





CASE REPORT

Superior medial and superior lateral genicular artery perforator flaps as alternatives for the reconstruction of defects around the knee area. A report of three cases

Colgajos perforantes de las arterias geniculares lateral y medial superior como alternativas para la reconstrucción de defectos alrededor de la rodilla: reporte de tres casos

Carlos Eduardo Torres-Fuentes¹⁻³  Lorena Barrera-Pinzón¹  Daniel Andrés Ruiz-Abaunza² 
Julián Esteban Padilla-Rojas¹ 

¹ Clínica Medcentro Familiar - Plastic Surgery and Microsurgery Service - Bogotá D.C. - Colombia.

² Clínica Nueva El Lago - Plastic Surgery Service - Bogotá D.C. - Colombia.

³ Hospital de San José - Aesthetic and Reconstructive Plastic Surgery Service - Bogotá D.C. - Colombia.

⁴ Fundación Universitaria de Ciencias de la Salud - Specialty in Reconstructive and Aesthetic Plastic Surgery - Bogotá D.C. - Colombia.

Abstract

Introduction: Perforator flaps of the superior lateral genicular artery (SLGA) and superior medial genicular artery (SMGA) have been proposed as an alternative for reconstructing defects around the knee instead of muscle flaps, which have several disadvantages such as altered limb functionality, increased donor site morbidity, and poor cosmetic outcomes.

Case presentation: Three clinical cases of patients with soft tissue defects around the knee (the first two in the lateral aspect and the third in the medial portion), in whom perforator flaps of the genicular arteries were used for reconstruction of the defects (SLGA for cases 1 and 2, and SMGA for case 3). In all three cases, satisfactory functional and cosmetic outcomes were achieved after one month of follow-up. Only one patient presented a complication (postoperative hematoma at the flap site), which was resolved without issues. The three patients were men aged 57, 41, and 18 and were admitted to a quaternary care center in Bogotá, Colombia. The cause of the defect was a traffic accident in the three cases.

Conclusion: SMGA and SLGA perforator flaps have proven to be a safe and effective option for covering soft tissue defects around the knee, achieving satisfactory functional and aesthetic outcomes in all three cases reported.

Resumen

Introducción. Los colgajos perforantes de la arteria genicular lateral superior (AGLS) y la arteria genicular medial superior (AGMS) se han propuesto como alternativa para la reconstrucción de defectos alrededor de la rodilla en lugar del uso de colgajos musculares, los cuales tienen varias desventajas como alteración de la funcionalidad de la extremidad, mayor morbilidad del sitio donante y pobres resultados cosméticos.

Presentación de casos. Se presentan tres casos clínicos de pacientes con defectos de tejidos blandos alrededor de la rodilla (los primeros dos en el aspecto lateral y el tercero en la porción medial) en los que se usaron colgajos perforantes de las arterias geniculares para la reconstrucción de los defectos (AGLS en los casos 1 y 2, y AGMS en el caso 3). En los tres casos se obtuvieron resultados funcionales y cosméticos satisfactorios al mes de seguimiento; además, solo un paciente presentó una complicación (hematoma posoperatorio en el sitio del colgajo), la cual fue resuelta sin problemas. Los tres pacientes eran hombres de 57, 41 y 18 años admitidos a una institución de salud de cuarto nivel de atención de Bogotá (Colombia). La causa del defecto fue un accidente de tránsito en los tres casos.

Conclusión. Los colgajos perforantes de la AGMS y de la AGLS demostraron ser una opción segura y efectiva para cubrir defectos de tejidos blandos alrededor de la rodilla, lográndose resultados funcionales y estéticos satisfactorios en los tres casos reportados.



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Corresponding author: Daniel Andrés Ruiz Abaunza. Servicio de Cirugía Plástica, Clínica Nueva El Lago. Bogotá D.C. Colombia.
E-mail: danielruiz1825@gmail.com.

