

Musculocutaneous Gastrocnemius Flap Advantages in Lower Limb Reconstruction

Ali Yavari^{1,2}, Omid Etemad^{1,3}, Changiz Delavari^{1,2} and Hojjat Molaei^{1,2*}

¹Plastic & Reconstructive Surgery Department, Medicine School, Tehran University of Medical Sciences, Tehran.

²Plastic & Reconstructive Surgery Department, Razi Hospital, Tehran University of Medical Sciences, Tehran.

³Plastic & Reconstructive Surgery Department, Amir Aalam Hospital, Tehran University of Medical Sciences, Tehran.

*Correspondence:

Hojjat Molaei, Plastic & Reconstructive Surgery Department, Medicine school, Tehran University of Medical Sciences, Tehran, Iran, Phone: +989127798804.

Received: 02 Dec 2024; Accepted: 13 Jan 2025; Published: 25 Jan 2025

Citation: Ali Yavari, Omid Etemad¹, Changiz Delavari, et al. Musculocutaneous Gastrocnemius Flap Advantages in Lower Limb Reconstruction. Japanese J Med Res. 2025; 3(1): 1-4.

ABSTRACT

Background: Lower limb injuries increased challenges about reconstruction of complex open fractures with soft tissue defects. There are numerous solutions and gastrocnemius flap is mostly used by surgeons. Only-muscle flap is available and can be harvested easily, but musculocutaneous flap needs more experience to preserve vital dermal perforators.

Patients and Methods: 5 patients with proximal leg and knee area soft tissue defects treated as reconstruction by musculocutaneous gastrocnemius flap. During surgery considerations were toward saving dermal perforators from muscle and adjacent sural nerve. Data related to technique and outcomes were gathered.

Results: 5 patients were evaluated who (100%) were men. The average age was 38.9 yrs old (min. 24 vs max.65). 2 patients (40%) had defect of proximal leg and 3 ones (60%) had defect of middle leg. Defects were mostly due to trauma. The average size of skin defect was approximately 1020 mm². 2 cases (40%) had complication as wound infection and it seems it was due to partial skin dehiscence. One patient had defect on lateral leg and lateral belly selected for reconstruction with acceptable skin blood supply (20%).

Discussion: Gastrocnemius muscle is a superficial muscle of posterior calf, can be reached easily by direct incision and harvested straight-forwardly, as its blood supply is type 1 and transferred to the site of defect. Surgeons mostly prefer to use muscle flap and skin graft over it to have reassurance about fate of skin coverage. Assessments of fresh cadavers and clinical cases on combined muscle and skin flap, demonstrated some reliable perforators from gastrocnemius muscle and sural nerve collateral perforators may preserve proper blood supply and better flap survival.

Conclusion: Musculocutaneous gastrocnemius flap with reliable perforators is a work horse in proximal leg defects. Preserving more dermal perforators warranty flap survival and prevent extra skin graft.

Keywords

Gastrocnemius muscle, Musculocutaneous flap, Sural artery.

Introduction

Traffic accidents are increasing in industrial societies, and eventually injuries and catastrophes make challenges for medical system. Among injuries, the lower limb traumas are more

challenging, as the type of trauma and blood supply in this location may need more considerations. On the other hand, lower limb is a common location of traumas in sport and athletes, which involve thigh, leg, and foot injuries [1]. Elective lower limb arthroplasties especially around knee joint increased soft tissue manipulations which affected the prevalence of reconstructive surgeries in lower limb [2].

Weight bearing bones and their peripheral tissues need sufficient support to have ideal function. Thus, coverage is significant in injured limbs and this is considerable when simple surgeries like skin graft, secondary healing, or primary closure would not be possible or effective.

Gastrocnemius muscle as one of superficial muscles of posterior compartment of calf is a good choice for transport to the soft tissue defect as only muscle flap, or musculocutaneous flap with its type 1 blood supply [3-7]. Two bellies of this muscle provide both lateral and medial approaches of rotation for muscle transfer. On the other hand, subcutaneous perforators from muscle to the skin, makes the musculocutaneous flap of gastrocnemius muscle a possible option. Many flaps, including muscle and skin, have unique benefits and drawbacks and we should consider their advantages and disadvantages [5]. Here, we gathered our previous experiences about our patients who treated with musculocutaneous gastrocnemius flap to emphasize the key role of muscle in some limb saving reconstructions.

Patients and Methods

5 patients who referred to our hospital in recent 3 years for reconstruction of skin defect of lower limb, treated by musculocutaneous gastrocnemius flap to cover the defects. All patients had traumas in their lower limb with exposed vital tissues that needed coverage. They may experience unsuccessful primary or advancement flap repairs and eventually presented to us to be reconstructed. They signed formal consent forms and underwent standard surgeries. All data gathered upon completion of surgeries and recoveries.

Surgery Technique

Every patient underwent surgical debridement until healthy margin around the wound appeared (Figure 1). If the posterior compartment was intact, the design of gastrocnemius musculocutaneous flap.



