

Gastrocnemius Muscle Flap vs. Proximally Based Sural Fasciocutaneous Flap for Coverage of Knee, Proximal and Middle Third of Leg: A Comparative Study of 22 Cases in a Tertiary Level Hospital

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DOI: [10.36347/sajs.2021.v07i11.012](https://doi.org/10.36347/sajs.2021.v07i11.012)

| Received: 08.10.2021 | Accepted: 15.11.2021 | Published: 24.11.2021

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Abstract

Original Research Article

Introduction: A high pace of urbanization and improvised high-velocity motor vehicles are the leading factors for high energy lower limbs trauma in a middle-income country, Bangladesh resulting in a common compound fracture and dislocation at the level of knee; the proximal and middle third of the leg in the salvageable limb. Among the coverage options, gastrocnemius muscle flap (GMF) and proximally based sural fasciocutaneous flap (PBSFC flap) were used for a long period to meet the good reconstructive goals. **Aims and objectives:** The study aims to compare between gastrocnemius muscle flaps and proximally based sural artery fasciocutaneous flaps for coverage of soft tissue defect on proximal and middle third of leg with the exposed tibia and/or knee joint in terms of operating time, flap viability and its complications, donor site morbidity, time taken for bone healing. **Methods and materials:** This study is a retrospective study of 22 cases of those who came with soft tissue defects on knee and proximal and middle third of leg requiring flap coverage in Rajshahi Medical College Hospital from August 2019 to July 2021. Here we harvested medial gastrocnemius muscle flap for coverage of knee and proximal third of the leg and PBSFC flap based on median sural artery was done for the defect on knee to proximal two third of leg. All the donor sites of PBSFC flaps were covered by split thickness skin graft, whereas, in case of GMF, the donor site was tried for direct closure. **Results and discussion:** 13 GMF and 09 PBSFC flap were done in the study period. All collected data were analyzed in GMF group and PBSFC flap group and made the comparison between two groups by standardized analytic testing tools. **Conclusion:** In comparisons of two different flaps of the study, none was superior in terms of survivability of the flap, rate wound infection control, bone healing.

Keywords: GMF, PBSFC flap, compare.

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INTRODUCTION

A high pace of urbanization and improvised high-velocity motor vehicles are the leading factors for high energy lower limbs trauma in a middle-income country, Bangladesh resulting in amputation [1].

So, Compound fracture and dislocation at the level of knee; the proximal and middle third of the leg in the salvageable limb is not now uncommon. Reconstructive goals are good coverage of the wound, infection control, healing of the bone, and not creating

any hurdle in function, especially for around knee joint movement [2-5]. For that reason, different types of muscle and fasciocutaneous flaps are harvested. Among the coverage options, gastrocnemius muscle flap (GMF) and proximally based sural fasciocutaneous flap (PBSFC flap) were used for a long period [2, 6].

The study aims to compare GMF and PBSFC flaps for coverage of soft tissue defect on the proximal and middle third of the leg with the exposed tibia and/or knee joint in terms of operating time, flap viability and its complications, donor site morbidity, time is taken for

bone healing. In this study, both plastic and orthopedic teams worked together to meet the reconstructive goal.

METHODS AND MATERIALS

This study is a retrospective study of 22 cases of those who came with soft tissue defects on knee and proximal and middle third of the leg requiring flap coverage in Rajshahi Medical College Hospital from August 2019 to July 2021. After proper evaluation of each patient, aggressive debridement and bone fixation (Uniaxial External fixator, Ilizarov ring, internal fixator) for stabilization were done according to the requirement under subarachnoid block. Flaps that were selected randomly for coverage of the wound were done immediately especially where the implant was used or within 7 days after the bony procedure. Here we harvested medial gastrocnemius muscle flap for coverage of knee and proximal third of leg and PBSFC flap based on median sural artery was done for the defect on knee to proximal two-thirds of leg. All the donor sites of PBSFC flaps were covered by split-thickness skin graft, whereas, in case of GMF, the donor site was tried for direct closure.

Following flap coverage, injured limb was splinting for 2 to 3 weeks to prevent flap retraction and was elevated till the flap settled. In case of gastrocnemius flap coverage, the first dressing was done on 5th postoperative day to evaluate split skin graft viability that was done over muscle flap. Whereas, in the case of proximally based sural fasciocutaneous flap, a window was made preoperatively to monitor the flap. We evaluated the wound subsequently for any discharging pus, wound dehiscence, donor site morbidity for grafting, and bone union. Here, Clinical

criteria for union were the ability of the patient to bear weight on the injured limb and with no pain at the fracture site on palpation and physical stress. Radiological bridging of at least three cortices on standard AP and lateral views, with partial obliteration of the fracture line, was taken as a reliable criterion for fracture healing.

All data were collected from the hospital record section office and were divided them in GMF group and PBSFC flap group. Microsoft Excel 2010 was used for data analysis and our confidence interval was set at 95% (CI: 0.05%).

RESULTS

Among 22 cases, 5 patients were female and the age range was 21- 65 years. Medial gastrocnemius muscle flap with STSG over flap was done in 13 patients and PBSFC flap was done in 09 patients. Demographic distributions, including the reason for flap coverage, site of injury, operating time and hospital stay after flap coverage, were shown in Table 1. There was no flap loss but one proximally based sural flap had marginal loss which was healed by secondary intention. Wound infection defined by pus or serosanguinous discharge was developed in 5(38.46%) patients of GMF group and in 2 (22.22%) patients of PBSFC flap group. The entire flap donor sites were closed by STSG in PBSFC flap group whereas only one patient was required STSG in GMF group. Complications of flap and its donor site were showed in Table 2. Meantime taken for the bone union was 25.83 (± 6.28) weeks in GMF group and 25.13 (± 3.48) weeks in PBSFC flap group.

Table-1: Demographic features

| Criteria | | Gastrocnemius flap (n=13) | Proximally based sural flap (n=09) | P -value |
|---|---|---------------------------|------------------------------------|-------------|
| Age (year) | Range | 24 -65 | 21- 55 | - |
| | Mean (SD) | 40.54 (± 12.89) | 31.67 (± 11.29) | - |
| Sex | Male | 10 (76.92%) | 7 (77.78%) | - |
| | Female | 3 (23.08%) | 2 (22.22%) | - |
| Etiological factors for coverage | Gustilo Type IIIb | 10 (76.92%) | 7 (77.78%) | - |
| | Soft tissue defect after sequestrectomy for chronic Osteomyelitis | 01 (7.69%) | - | |
| | Necrotizing fasciitis | 01 (7.69%) | - | |
| | Tibial plateau fracture with exposed implant | 01(7.69%) | 2 (2.22%) | |
| Site of soft tissue defect | Knee | 1 (7.69%) | 2 (22.22%) | - |
| | Knee extending up to proximal third of leg | 3 (23.08%) | 1 (11.11%) | |
| | Proximal third of leg only | 8(61.54%) | 1(11.11%) | |
| | Proximal third of leg extending to transitional zone between proximal & middle third of leg | 1 (7.69%) | 3(33.33%) | |
| | Both proximal and middle third of leg | - | 1(22.22%) | |
| | Middle third of leg only | - | 1(11.11%) | |
| Operating time for flap surgery (minutes) | | 106.15 (± 17.58) | 127.22 (± 21.38) | 0.00991 NS |
| Hospital stay (days) | | 8 (± 2.92) | 8.33 (± 2.40) | 0.390201 NS |

NS: Non- significant

Table-2: Outcomes of flap

| Outcome /Flaps | Gastrocnemius flap (n=13) | | Proximally based sural flap (n=9) | | p-value |
|---------------------------------|---------------------------|------------|-----------------------------------|------------|---|
| | Frequency | Percentage | Frequency | Percentage | |
| Survivability | | | | | |
| No loss | 13 | 100 | 8 | 88.89 | 0.219α |
| Marginal loss | 0 | 0 | 1 | 11.11 | |
| Partial loss | 0 | 0 | | 0 | |
| Wound infection | | | | | |
| Present | 5 | 38.46 | 2 | 22.22 | 0.421 α |
| absent | 8 | 61.54 | 7 | 77.78 | |
| Wound dehiscence | | | | | |
| Yes | 3 | 23.08 | 2 | 22.22 | 0.962 α |
| No | 10 | 76.92 | 7 | 77.78 | |
| Flap retraction | | | | | |
| Yes | 0 | 0 | 2 | 22.22 | 0.075 α |
| No | 13 | 100 | 7 | 77.77 | |
| Donor site closure | | | | | |
| Direct closure | 12 | 92.31 | 0 | 0 | |
| STSG | 1 | 7.69 | 9 | 100 | - |
| Donor site complications | | | | | |
| Wound dehiscence | 2 | 15.38 | 0 | 0 | |
| Graft loss | 0 | 0 | 1 | 11.11 | |
| total complications | 2 | 15.38 | 1 | 11.11 | 0.083 α NS |
| Time taken bone union | | | | | |
| | (n=12) | | (n=08) | | 0.750 β NS |
| Range (weeks) | 19- 39 | | 19- 30 | | |
| Mean (SD) weeks | 25.83 (\pm 6.28) | | 25.13 (\pm 3.48) | | |

α : Chi- square test; β : students' t- test. NS: Non- significant

DISCUSSION

In the study, 13 medial GMF and 7 PBSFC flap were harvested to cover the soft-tissue defect on knee, proximal and middle third of leg. Most (77.27%) of the defect were presented as Gustilo type IIIb. Pers M, *et al.* [6, 7] first described in 1973, about vascularity, arc of rotation and applications of medial GMF for coverage of knee defect. Mc. Craw JB, *et al.* [6, 8] in 1977 introduced myocutaneous flap and in 1978 he and his team first described the coverage of around knee joint and proximal leg instead of cross leg [6, 9]. Then, Arnold PG, *et al.* [6, 10] in 1983 published their 5 years of experience and recommended for modification of medial GMF and lateral GMF for leg reconstruction. Since then, medial GMF has been popular among reconstructive surgeons for around knee and proximal third of leg coverage.

Moscona AR, *et al.* [11, 12] published a clinical case report in 1985, where they showed posterior calf islanded fasciocutaneous flap for knee coverage. But, the anatomy and vascularity of sural artery flap was previously described by Walton RL, *et al.* [11, 13] in 1984 and the authors successfully used this flap as microvascular transplantation too.

We divided the location of defect in to 5 sites, knee, knee extending to proximal tibial, proximal tibia only, proximal tibia extending to the transitional zone between a proximal and middle third of leg and middle third of leg. Among 13 medial GMF; mostly (61.54%) were harvested for coverage of proximal third of leg defect and 3 (23.08%) flaps were done for defect on knee extending to the proximal third of leg. In case of PBSFC flaps, most (33.33) of the flaps were harvested for a defect on the proximal tibia extending to the transitional zone between a proximal and middle third of leg. One case was presented with a large wound measuring 18X 7 cm² on full length of middle third of leg extending proximal third and was covered with PBSFC flap. Our study covered defects of all the sites by a single FC flap, but GMF was short of reaching for coverage of the middle third of leg defect [6, 14, 15]. As muscle was transposed with an arc of rotation, muscle bulk was a determinant factor to cover the large wound and exposed tibia at distal part of the middle third of leg.

Mean operating times for flap harvesting, in setting and donor site were 106.15 (\pm 17.58) and 127.22 (\pm 21.38) minutes for GMF and PBSFC flaps, respectively. A similar picture was in a hospital stay.

Average 35 (20- 50) minutes were taken by Cheon SJ, *et al.* [16] for only harvesting PBSFC flaps.

In our study, all the flaps were survived with few complications. Though one (1.11%) PBSFC flap had marginal necrosis, but this was insignificant for the comparison of flap survivability of two different types of flaps. Moreover, wound was healed by standard wound dressing. Partial flap loss in Suri MP, *et al.* [17] was 5.41% (2/of 37cases) cases, Reddy GR, *et al.* [18] was 1 in 09 cases. Almokatader MAA. [15] and Kim D, *et al.* [19] showed full success of flap GMF survivability. Shahzad MN, *et al.* [2], Yusof MN, *et al.* [20] and Mayoly A, *et al.* [21], showed high rate of survivability of medial GMF and medial gastrocnemius myocutaneous flap.

In GMF group, 5 (38.46%) patients and in PBSFC flap group only 2 (22.22%) patients developed wound infection. Wound infection rate was 25% and 12% in Yusof MN, *et al.* [20] and Shahzad MN, *et al.* [2] studies respectively for GMF coverage. Mean time of control of infection (absence of discharging serosanguinous fluid or pus) were 2.6 (± 1.52) and 1.5 (± 0.71) weeks among GMF and PBSFC flap groups respectively. These differences were neither significant statistically nor making any significant change in mean hospital stay between the groups.

3 (23.08%) cases in GMF group and only 2 (22.22%) patients PBSFC flap group developed wound dehiscence. Here, wound infection was the reason for dehiscence for GMF group and flap retraction and infection were the reasons for PBSFC flap group. No flap retraction has occurred in GMF group. Proper immobilization of injured limbs and taking 1-2 cm segment of tendon distal to muscle bulk prevented such complications. Wound retraction in a single case was managed by reinserting of flap and other cases were healed after controlling infection without any further surgical procedure.

Donor sites of all the cases of PBSFC flap were covered with STSG. In the case of GMF group, the donor site closed primarily except one case, which was required STSG for donor site coverage due to avulsion injury on the back of the leg. There was no

Graft loss on both GMF and donor sites in two groups except one case in PBSFC flap group. STSG was done for the residual area of that case. Such donor complication is not uncommon. Suri MP, *et al.* [17] showed 3cases among 37 cases, and Reddy GR, *et al.* [18] showed one case in 09 cases and Cheon SJ *et al.*[16] showed one case in 10 cases developed donor site graft loss in PBSFC flap coverage.

We also observed the time taken for bone union in both groups. The ranges (average) were 19-39 (25.83) weeks and 19-30 (25.15) weeks in 12 patients among GMF group and 8 patients in PBSFC flap group respectively. Here, a case of GMF group, who presented with necrotizing fasciitis with exposed tibia but without any radiological change, was excluded. Another case was excluded for the requirement of bone transportation in PBSFC flap group. Singh J, *et al.* [22] and Kamath, *et al.* [23] showed the range of (average) time taken for bone union were 16-88 (40.3) weeks and 5.3 to 30 (8.4) months respectively in their studies.

Muscle flaps were often selected previously to cover the complex wounds in the lower limb for their rapid rate of wound healing properties [24-27]. Muscle has osteogenic mesenchymal stem cells and cytokines like Interleukin-6; fibroblast growth factor-2 for bone healing [24, 28-30]. For rich blood supply, muscle flaps are a good choice for infected wound coverage [31-33]. Recently, axial and perforator-based fasciocutaneous flaps are becoming the prime choice to cover the large complex wound because they have "Like with like" property and can escape motor units required for rehabilitation [28-30 33-38]. Moreover, they can survive in infected wounds and supply adequate antimicrobials to wound through their circulation and have an equivalent rate of bone healing [24]. In the comparison of GMF and PBSFC flaps for coverage of knee, the proximal and middle third of leg, no significant difference was found in operating time, hospital stay; wound healing and bone union time; and rate of infection control in this study. Though PBSFC flaps had inconspicuous graft in donor sites and sensory loss in the lateral side of feet, they were sensate, which was needed for those patients working in kneeling position; on the other hand, GMF was too short to cover the middle third of leg.

