

## Lateral Genicular Artery Flap for Reconstruction of a Large Knee Defect, Following Oncological Resection – Case Report

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### Rezumat

*Lambou bazat pe artera geniculată laterală pentru reconstrucția unui defect extins la genunchi, după rezecție oncologică - prezentare de caz*

Această lucrare prezintă cazul unui pacient în vârstă de 53 de ani, cu dermatofibrosarcom ulcerat și infectat, extins pe fața antero-laterală a genunchiului stâng Defectul postexcizional, cu expunerea patellei, a fost acoperit printr-un lambou cutanat regional din 1/3 distală a coapsei, bazat pe artera geniculată laterală superioară, cu dimensiuni de 20/10 cm, împreună cu grefe expandate de piele liberă despicată, aplicate în 1/3 proximală a gambei și 1/3 proximală a coapsei stângi. Sunt expuse etapele intervenției chirurgicale și evoluția favorabilă postoperatorie. De asemenea, sunt discutate selecția procedurii chirurgicale alese, în funcție de extensia și localizarea defectului postexcizional, precum și alternativele terapeutice, în conformitate cu datele din literatura de specialitate. În concluzie, lamboul geniculat lateral reprezintă un procedeu util pentru acoperirea chirurgicală a defectelor extinse antero-laterale ale genunchiului, prin aportul de țesut cutanat pliabil, suplu și flexibil, similar tegumentului original, fără neregularități sau creșteri de volum. În plus, disecția și transpoziția acestui lambou la nivelul defectului nu implică realizarea de anastomozes vasculare microchirurgicale.

**Cuvinte cheie:** reconstrucție genunchi, expunere patelară, lambou geniculat lateral

### Abstract

This article presents the case of a 53 years old patient, with ulcerated and infected dermatofibrosarcoma, extended on the anterolateral side of the left knee. The postexcisional defect, exposing patella, was covered through a regional cutaneous flap of the distal third of the thigh, upper lateral genicular artery-based, measuring 20/10 cm, together with expanded free skin split grafts, applied in proximal third of the leg and distal third of the left thigh. Surgical stages and favorable postoperative evolution are exposed. Selection of a particular surgical procedure, depending on the extent and location of the postexcisional defect, as well as therapeutic alternatives according to the literature data, are also discussed. In conclusion, the lateral genicular artery flap represents a useful surgical procedure for covering anterolateral extended defects of the knee, by bringing pliable, supple and flexible cutaneous tissue, similar to original skin, without bulk or irregularities. Moreover, this flap dissection and transposition to the defect does not involve making microsurgical vascular anastomosis.

**Key words:** knee reconstruction, patellar exposure, lateral genicular artery flap

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## Introduction

The knee is a major and representative joint of the human body, easily exposed to injuries due to its accessibility, conformation and functionality. Tissue defects around the knee can be attributed to a series of events, such as traumatic wounds, oncologic surgery, invasive infections, very deep burns or post-combustional contractures. Surgical reconstruction of knee and lower leg defects has always been a challenge and an area of great interest in the field of plastic surgery. The knee defects, posttraumatic or postexcisional, are more difficult to reconstruct, due to the easily exposure of osteo-articular, tendino-muscular and neuro-vascular structures, as well as to the biomechanics of the knee.

Available surgical options for knee reconstruction include:

- local flaps for small defects;
- regional flaps: muscular, musculo-cutaneous or fascio-cutaneous;
- distant flaps: pedicled or microsurgical transferred (1, 2).

All these previously described methods, ranging from simple to more complex and involving more resources, have specific indications and advantages, but also some disadvantages, related to available flap size and limited pedicle length and, in case of free flaps, difficult and time-consuming vascular anastomosis due to deep recipient vessels. Traditionally a local flap is preferable for knee defect reconstruction, because it requires a simpler and less destructive surgical intervention. However, the use of a local cutaneous flap is sometimes limited because the pedicle length is quite short for some locations and sizes of the skin defects (3).

This work presents the case of a 53-year old man with a large antero-lateral left knee defect, following tumoral resection, which was successfully managed therapeutically by a cutaneous flap based on the lateral superior genicular artery. The article intends to highlight and promote in the plastic surgery armamentarium a useful method for reconstruction of knee defects, in selected cases, by a locoregional flap, easily and safely available, without resorting to microsurgical reconstruction.

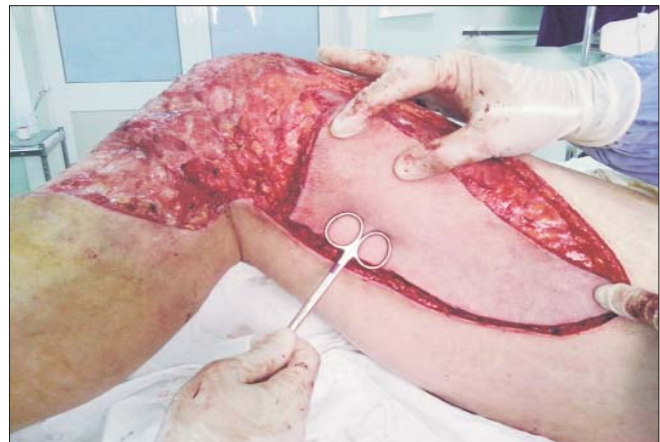
## Case report

A 53-year old man, with ischemic heart disease, was admitted to the Department of Surgery of the County Emergency Hospital of Ploiesti for the treatment of a large, ulcerated and infected tumor, located at the anterior and partial lateral side of the left knee. The tumor appeared two years ago and a previous excisional biopsy revealed dermatofibrosarcoma. The tumor was excised by the general surgeon and then the patient was transferred to the Department of Plastic Surgery for knee reconstruction - Fig. 1.

After patient's detailed investigation and correction of a moderate anemia by blood transfusion, the appropriate surgical procedure of knee reconstruction was selected, according to extension and localization of the postexcisional defect, with dimensions of 30/12 cm. For covering the critical patellar region, a regional cutaneous thigh flap based on the lateral



**Figure 1.** Extensive antero-lateral knee defect following dermatofibrosarcoma resection, with patellar exposure



**Figure 2.** Lateral genicular artery flap, dissected and elevated, with capillary refill

superior genicular artery was selected and used, with dimensions of 20/10 cm - Fig. 2. The remaining non-critical skin defect on the level of the proximal third of the leg was going to be conveniently covered by a skin graft, due to its fairly well vascularized wound bed.

During surgery, we identified the main pedicle, located at the level on thigh lateral intermuscular septum, 7 cm proximal from the lateral femoral condyle, but also a second pedicle, a muscular perforator from vastus lateralis, which had to be sacrificed to allow rotation of the flap and positioning onto defect - Fig. 3.

The flap viability was assessed as pretty good and the resulting defect was partial closed primarily. Split skin grafts were also used for covering the third proximal of the leg (postexcisional defect) and the third distal of the thigh (a small remaining defect after harvesting the flap) - Fig. 4.

The postoperative evolution was good, uneventful, with integral survival of the flap and skin grafts revascularization and integration - Fig. 5.

## Discussions

Different soft tissue defects of the lower extremity, posttraumatic or after tumor ablation, have presented a real and formidable challenge for the plastic surgeon, due to relative



**Figure 3.** Main pedicle and a muscular perforator, which was divided to allow the rotation of the flap

lack of reliable local coverage provided by muscular or fasciocutaneous flaps.

A series of conventional reconstructive methods have been developed in the course of time and they include, from simple to more complex, according to reconstructive ladder:

- Split skin grafting;
- Local random fasciocutaneous flaps;
- Cross leg fasciocutaneous flap;
- Pedicled muscular or musculocutaneous flaps;
- Microvascular free tissue transfer, which represents the “gold standard” for coverage of severe lower extremity injuries (1).

Over time, various flaps have been used for covering of soft tissue defects around the knee. The particular type of flap can be selected according to the location and size of the defect, potential donor site morbidity and status of the recipient vessels (3):

- A local random pattern skin flap has indistinct perfusion and is limited in size.
- The cross-leg flap has the disadvantage of a long period of immobilization and several operative stages.
- The distally based vastus lateralis muscle flap is too bulky for covering the knee defect, and morbidity of donor site has to be taken into account (4).
- The conventional gastrocnemius muscle flap is also a choice for providing soft-tissue over the knee region; the main disadvantages are the bulk of local muscle flaps, as well as the small volume of the distal part of the muscle, which sometimes does not provide enough viable muscle tissue coverage for large defects around the knee joint, especially in the suprapatellar region (5, 6).
- The sural artery perforator flap can provide thin and pliable tissue for covering of a knee defect, but the size of the flap is rather limited (7, 8).
- Although the free flaps can cover the knee defect successfully and in a one-stage operation, they require a long operating time and can be technically difficult because of deep recipient vessels (3, 9).



**Figure 4.** Left knee reconstruction with lateral genicular artery flap and split skin grafts (proximal and distal)



**Figure 5.** Favorable postoperative evolution of the lateral genicular artery flap and integration of the split skin grafts

All these procedures have their limitations and associated morbidity at the donor site. In present, reconstruction of the lower extremity addresses not only soft tissue coverage, but also takes into consideration functional recovery and aesthetic result.

Research for improvements of the final anatomic and functional outcome and for reduction in donor site morbidity led to the development of the perforator flaps.

The advantages of the perforator flaps include:

- minimal donor site morbidity;
- replacement with similar tissue;
- no concern of anatomic variation in different individuals;
- less painful postoperative recovery and less postoperative bleeding, as no muscle is divided;
- main source vessel is not divided;
- no need for microvascular anastomosis and shorter operatory time.

The lateral genicular artery flap is a fasciocutaneous flap based upon the skin perforators of the lateral superior genicular artery (LSGA), branch of the popliteal artery, which can be used for reconstruction of the knee region, with low donor site morbidity. This flap was first described in 1990 by Hayashi and Maruyama for reconstruction of defects around the knee, popliteal region, lower third of the thigh, and upper third of the leg (10, 11).

In an anatomic and histomorphometric study, Zumiotti et

al. (10) found a constant vascular pedicle, which is a skin perforator of the lateral superior genicular artery present in all specimens (100%) with an intramuscular course in 40% of dissections. The perforator was situated at  $7.40\text{cm} \pm 2.77$  above lateral condyle of the femur, between vastus lateralis muscle and the biceps femoris muscle. The mean length of the pedicle was  $2.57 \pm 0.87$  cm up to the lateral intramuscular septum of the thigh and  $6.09 \pm 1.91$  cm up to the origin of the popliteal artery.

In presented case, the perforator artery was found located at approx. 7 cm proximal from the lateral condyle of the femur, which is also the distance described in literature.

This flap showed constant anatomy (10) and, as previously stated, is a useful and reliable tool in the plastic surgery armamentarium for coverage of the soft-tissue defects of:

- the distal third of the thigh;
- the superior and lateral portions of the knee;
- the popliteal fossa;
- the proximal part of the leg, with the exceptions of the medial aspects of these regions (2, 3, 10-14).

This flap presents a series of advantages:

- allows single stage reconstruction;
- has a constant vascular pedicle;
- excellent clinical result, without bulk or irregularities;
- good clinical outcome at the donor site, without functional impairment. A donor site which is less than 10 cm in width can be closed primarily in most cases. Moreover, no functional or sensory losses appear in the lower limb (2);
- can be used for covering a variety of posttraumatic or postoperative defects, including total knee arthroplasty and exposed knee prosthesis (9, 14).

According to the aforementioned advantages, the lateral genicular artery flap represents a reliable and effective alternative to the previously reported muscle, musculocutaneous and fasciocutaneous flaps (2, 6, 10). The fasciocutaneous lateral genicular artery flap represents an effective and reliable option for reconstruction of soft-tissue defects around the knee and proximal calf. Its advantages are a long pedicle, thin tissue, good appearance without bulk, and minimal donor site morbidity without obvious depressive deformation (3, 10, 14).

Same advantages as the lateral genicular artery flap have other fasciocutaneous flaps based on the cutaneous perforators around the knee, such as:

- the posterior popliteal thigh flap;
- the medial genicular artery flap;
- the sural artery perforator flap.

The selection among these perforator flaps is based on the clinical assessment of the location of posttraumatic or postoperative defect and of the tissue availability at the donor site (2, 7, 15, 16).

## Conclusions

1. The large knee defects are relatively difficult to reconstruct, due to the bio-mechanics of the knee, as well as the easily exposure of osteo-articular, tendino-muscular

and neuro-vascular structures.