Figure 1: Exposed plate and bone following fx fixation.

Would be done according to the location of defect on lateral or medial side. As the skin perforators were dominant in upper part of muscle, skin paddle marking was in that area to quarantine dermal blood supply (Figure 2). On prone position, a longitudinal

lazy s incision was done from below the popliteal cavity to the proximal part of skin paddle marking. Subcutaneous flaps elevated bilaterally (medial and lateral sides) and muscle belly was exposed and selected belly prepared according to previous plan. Flaps were transferred to the defect side from medial or lateral side based on the proximity to the defect. Finally, flap transferred to the defect through the subcutaneous tunnel and secured safely (Figure 3).



Figure 2: Marking of skin paddle over the gastrocnemius muscle, considering consisting dermal perforators in the primary plan.



Figure 3: Flap inset in the defect after transfer under lateral side subcutaneous tunnel.

All patients had passed recovery successfully and extra surgeries were done, according to orthopedic experts, if needed. Data were gathered and recorded in provided tables to be illustrated.

Results

5 patients entered in this evaluation and their data were analyzed (Table 1). All patients (100%) were men. The average age was 38.9 yrs old (min. 24 vs max.65). 2 patients (40%) had defect of proximal leg and 3 ones (60%) had defect of middle leg. Most of defects were due to trauma and postoperative osteomyelitis (60%). One case (20%) was about prosthesis infection (illustrated case) and one patient (20%) had defect after tumor removal.

Patients underwent reconstruction as pedicled musculocutaneous gastrocnemius flap according to the defect size and orientation of the defect- medially or laterally. All the results were recorded and illustrated in table 2. The average size of skin defect were approximately 1020 mm². 2 cases (40%) had complication as wound infection and it seems it was due to partial skin dehiscence. These patients had the largest sizes. One patient (20%) had leg amputation due to prolonged sever osteomyelitis. The other patients (80%) had improved and weight bearing was excellent. One patient had defect on lateral leg and lateral belly selected for reconstruction with acceptable skin blood supply (20%). In the others (80%) the medial part was selected and transferred from med tunnel.

Table 1: Demographic data of patients who were treated in referral setting.

Demographics - patient	Age	Sex	Cause	Defect location
1	42	Man	Prosthetic infection	Proximal leg and knee
2	65	Man	Trauma & Osteomyelitis	Middle and proximal leg
3	58	Man	trauma	Middle and distal leg
4	24	Man	trauma	Proximal leg and knee
5	28	man	malignant	Middle and proximal leg

Table 2: Outcome of patients and their reconstruction by gastrocnemius flap.

Flap details- patient	Result	Complication	Gastrocnemius	Flap skin area (mm ²)
1	improvement	wound infection	Inside (med)	30*40
2	amputation	Severe osteomyelitis	Inside (med)	30*45
3	improvement	-	Inside (med)	50*20
4	improvement	-	Outside (lat)	20*25
5	improvement	-	Inside (med)	30*35

Discussion

Skin and soft tissue defects in proximal lower leg are important and reconstruction is challenging. In contrast to distal leg, there are more local and regional flaps in surgeons` hands. So, patients seek better outcomes with less morbidities, functionally or aesthetically.

Gastrocnemius muscle is the most superficial muscle of the calf in the posterior compartment, has its blood supply from medial sural artery as type 1. Medial and lateral bellies receive their vessels by separate branches, so preparing both lateral and medial muscle flaps feasible [8-10]. However, the muscle changes to the tendon in half the route that should be considered during flap design. The arc of rotation and the highest level at which the flap can be transferred, is significantly impressive on outcome, because wound dehiscence and bone or tendon exposure equals to failure totally [11-13].

Panse et al. used this flap for coverages around knee and evaluated the highest level of flap reach which was up to lower thigh. They had six patients who underwent reconstruction by musculocutaneous

flap they saved the sural nerve to preserve small skin perforators and lesser saphenous vein, too [7]. On the other hand, Yusof et al. presented their experience on 12 patients with skin defect around knee who were treated by musculocutaneous gastrocnemius flap successfully. In their study which used musculocutaneous flap, they showed that a large musculocutaneous perforator from the medial gastrocnemius muscle can be found consistently at the distal half of the muscle approximately 15cm from the popliteal crease [14,15] and notified that those perforators must be included in the skin island for the cutaneous part of the flap to survive [13]. When plan is musculocutaneous gastrocnemius flap, it is critical to preserve mentioned perforator, though, some recommend to preserve sural nerve with adjacent perforators to compensate lost dermal perforator from muscle.

Sapino et al. added another perforator to the previously mentioned perforator, which was in a line from mid popliteal fossa to medial malleus 8 cm distal from popliteal crease in a semicircle with a 2-3 cm radius, though this perforator was smaller than the other perforator, but including in the flap increases the flap survival [3].

Shahzad et al. evaluated the outcome of 139 patients who received treatment for their skin defects of leg and used both muscle and musculocutaneous gastrocnemius flap with acceptable results and eventually demonstrated that this flap has robust blood supply, especially when used for 2/3 proximal leg [16]. We experienced such results with concise notification on preserving the skin perforators in primary design.

Peng et al. had a brief study on anatomy of lateral sural artery and used extended lateral gastrocnemius flap to cover bigger defects. According to their evaluation which was on 5 fresh cadaver, and 27 cases, Both the lateral popliteal cutaneous artery and musculocutaneous perforators from the lateral sural artery showed robust linked arteries communicating with the arterial network around both the posterolateral intermuscular septum and the sural nerve, and they also had rich transverse communicating arteries connecting with the perifascial arterial network overlying the anterior compartment in the upper and middle calf. It is the basis of their logic in applying extended lateral gastrocnemius musculocutaneous flap [17]. This view of point is important, as some times we need more arc of rotation in complex fractures.

Conclusion

Gastrocnemius flap as musculocutaneous flap with robust perforators is a work horse in complicated exposed plates or bones in proximal leg. Preserving more dermal perforators warranties flap survival.

References

1. Glazer JL, Hosey RG. Soft-tissue injuries of the lower extremity. *Prim Care*. 2004; 31: 1005-1024.
2. Yavari A, Delavari C, Etemad O, et al. Propeller Flaps in Reconstruction of Tissue Defects Around Knee. *Japanese J Med Res*. 2024; 2: 1-3.
3. Sapino G, Guiller D, Osinga R, et al. Muscle-only versus

-
- chimeric musculocutaneous gastrocnemius pedicled flap in complex orthoplastic reconstructions of the knee region: A retrospective study. *J Plast Reconstr Aesthet Surg.* 2023; 77: 298-308.
4. Mayoly A, Mattei JC, Moullot P, et al. Gastrocnemius Myocutaneous Flaps for Knee Joint Coverage. *Ann Plast Surg.* 2018; 81: 208-214.
 5. Ravindra Bharathi R, Ramkumar S, Venkatramani H. Soft tissue coverage for defects around the knee joint. *Indian J Plast Surg.* 2019; 52: 125-133.
 6. Sapino G, Osinga R, Maruccia M, et al. Role of the Gastrocnemius Musculocutaneous with a Propeller Style Skin Flap in Knee Region Reconstruction: Indications and Pitfalls. *Arch Plast Surg.* 2023; 50: 593-600.
 7. Panse N, Bhadgale R, Karanjkar A, et al. The Reach of the Gastrocnemius Musculocutaneous Flap: How High Is High?. *World J Plast Surg.* 2018; 7: 319-325.
 8. Daigeler A, Drücke D, Tatar K, et al. The pedicled gastrocnemius muscle flap: a review of 218 cases. *Plast Reconstr Surg.* 2009; 123: 250-257.
 9. Panse N, Bhadgale R, Karanjkar A, et al. The reach of the gastrocnemius musculocutaneous flap: how high is high?. *World J Plast Surg.* 2018; 7: 319-325.
 10. Gkiatas I, Korompilia M, Kostas-Agnantis I, et al. Gastrocnemius pedicled muscle flap for knee and upper tibia soft tissue reconstruction. A useful tool for the orthopaedic surgeon. *Injury.* 2021; 52: 3679-3684.
 11. Mayoly A, Mattei JC, Moullot P, et al. Gastrocnemius myocutaneous flaps for knee joint coverage. *Ann Plast Surg.* 2018; 81: 208-214.
 12. Innocenti M, Cardin-Langlois E, Menichini G, et al. Gastrocnemius-propeller extended myocutaneous flap: a new chimaeric flap for soft tissue reconstruction of the knee. *J Plast Reconstr Aesthet Surg.* 2014; 67: 244-251.
 13. Yusof MN, Ahmad-Alwi AA. Outcome of Islanded Gastrocnemius Musculocutaneous Flap in Orthopaedic Practice. *Malays Orthop J.* 2019; 13: 25-29.
 14. Kim HH, Jeung JH, Seul JH, et al. New design and identification of the medial sural perforator flap: An anatomical study and its clinical applications. *Plast Reconstr Surg.* 2006; 117: 1609-1618.
 15. Hallock GG. Anatomic basis of the gastrocnemius perforator-based flap. *Ann Plast Surg.* 2001; 47: 517-522.
 16. Shahzad MN, Ayub M, Sajid MA. Use of Gastrocnemius Muscle and Musculocutaneous Flaps for Coverage of Soft Tissue Defects in Leg. *Journal of Islamabad Medical & Dental College.* 2016; 5: 126-130.
 17. Ping P, Dong Z, Wei J, et al. Modified lateral gastrocnemius myocutaneous flap with extended anterior and/or inferior boundary. *Scientific Reports.* 2022; 12: 1031.