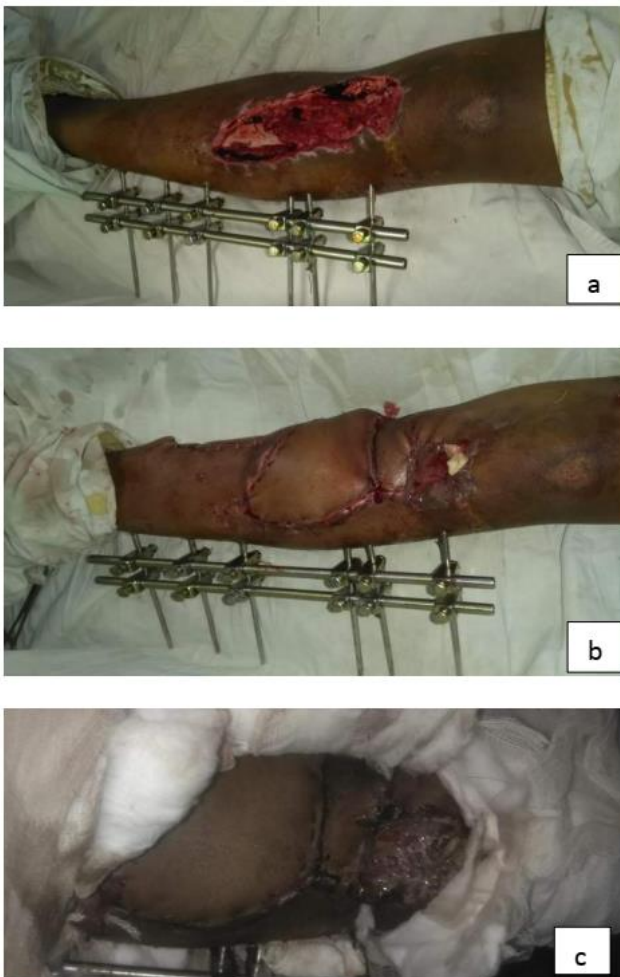


Fig-1: Proximally based sural fasciocutaneous flap for proximal third extending to the middle third of left leg. a. After wound excision; b. after flap coverage c. 7th postoperative day

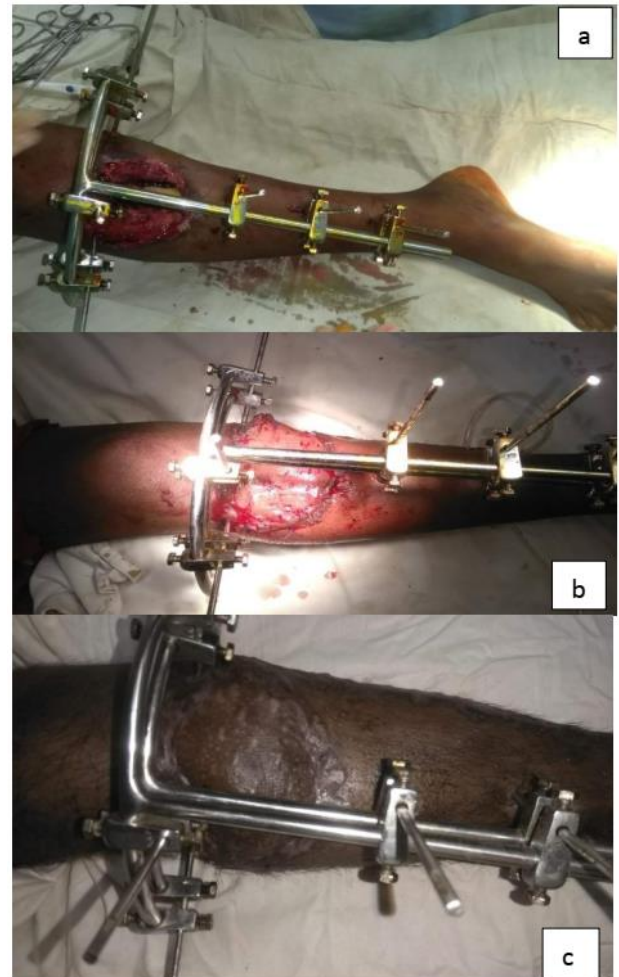


Fig-2: Medial Gastrocnemius muscle flap coverage for a proximal third of the right leg. a. After wound excision. b. STSG over muscle flap. c. 6th week after flap coverage.

CONCLUSION

The two most reliable flaps were selected in our study for coverage of knee to the middle third of leg defect coverage. The demerits of both flaps were, medial gastrocnemius flap was inadequate for coverage of the middle third of leg, PBSFC flaps had flap donor site morbidity. In comparisons of two different flaps of the study, none was superior in terms of survivability of the flap, rate of wound infection control, bone healing.

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