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Introduction

The knee is a hinge joint that allows bending, extending, and rotating the leg, as well as rotating it when the limb is flexed.¹ The main causes of soft tissue defects around the knee include post-traumatic defects, surgical release of post-burn contractures, complications of total knee arthroplasty (primary or revision), and oncological resections.¹

Reconstruction of defects around the knee requires the use of thin and pliable flaps.² In this regard, gastrocnemius muscle flap is the most frequently used local flap for reconstruction of soft tissue defects in this area.³ While the greatest advantage of using this flap is that it involves an easy operative technique, it also has several disadvantages including potential loss of functionality and unfavorable aesthetic outcomes, as the final appearance often looks thick and the necessary skin graft may not integrate well with the surrounding skin.

Furthermore, morbidity at the donor site is higher compared to the use of cutaneous-subcutaneous flaps, as the use of this muscle may compromise function and strength of the lower limb.³ Therefore, the use of alternatives involving less comorbidity at the donor site and better aesthetic outcomes has been proposed (better contour of the reconstructed area), such as fascio-cutaneous flaps, including flaps based on the cutaneous perforators (or perforator flaps) of genicular arteries.³

The following are three cases of patients with soft tissue defects around the knee in whom superior lateral genicular artery (SLGA) and superior medial genicular artery (SMGA) perforator flaps were used for reconstruction of the defects, with satisfactory functional and aesthetic outcomes.

Case presentation

Before presenting the three clinical cases, it is necessary to describe the surgical technique used for the reconstruction of the defects around the knee with SLGA and SMGA perforator flaps.

Surgical technique for reconstruction of soft tissue defects of the knee with SLGA flap (cases 1 and 2)

The surgical technique used for the reconstruction of defects around the knee with the SLGA perforator flap was described by Hayashi and Maruyama in 1990.²⁻⁴ First, a skin island with a size matching the size of the defect is designed on the lateral aspect of the lower thigh. The distal end of the flap must cover the skin over the lateral condyle of the femur and, therefore, the cutaneous perforating branches of the SLGA. The proximal end of the flap can be extended to the midpoint between the greater trochanter and the lateral condyle of the femur, as illustrated in Figure 1. Dissection begins at the proximal end of the flap until the deep fascia is identified. The vastus lateralis and the short head of the biceps femoris are then dissected to identify the vascular pedicle just above the lateral condyle of the femur. The pedicle is then dissected between the muscles as much as necessary to obtain an adequate rotation arc and tension-free reach into the defect. Finally, once adequate flap perfusion is verified, the flap is transposed and fixed to the defect and primary closure of the donor site is performed.

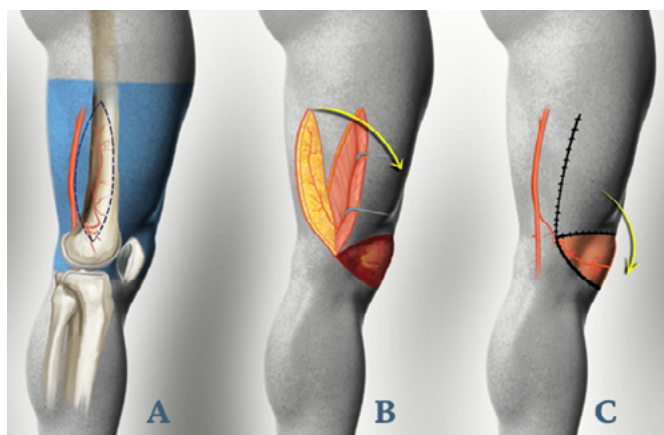


Figure 1. Surgical technique for reconstruction of soft tissue defect around the knee with superior lateral genicular artery flap. A) The distal end of the flap should cover the skin over the lateral condyle of the femur to include the cutaneous perforator of the superior lateral genicular artery, while the proximal end can be extended to the midpoint between the lateral condyle of the femur and the greater trochanter. B) Rotation of the flap into the defect. C) Transposition and fixation of the flap into the defect and primary closure of the donor site or use of split-thickness skin graft if required.

Surgical technique for reconstruction of soft tissue defects of the knee with SMGA flap

The surgical technique used for the reconstruction of defects around the knee with the SMGA perforator flap is the one described by Hayashi & Maruyama.⁵ First, a skin island is designed on the medial aspect of the lower thigh; the distal end of the flap should cover the skin over the medial condyle of the femur to include the cutaneous perforators of the SMGA, and the proximal end of the flap can be safely extended beyond the midpoint of the thigh (Figure 2). The axis of the flap is along the lower third of the sartorius muscle, which is equivalent to drawing a line between the medial condyle of the femur and the midpoint of the inguinal ligament (Figure 2). Then, the incision is made from the proximal apex of the flap to the deep fascia. Once the sartorius muscle is localized, it should be retracted posteriorly to identify the vascular pedicle of the SMGA, which is located just above the medial condyle of the femur and between the vastus medialis and the adductor magnus tendon. Afterwards, the pedicle is dissected further to release tension so that the flap can be elevated and transferred to the defect.⁵

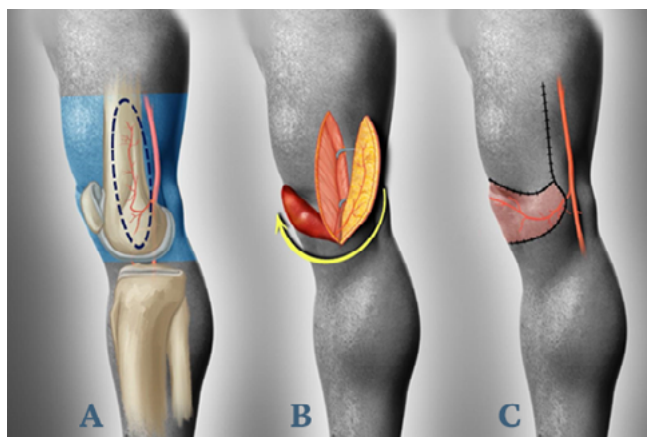


Figure 2. Surgical technique for the reconstruction of soft tissue defect around the knee with medial superior genicular artery flap. A) The distal end of the flap should cover the skin over the medial condyle of the femur to include the cutaneous perforator of the middle superior genicular artery and may extend proximally to the midpoint of the thigh. B) Rotation of the flap to the defect. C) Transposition and fixation of the flap and primary closure of the donor site or use of split-thickness skin graft if necessary.

Case 1

A 57-year-old man with no relevant medical history was admitted to the emergency department of a quaternary care center in Bogotá (Colombia) in May 2022 due to an open fracture of the left patella as a result of a traffic accident while riding a motorcycle. During his hospital stay, multiple lavages were performed at the wound site and, by means of soft tissue and bone cultures, polymicrobial infection by *Escherichia coli* (usual susceptibility pattern), *Enterobacter cloacae*, and *Enterococcus faecalis* was confirmed. Consequently, antibiotic treatment was started with cefepime (2 grams intravenously every 8 hours for 42 days) and ampicillin (2 grams intravenously every 4 hours for 14 days).

Once antibiotic therapy was completed (June 2022), open reduction of the fracture was performed. However, due to the trauma and infection, the patient developed a 10x6 cm soft tissue defect on the anterior and lateral aspect of the left knee, which was reconstructed in July 2022 using a SLGA perforator flap; partial-thickness skin graft was used to close the donor site. During the immediate postoperative period, a hematoma was observed at the coverage site, which was surgically drained (obtaining 500cm³ of blood) and did not affect the integrity of the flap or the grafts. Three days after drainage, and given that there were no further complications, the patient was discharged with an indication for analgesic treatment (oral acetaminophen 100mg oral every 8 hours and tramadol 5 drops every 8 hours for 5 days), partial weight bearing (use of crutches), and indications to attend a follow-up appointment after one month.

At the follow-up appointment one month after discharge, a physical examination revealed that the flap had complete integrity, there were no signs of dehiscence or infection, the graft donor site was in the process of epithelialization, and knee range of motion (ROM) in flexion was 50°. Given all of this, the patient was instructed to attend a follow-up appointment in 3 months and was authorized to start physical therapy, but he did not attend any more appointments.

Figure 3 shows the sequence of soft tissue defect reconstruction steps with the SLGA perforator flap.

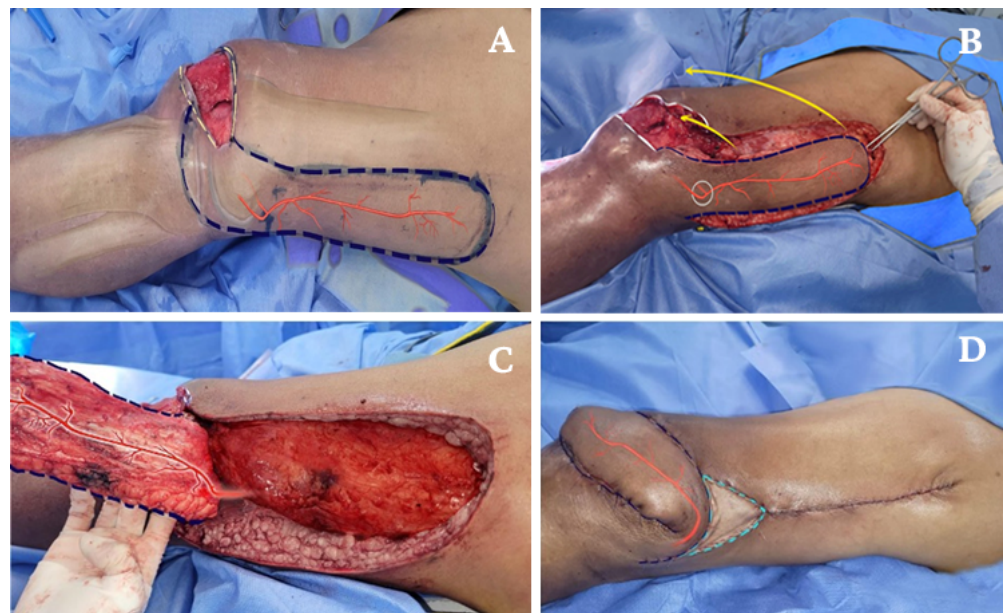


Figure 3. Sequence of steps of soft tissue defect reconstruction around the knee with superior lateral genicular artery flap. A) Planning of the superior lateral genicular artery flap. B) Dissected superior lateral genicular artery flap. C) Elevation and transposition of the flap into the defect. D) Outcome in the immediate postoperative period.

Case 2

A 41-year-old man was admitted to the emergency department of a quaternary care center in Bogotá (Colombia) in June 2022 due to an open fracture of the left distal femur secondary to a traffic accident while riding a motorcycle. During his hospital stay, multiple washings were performed at the wound site and the fracture was reduced with a hybrid external fixator. Soft tissue and bone cultures showed polymicrobial infection by multidrug-resistant germs (carbapenem-resistant *Pseudomonas aeruginosa*, carbapenem-resistant *Serratia marcescens*, and *Candida albicans*), so the following antibiotic treatment (multiple regimens) was initiated: aztreonam (2 grams intravenously every 6 hours), ceftazidime/avibactam (2 grams intravenously every 8 hours for 28 days), and fluconazole (400mg intravenously every 24 hours for 14 days).

Once antibiotic treatment was completed and eradication of the infection was confirmed, a 12x7cm soft tissue defect reconstruction was performed in July 2022 on the lateral aspect of the left knee with SLGA perforator flap and using partial-thickness skin graft to close the donor site. Since the patient had no complications during the immediate postoperative period, he was discharged 4 days after the procedure with the following indications: analgesic management (oral acetaminophen 1000mg every 8 hours for 30 days, naproxen 250mg every 8 hours for 5 days, tramadol 8 drops every 8 hours for 10 days), partial weight bearing (use of crutches) since he was still wearing the hybrid external fixator, and a follow-up appointment after one month.

During the follow-up appointment one month after discharge, the following was observed in the physical examination of the limb: 100% viable flap, no signs of dehiscence or infection, and donor site in the process of epithelialization with skin grafts integrated in 90% of the area. The patient also had ROM in flexion of approximately 20°, limited by the hybrid external fixator. The plastic surgery service discharged him, and the orthopedic service continued treating the fracture. The external hybrid fixator was removed in January 2023. Physical examination of the limb revealed an intact flap without fistulas or dehiscence, as well as joint stiffness with non-progressive ROM (persisting at 20°). Given the latter finding, reconstructive surgery of the left femur was proposed by the orthopedic service, but the patient decided not to undergo the procedure.

Figure 4 shows the sequence of steps of soft tissue defect reconstruction with the SLGA perforator flap.

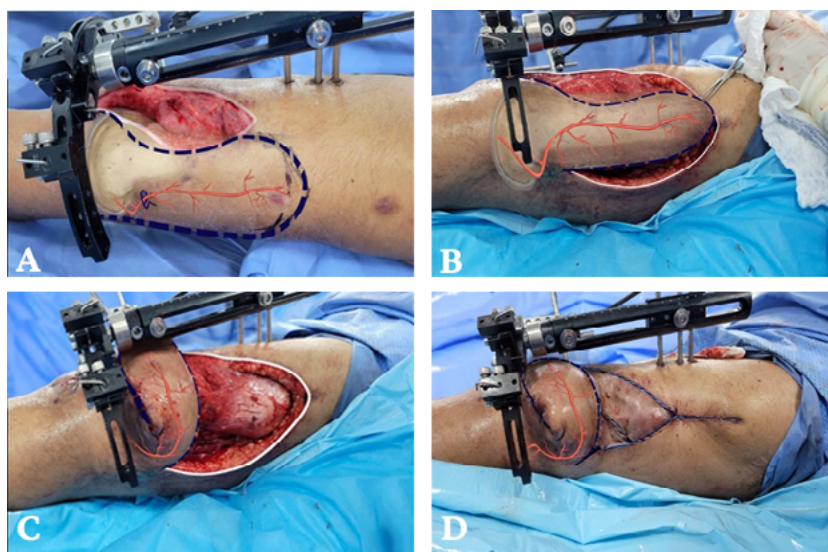


Figure 4. Sequence of steps of soft tissue defect reconstruction around the knee with superior lateral genicular artery perforator flap. A) Planning of the superior lateral genicular artery flap. B) Dissected superior lateral genicular artery flap. C) Elevation and transposition of the flap into the defect and donor site closure with partial-thickness skin graft. D) Outcome in the immediate postoperative period.

Case 3

A 19-year-old man was admitted to the emergency department of a quaternary care center in Bogotá (Colombia) in April 2021 due to a comminuted fracture of the left patella and tear of the patellar tendon (proximal portion) secondary to a traffic accident while riding a motorcycle. During his hospital stay, open reduction of the fracture and repair of the knee extensor mechanism were performed and, since there were no complications, he was discharged 5 days after admission. However, 11 days later, the patient visited the emergency department again due to pain, dehiscence of the surgical wound, and purulent secretion in that area. For this reason, samples of the secretion were collected to test for bacterial cultures, a new surgical lavage was performed, and a subatmospheric pressure device was placed for wound treatment. In view of his condition, the patient was admitted to the hospital for broad-spectrum antibiotic treatment with cefepime (2 grams intravenously every 8 hours) and vancomycin (15mg/kg every 12 hours) until the infectious agent was identified.

On the sixth day of hospital stay, the secretion bacterial culture test report was received, confirming the presence of pan-resistant *Pseudomonas aeruginosa* isolates, so the administration of cefepime and vancomycin was suspended and a new antibiotic regimen was prescribed with meropenem (2 grams intravenously every 8 hours) and fosfomicin (4 grams intravenously every 6 hours). However, due to the limited stock of these antibiotics in the institution, antibiotic therapy with ceftazidime/avibactam (2.5 grams intravenously every 8 hours) was started for 28 days.

On the 14th day of hospitalization, an 8x3cm soft tissue defect in the anteriomedial region of the left patella was reconstructed with a SMGA perforator flap using a partial-thickness skin graft to complete the closure of the donor site. Since there were no complications in the immediate postoperative follow-up, the patient was discharged 3 days after the procedure with indication for home hospitalization to finish the antibiotic treatment. At discharge, he was indicated analgesic management (oral acetaminophen 1000mg every 8 hours for 30 days and naproxen 250mg every 8 hours for 5 days), as well as partial weight bearing (use of crutches) and a follow-up appointment after one month.

At the follow-up appointment one month after discharge, the physical examination of the limb revealed: fully viable flap with no dehiscence or signs of infection, donor site in the process of epithelialization with skin grafts integrated in 95% of the area, and an approximate ROM of 30°, limited by the orthopedic procedure and reconstruction of the patellar ligament. After this appointment, the patient unfortunately did not attend any further check-ups. Figure 5 shows the sequence of steps of the reconstruction of the soft tissue defect with the SMGA perforator flap.



