques, this procedure can be learned and practiced by orthopaedic surgeons as well. The results are comparable.

Chou et al in their study of 16 cases of medial gastrocnemius flap reconstruction in tibial plateau fracture showed success in 15 cases. One case developed muscle necrosis and needed a free flap. Functional restoration of the knee was good in 10 cases. The study done by Gkiata et al showed all flap survival in 21 cases of medial gastrocnemius flap out of 27 different muscle pedicle flap reconstructions in the leg and knee with soft tissue defect.

Flap length can be increased by pie crusting as shown in figure 1, increasing proximal dissection, or even detaching its origin from the medial femoral condyle. Pie crusting was done in the cases when the length was inadequate but a detachment of the origin was not done in any of the cases in the present study. Yosuf et al had shown excellent results with all the flap and graft take up in their study of 32 cases of medial gastrocnemius flap reconstruction for different etiology. Jitrapailkulsaran et al had shown good flap take up in all 12 patients in their study of medial gastrocnemius and soleus flap in traumatic high-grade open fracture tibia. All the fractures united and there was no residual cosmetic issue or complications. Kilic A et al in their study of 21 medial gastrocnemius flap reconstruction for defects around the knee showed good flap survival in all except one case of flap necrosis.

The most common use of medial gastrocnemius flap is the reconstruction of soft tissue defect of traumatic etiology with an excellent success rate. The present study had almost all the cases of traumatic defects of the soft tissue with exposed bones, tendons, or neurovascular structures. Besides it, the infective and tumorous cause of soft tissue defect around the knee and proximal leg also give rise to satisfactory outcomes with gastrocnemius muscle pedicle flap reconstruction.

Malawer et al had performed proximal leg soft tissue reconstruction and reconstruction of the patellar tendon using medial gastrocnemius muscle pedicle flap after resection of osteosarcoma in 6 cases. All the flap and grafts survived well. The commonest cause of exposed bone is trauma and its sequelae. This was true in our study also. We had one case of soft tissue defect of the proximal leg with an infective cause. It was soft tissue loss with the exposed proximal part of tibia due to complications of necrotizing fasciitis. This patient had co-morbidity in terms of diabetes mellitus and chronic kidney disease. The current study had a higher percentage of cases (47.6%, n=10) with a preoperative infection which is a relative contraindication for primary flap reconstruction. The high prevalence of preoperative infection in our case series could be due to late presentation, inadequate initial debridement by junior residents, delayed definitive fixation, and late flap reconstruction due to a greater load of cases with high-velocity injury in the department. Primary flap reconstruction to cover the defect was done at the time of first debridement or second seating once the operating surgeon was satisfied with the extent of debridement in this study. Definitive fixation of the fracture was done with Ilizarov at the time of flap reconstruction or 1 week after initial surgery of unilateral external fixator.

Limitations of the present study were the retrospective nature of the study, relatively small number of cases, single surgeon, and single-center study. A large number of cases with multiple operating surgeons, a prospective cohort, and a longer duration of follow-up would substantiate the result of this study further.

CONCLUSION

Medial gastrocnemius muscle pedicle flap reconstruction for addressing soft tissue defects about the knee and proximal third leg is a reliable option that can give rise to satisfactory results in almost all cases. The operation is technically easy and an orthopaedic surgeon can learn and perform this operation in indicated cases when plastic surgeons are not available.

CONFLICT OF INTEREST: None

FINANCIAL DISCLOSURE: None
REFERENCES:


