



Original Research Article

Gastrocnemius flap: Anatomical study of perforators of posterior upper and middle third of leg

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ABSTRACT

Background: Huge easy nerve limb flap connecting higher and mid-3rd remains a therapeutic challenge. The objective of this study was to evaluate the effectiveness and versatility gastrocnemius myocutaneous flap cover for post traumatic large defect of greater and mid-3rd of leg.

Materials and Methods: As accomplished cadaveric partition in twenty legs to copy the place of the proximal and distal greatest perforators rising since the sural, peroneal and later tibial blood vessel on the later feature of the leg spreading since the intercondylar streak upon eight cm centre of the body to the middle n adjacent a bony projection with a shape likened to a hammer head. The part of middle stomach of gastrocnemius through the end-to-end later tibial a nerve was selected as the mid lap & the area ended adjacent stomach of gastrocnemius with together peroneal a nerve was elected as adjacent flap.

Results: In the area definite as the middle flap we originate a regular of 2.4 a nerve arising since the middle sural blood vessel & 1.8 rising since the later tibial blood vessel. In the mid flap the distal greatest a nerve was the later tibial sept cutaneous a nerve, such as a regular 23.2 cm since the notch separates the condyles of the femur line, about 6.8 cm beyond away since the distal greatest mid sural a nerve. Cutting-edge the side fold area, as originate a regular of 1.8 adjacent sural a nerve alongside by 1.6 peroneal blood vessel forming a connection between a deep system and a superficial one. In this lappet the distal greatest blood vessel forming a connection between a deep system and a superficial one was the peroneal septocutaneous, at a normal space of 23.2cm distal to the notch separates the condyles of the femur streak and at a normal of 7.3cm additional missing since the distal greatest adjacent sural blood vessel forming a connection between a deep system and a superficial one.

Conclusion: At the time of inspection of the functional base of mutual mid and adjacent flap it is probable to increase extensive flaps of about 25-30 cm, such could be perfect to rise lengthy flaps on the forward feature of leg. Hovering these flaps by the gastrocnemius strength in the flap might support to surge the alliance of revolution of the flap letting the flap to change to the forward phase of leg and uniform for rising great flaps above the lap.

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1. Introduction

It is challenging to repair the defect and severe trauma with extended soft tissue loss over anterior aspect of upper and middle third of legs because of paucity with large defects.¹

Option are available like cross leg flap cover and free flap, an old method which is commonly used is cross leg flap cover and still free flap is needed by the expertise advice.¹ With extremely blood supply gastrocnemius myocutaneous flap is an best option available for a large defect to the posterior region of leg due to severe trauma are any injury.²

In 1977, gastrocnemius myocutaneous flap was originally described for giving coverage over the knee

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region.³ Gastrocnemius muscle which is having 2 heads (medial & lateral). Both the heads can be removed and mobilised based on their neurovascular pedicles.⁴ Gastrocnemius muscle is supplied by sural arteries one medial and one lateral artery and also supply musculocutaneous perforator over the large area of skin proximally and also a significant amount distal to muscle belly.⁵ Gastrocnemius myocutaneous perforators are mostly located at 7–18 cm from the popliteal crease.⁶ The lesser saphenous vein can also be used to increase venous drainage or as the sole outflow for the flap.⁷

Medial and lateral gastrocnemius flaps are large flaps that can be taken in the lower extremity with no delay. They have a wide arc of rotation from above the patella in the thigh to the upper portion of the lower tibia. Both flaps can be taken simultaneously. They can cover extremely large defects of the anterior leg or knee. The use of these flaps with their ready availability, excellent blood supply, and wide range of coverage has tremendously facilitated immediate correction of severe injuries of the knee and lower leg. We studied the perforator anatomy of the fasciocutaneous territory over the gastrocnemius muscle along with the posterior tibial and peroneal perforator system with the object of designing a combined flap that maybe harvested with the gastrocnemius perforators in order to cover long defects of tibia. This combined flap may be raised with the gastrocnemius muscle as well in order to increase the axis of rotation of the combined flap. We planned to record the number and the distance of the standard posterior tibial perforators, running between soleus and flexor digitorum longus, the medial and lateral gastrocnemius perforators and the peroneal perforators, running between soleus and flexor hallucis longus, from the intercondylar line/ knee joint. This data can help determine the reliability of large flaps raised from the posterior aspect of the leg in order to cover exposed tibia in cases of open fractures. Medial and lateral muscle bellies each carry long flaps of skin and fascia from the posterior calf and are most often used as myocutaneous flaps; these flaps are most useful for upper tibial defect reconstruction.

2. Materials and Methods

Our reading has been showed by dividing 20 legs of 7 men and 3 feminine corpses. Anthropometric information of individually separate has verified and throughout division the subsequent limits remained noted.

1. Amount of pricking containers rising after the adjacent and mid sural blood vessel wandering over the 2 heads of gastrocnemius strength sideways with thickness of the containers.
2. Sum of septocutaneous blood vessel forming a connection between a deep system and a superficial one rising end-to-end to the mid and adjacent

gastrocnemius muscle stomach alongside with thickness of the blood vessel forming a connection between a deep system and a superficial one.

3. Space of the pricking containers from intercondylar line/ Knee combined

2.1. Dissection

Partition happening by representing a square on legs later part, on behalf of the part of a fasciocutaneous flap. The volar border of the flap partition is upto the intercondylar streak at the lap.⁸ The adjacent cut has assumed 2cm later to the adjacent intravenous edge of the fibula. The mid cut was specified 2cm later to the mid intravenous edge of the tibia. The distal cut has prepared about 8 cm proximal upto ankle malleolus.

This flap was picked below loupe amplification since distal to proximal and place of the gastrocnemius perforators striking in centimetres since the intercondylar streak of the lap. The amount of later tibial septocutaneous blood vessel forming a connection between a deep system and a superficial one adjacent the mid gastrocnemius perforators and the amount of peroneal septocutaneous blood vessel forming a connection between a deep system and a superficial one together to the adjacent gastrocnemius blood vessel forming a connection between a deep system and a superficial one remained also recorded. This area has been separated in 2 shared folds. The area of mid gastrocnemius by the later tibial septocutaneous blood vessel forming a connection between a deep system and a superficial one was nominated as the mid flap. The area covering the adjacent gastrocnemius through the peroneal septocutaneous perforators has been entitled as the adjacent flap. This partition has been prepared to learn the feasibility of hovering a shared gastrocnemius myocutaneous fold by nearby septocutaneous perforators involved as healthy. The thickness of the containers was resolute by control established upon the peripheral perimeter. The containers remained untied longitudinally and untied completely and the distance of the perimeter has been dignified by means of a descending caliper. One vessels with a distance of extra than 0.2 mm remained measured.

3. Results

Information have been collected from the cases exposed that on a regular there are 2.4 perforators (series 1-4) get up from the middle skull of the gastrocnemius and 1.6 perforators (series 1-3) get up from the adjacent skull. The proximal utmost perforator in the middle stomach have 6.7 cm distal to the intercondylar streak (series 4.8-8.4) & the distal utmost perforator 16.4 cm distal to the intercondylar streak (series 14.8-18.2cm) On the adjacent stomach the proximal utmost perforator was 6.3 cm distal to the intercondylar streak (series 4.8-23.2cm) & the distal utmost perforator

Table 1: Anthropometric data and number of perforators

	Total	Male	Female
No. of Subjects	20	14	6
Age	62.3	64	61
Average Tibia length	33 (26-37)	35 (34-37)	28 (26-30)
Average No. of PTA perforators in medial flap	1.8	1.7	1.4
Average No. of peroneal Perforators in lateral flap	1.6	1.3	1.5
Average No. of Medial Sural perforators in the medial flap	2.4	2.1	3.1
Average No. of Lateral Sural Perforators in the lateral flap	1.8	1.7	1.3

Table 2: Details of perforator anatomy in the dissected region

Location from intercondylar line	Medial sural	Posterior Tibial Septocutaneous	Lateral sura	Peroneal Septocutaneous
Proximal most	6.7 cm	8.3 cm	6.3 cm	8.3cm
Distal most	16.4cm	23.4cm	15.9cm	23.2cm
Average Diameter	1.01mm	1.08mm	0.9mm	1.28 mm

15.9 cm distal to the intercondylar streak (series 14.6-17.2cm).

The despicable distance of the perforators starting at the middle skull are 1.01mm (series 0.7-1.3) & individuals from the adjacent skull were 0.9mm (series 0.7-1.2mm).

The amount of later tibial septocutaneous perforators delivering the joint meddial covering flap was 1.8 (series 1-3) by a regular distance of 1.08mm (range 0.6- 2mm). The normal amount of peroneal blood vessel perforators delivering the joint adjacent skin flap in the partition of the covering flap was 1.6 (series 1-2) by a normal distance of 1.28mm (series 0.6mm-2.3mm).

The place of the distal utmost posterior tibial blood vessel perforator after the intercondylar streak was 23.4cm (series 21- 27cm) and the proximal utmost was 8.3cm (series 6-12cm) in the meddle covering flap. The distance of the distal utmost peroneal blood vessel perforator after the intercondylar streak was 23.2cm (series 19 -26 cm) & the proximal utmost was 8.3 (series 6-11cm) in the adjacent covering flap. [Table 1].

4. Discussion

Here is a wide learning on the vascularity of the mediocre leg by admiration to the existence of vascular alliance. As per the angiosome idea it is probable to imprisonment the terrain of the together angiosome by ligating the cause container of the adjacent angiosome and let obstruct containers to exposed up.⁹⁻¹² In physical readings the border of flap presence had regularly up to the connection of the another and the third terrain and to imprisonment the 3rd terrain regularly an interruption has remained mandatory.¹³ This is mostly somewhere the problematic with inspirational extensive proximally founded subsequent tibial or peroneal perforator flap deceits, which is, that matter external the

additional perforator is incessantly at threat for necrosis if here no disruption. The problematic by this impression is that in a therapeutic situation it difficult to get a valuation of the significant of nerve that can be calculated as per solitary perforator regardless of the basis mood. So as per this philosophy it is difficult to define how perforators are two dissimilar base veins (sural and posterior tibial) might be cooperating by individually.

One of the philosophies ensures proposal of awareness in to this concern which is vasculosome theory which indorses the existence of vascular axes which are served by cutaneous perforators and the directionality of these axes is dynamic and differences with consecutive ligation of “feeder” containers. So, if the whole alliance is preserved formerly the entire nerve flap must persist.¹⁴ After our anatomical barriers it is perfect that we can embrace the meddle sural axis with the later tibial septocutaneous streak and the adjacent sural with the peroneal septocutaneous streak. So, we can deliberate rising a flap, which embraces together these axes. In the flaps upper in the functional partition the distal utmost posterior tibial or peroneal perforator is greatly nearer to the distal gastrocnemius cutaneous perforator than the proximal utmost septocutaneous perforator that is released in flap crop. It is likely that the distal utmost area of the flap will endure because of the statement among the meddle sural and later tibial in the meddle side of leg and the adjacent sural and peroneal axis on the adjacent side of leg. When a gastrocnemius myocutaneous flap is greater the area further than the muscle stomach is regularly measured to be the arbitrary share of the lonely flap and conferring to agreement must be greater by a measurement is to extensiveness of 1:1.¹⁵ But if a statement amongst the septocutaneous vascular axes and the sural vascular axes happens in this part might be comprised in the flap with

additional constancy and a large flap which might shield equally proximal and middle faults of tibia might be formed. It might be statement as the distal most later tibial perforator in the flap is on a normal 6.8 cm distal to the middle gastrocnemius perforator and the distal utmost peroneal perforator is on a normal 7.3cm distal to the adjacent sural perforator emerging from the adjacent stomach of gastrocnemius [Table 2].

The consequences of our anatomic learning is alike to readings by Torres et al. and Otani et al. which lead the distal utmost middle and adjacent gastrocnemius strength perforators at 16.3 and 17.5 cm distal to the popliteal crease or the intercondylar line.^{16,17} Concerning the number of perforators rising from the lateral skull our consequences are varied from the learning by Otani et al. which did not catch any cutaneous perforator in 57% of the patients however we have established at least 1 cutaneous perforator at the adjacent skull in 100% of the cadaveric partitions.

5. Conclusion

Proceeding examination of the information we originate that it might be conceivable to rise joint flaps that embrace equally the sural perforators developing over the gastrocnemius strength and the later tibial or the peroneal septocutaneous perforators. These joint flaps might assist protection extended flaws of the tibia that is habitually visible in the proximal and middle 3rd of the leg subsequent Gustillo 3b breaks of tibia.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare no conflict of interest.

References

- Ries MD, Bozic KJ. Medial Gastrocnemius Flap Coverage for Treatment of Skin Necrosis after Total Knee Arthroplasty. *Clin Orthop Relat Res.* 2006;446:186–92. doi:10.1097/01.blo.0000218723.21720.51.
- Osei DA, Rebehn KA, Boyer MI. Soft-tissue Defects After Total Knee Arthroplasty. *J Am Acad Orthop Surg.* 2016;24(11):769–79. doi:10.5435/jaaos-d-15-00241.
- Veber M, Vaz G, Braye F, Carret JP, Saint-Cyr M, Rohrich RJ, et al. Anatomical Study of the Medial Gastrocnemius Muscle Flap: A Quantitative Assessment of the Arc of Rotation. *Plast Reconstr Surg.* 2011;128(1):181–7. doi:10.1097/prs.0b013e318217423f.
- Panni AS, Vasso M, Cerciello S, Salgarello M. Wound complications in total knee arthroplasty. Which flap is to be used? With or without retention of prosthesis? *Knee Surg, Sports Traumatol, Arthrosc.* 2011;19(7):1060–8. doi:10.1007/s00167-010-1328-5.
- Bos GD, Buehler MJ. Lower-Extremity Local Flaps. *J Am Acad Orthop Surg.* 1994;2(6):342–51. doi:10.5435/00124635-199411000-00006.
- Lazaro LE, Cross MB, Lorich DG. Vascular anatomy of the patella: Implications for total knee arthroplasty surgical approaches. *Knee.* 2014;21(3):655–60. doi:10.1016/j.knee.2014.03.005.
- Lamaris GA, Carlisle MP, Durand P, Couto RA, Hendrickson MF. Maximizing the Reach of the Pedicled Gastrocnemius Muscle Flap. *Ann Plast Surg.* 2017;78(3):342–6. doi:10.1097/sap.0000000000000796.
- Feldman JJ, Cohen BE, May JW. The medial gastrocnemius myocutaneous flap. *Plast Reconstr Surg.* 1978;61(4):531–9. doi:10.1097/00006534-197804000-00006.
- Arnold PG, Mixter RC. Making the Most of the Gastrocnemius Muscles. *Plast Reconstr Surg.* 1983;72(1):38–48. doi:10.1097/00006534-198307000-00010.
- Smet HT. Tissue transfers in reconstructive surgery. New York: Raven Press; 1989.
- Andres LA, Casey WJ, Clarke HD. Techniques in Soft Tissue Coverage Around the Knee. *Tech Knee Surg.* 2009;8(2):119–25. doi:10.1097/btk.0b013e3181a7eaeec.
- Mccraw JB, Fishman JH, Sharzer LA. The vesatile gastrocnemius myocutaneous flap. *Plast Reconstr Surg.* 1998;62:15–23.
- Tsetsonis CH, Kaxira OS, Laoulakos DH, Spiliopoulou CA, Koutselinis AS. The Arterial Communication between the Gastrocnemius Muscle Heads: A Fresh Cadaveric Study and Clinical Implications. *Plast Reconstr Surg.* 2000;105(1):94–8. doi:10.1097/00006534-200001000-00016.
- Cheng HH, Rong GW, Yin TC, Wang HY, Jiao YC. Coverage of wound in the distal lower leg by advancement of an enlarged medial gastrocnemius skin flap. *Plast Reconstr Surg.* 1994;73:671–8.
- Bashir AH. A gastrocnemius tenocutaneous island flap. *Br J Plastic Surg.* 1992;35:436–7.
- Otani M, Okamoto H, Kagami H. Anatomical study on perforators of the medial and lateral sural artery in Asians. *Nagoya Med J.* 2012;52(1):89–98.
- Masquelet AC, Sassu P. Gastrocnemius flap. In: Wei FC, Mardini S, editors. Flaps and Reconstructive Surgery. Elsevier; 2009. p. 415–8.

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