Figure 5. Sequence of steps of soft tissue defect reconstruction around the knee with superior medial genicular artery perforator flap. A) Planning of the medial superior genicular artery flap. B) Dissected medial superior genicular artery flap. C) Transposition and fixation of the flap in the defect and closure of the donor site with skin graft. D) Outcomes at postoperative follow-up.

Discussion

Even though muscle flaps have usually been used for the reconstruction of soft tissue defects around the knee, mainly in the gastrocnemius muscle, they often produce bulky, poorly aesthetic outcomes and may limit the function of the limb; likewise, the use of these types of flaps leads to considerable donor site morbidity.³ On the contrary, genicular artery perforator flaps are thin and pliable flaps that yield excellent esthetic outcomes and, since they are fasciocutaneous, do not cause functional alteration, resulting in lower donor site comorbidity.³

The SLGA perforator flap technique is particularly useful for covering defects on the lateral aspects of the knee, distal third of the thigh, and proximal third of the leg,^{2,4,6} whereas the SMGA perforator flap is used to cover defects on the medial aspect of the knee.⁵ Consistent with the foregoing, the soft tissue defects in cases 1 (anterior and lateral aspect of the left knee) and 2 (lateral aspect of the left knee) were reconstructed using a SLGA perforator flap, while the defect in case 3 (anteromedial region of the left knee) was covered with SMGA perforator flap, obtaining satisfactory functional and esthetic outcomes in all three patients.

The surgical technique described by Hayasi & Maruyama, for both the SLGA perforator flap²⁻⁴ and the SMGA perforator flap,⁵ allows easy, safe and reliable one-step flap dissection. Moreover, the constant vascular network of the area surrounding these arteries ensures that this technique is safe to use.^{3,5,7} In all three patients, flap vitality was confirmed to be 100% one month after the procedure.

Concerning donor site, in some cases it is possible to perform a primary closure.^{3,6} In this regard, it is worth mentioning that in the three cases reported here, the use of partial-thickness skin grafts was required to complete the primary closure of the donor site, which we believe was mainly due to the size of the defects.

Complications associated with the use of these flaps for reconstruction of soft defects in the knee area include flap tip necrosis, partial flap loss, delayed healing of the flap tip, and donor site hematoma.^{2,3} In this respect, only one complication occurred in one of the three patients (case 1), namely, a hematoma at the flap site, which was surgically drained and did not affect flap vitality.

Lastly, regarding the outcomes, both functional and aesthetic, of the reconstruction of the defects in the three patients, it could be said that, based on what was observed in the postoperative follow-up, they were acceptable. No patient presented wound dehiscence and an adequate reconstruction of the defects was achieved in all of them, who, in turn, reported being satisfied with the aesthetic outcome. However, the functional outcome was not as expected in all cases, although it should be noted that in two of the patients (case 1 and case 3) it was not possible to perform a clinical follow-up of more than one month and that the assessment of functionality in the third patient (case 2) was limited by the concomitant orthopedic procedures. In addition, the patient in case 2 decided not to undergo reconstructive surgery of the left femur for fracture management.

Considering the above, it can be stated that the outcomes of the reconstruction procedure, both in aesthetic and donor site morbidity terms, achieved in the three patients are in line with what has been reported in the literature.^{3,5,6} As for functional outcomes, they were limited by the fractures that were being treated concomitantly and the short follow-up time, as explained above (non-attendance at follow-up appointments in cases 1 and 3).

Conclusion

The SMGA and SLGA perforator flaps proved to be a safe and effective option to cover soft tissue defects around the knee, achieving satisfactory functional and aesthetic outcomes in the three cases reported here. Therefore, it is recommended to promote their use for the reconstruction of defects in this area instead of musculocutaneous flaps, since the latter, despite being frequently used, have several disadvantages such as alteration of limb functionality, high donor site morbidity, and poor cosmetic outcomes.

Informed consent

All patients signed an informed consent form in which they authorized the use of their clinical data and images for the preparation of this article.

Conflicts of interest

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Acknowledgments

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