2. The successful knee reconstruction requires the appropriate selection of the various available methods, a careful preoperative planning, a meticulous surgical technique and a close postoperative monitoring.
3. Perforator flaps represent a reliable and elegant option for the reconstruction of the soft tissue defects of the lower limb, due to the limited donor site morbidity, to the relatively rapid dissection and flap elevation, and to the reliable skin territory.
4. The lateral genicular artery flap represents a useful procedure for reconstruction of anterior and antero-lateral knee defects, as this cutaneous flap brings pliable, supple and flexible cutaneous tissue, similar to the original skin, without bulk or irregularities.
5. In addition, this flap dissection and rearrangement onto the defect does not require any special equipment or making microsurgical vascular anastomosis.

**Conflict of interest statement:** none.

## References

1. In: Mathes SJ, editor. Plastic Surgery. IInd ed. Vol VI Trunk and lower extremity. Saunders Elsevier, USA; 2006. p 1355-81.
2. Hayashi A, Maruyama Y. Chapter 479. Lateral genicular artery flap. In: Strauch B, Vasconez LO, Hall-Findlay EJ, Lee BT, editors. Grabb's Encyclopedia of Flaps. IIIrd ed. Vol. 3. Philadelphia: Lippincott Williams & Wilkins; 2009. p. 1369-72.
3. Al Moktader MA, Hassan M, Taman E, Taha A, Elaw S. Lateral Superior Genicular Flap for Reconstruction Around the Knee. J Plast Reconstr Surg. 2010;34(2):223-6.
4. Necmioglu S, Askar I, Lok V, Subasi M. Use of the vastus lateralis muscle flap with a grooving procedure in the surgical treatment of chronic osteomyelitis of the femur. Ann Plast Surg. 2004;53(6):570-6.
5. Gravvanis AI, Iconomou TG, Panayotou PN, Tsoutsos DA. Medial gastrocnemius muscle flap versus distally based antero-lateral thigh flap: Conservative or modern approach to the exposed knee joint? Plast Reconstr Surg. 2005;116(3):932-4.
6. 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.
7. Umamoto Y, Adachi Y, Ebisawa K. The sural artery perforator flap for coverage of defects of the knee and tibia. Scand J Plast Reconstr Surg Hand Surg. 2005;39(4):209-12.
8. Hallock GG. The medial sural (medial gastrocnemius) perforator local flap. Ann Plast Surg. 2004;53(5):501-5.
9. Sharma RK, Nanda V, Makkar S, Parasher A. De-epithelialised fasciocutaneous turnover flap: An alternative for defects in lower thigh and knee joint. Indian J Plast Surg. 2004;37(1):40-3.
10. Zumioti AV, Teng HW, Nairat C, Briceño NQ, Ishida LH, Lotierzo PH, et al. Lateral flap of the thigh based upon the lateral superior genicular artery: an anatomic and histomorphometric study and clinical applications. Acta ortop bras. 2005;13(1):24-7.
11. Hayashi A, Maruyama Y. The Lateral Genicular Artery Flap. An Plast Surg. 1990;24(4):310-7.
12. Spokevicius S, Jankauskas A. Anatomy and clinical applications of a composite cutaneo-subcutaneous flap based on the

- lateral superior genicular vessels. *J Reconstr Microsurg.* 1995; 11(1):15-20.
13. Wiedner M, Koch H, Scharnagl E. The superior lateral genicular artery flap for soft-tissue reconstruction around the knee: clinical experience and review of the literature. *Ann Plast Surg.* 2011;66(4):388-92.
  14. Taniguchi Y, Kitano T, Shimoe T, Asai Y, Yoshida M. Superior lateral genicular artery flap for coverage of a soft tissue defect after total knee arthroplasty. *J Reconstr Microsurg.* 2009; 25(8):479-82.
  15. Maruyama Y, Iwahira Y. Popliteo-posterior thigh fasciocutaneous island flap for closure around the knee. *Br J Plast Surg.* 1989;42(2):140-3.
  16. Akhtar MS, Khan AH, Khurram MF, Ahmad I. Inferiorly based thigh flap for reconstruction of defects around the knee joint. *Indian J Plast Surg.* 2014;47(2):221-6.