

Reconstruction of Acute Traumatic Defects around the Knee; our Experience with The Lateral Superior Genicular Flap

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ABSTRACT

Background: The reconstruction of knee defects has always been a challenge of high interest in plastic surgery. The lateral superior genicular artery flap is a reliable option. The main objective of this study was to evaluate the reliability of the lateral superior genicular perforator flap for reconstruction of the acute traumatic defects around the knee. **Methods:** The study was conducted in Emergency Department, Cairo University hospital, during the period from July 2012 to April 2015. We recruited patients between 19 to 59 years who needed coverage of traumatic soft tissue defect around the knee. We made the lateral superior genicular perforator flap in all cases acutely after exclusion of major life-threatening conditions. All cases have been followed up for three months for infection, hematoma, disfigurement, contracture and partial/complete flap failure. **Results:** Twenty cases were included in the study with a three month postoperative follow up. Age ranged between 19-59 years with average age 35.7. Eighty percent of the cases were males (16 cases) while the rest were females. The majority of cases 12 (60%) had right lower limb injury. Thirteen cases were associated with orthopedic fractures, seven with vascular injuries and two with bilateral lower limb fractures. Flap survival was seen in nineteen (95%) cases. Partial loss of the flap occurred in four (20%) cases, which showed areas of distal necrosis. The resulting raw areas that occurred were spontaneously closed by secondary intention during the follow-up period, one raw area required skin graft. Complete loss of the flap occurred only in one case (5%). Superficial epidermolysis occurred in two cases; one of them was plus infection which was treated by medical treatment and dressing. Hematoma occurred only in one case in which the flap was saved after the evacuation of hematoma. Sixteen cases had the donor site closed primarily; four of them got infected and one gapped. The other four cases required split thickness skin graft from the start. **Conclusion:** Finally, we conclude that for reconstruction of soft tissue defects around the knee, the lateral superior genicular perforator flap is a suitable option. It showed a high rate of flap survival with a good clinical outcome and considerable small adverse events rate.

Keywords: Traumatic injury; soft tissue defects; the knee; lateral superior genicular perforator flap

INTRODUCTION

The accessibility and the functionality of the knee make it undoubtedly exposed to traumatic injuries. Posttraumatic defects around the knee are substantially difficult to reconstruct, due to the easy exposure of the structures in this important area which are the bones, the joint, the tendons and muscles, and the neurovascular structures, added to that, the knee biomechanics. Thus, the reconstruction of knee defects has always been a challenge and a field of high interest in the plastic surgery.^[1]

The available surgical options for the reconstruction of defects around the knee include local flaps for small defects; regional flaps either muscular, musculocutaneous or fasciocutaneous;

and distant flaps either pedicled or microsurgically transferred.^[2,3]

All these previously described approaches, either simple or complex, have their definite indications. They have advantages, but also some disadvantages related to the available flap size and the limited pedicle length. In the case of the free flaps which are challenging and the vascular anastomosis in them is time-consuming because of the depth of the recipient's vessels.^[1]

The local flap is preferred for the reconstruction of defects around the knee as it requires a simpler and less destructive intervention. Nevertheless, their use is sometimes restricted because of the shortness of the pedicle length for some locations as well as the defects sizes.^[4]

As the popularity of perforator flaps evolves, the evolution of the understanding of perforator flap anatomy has increased their clinical use and improved flap design.^[5]

The lateral superior genicular artery flap has been previously described for knee coverage in the literature^[6-10]. One study found that 86% of the posterolateral thigh flaps was supplied by the lateral superior genicular artery.^[6] Another one in 1990, presented the reliability of the superior lateral genicular artery flap.^[7]

In line with the evolution of perforator flaps, some authors carried out a series of cadaveric anatomic studies which delineated the anatomy of the lateral superior genicular artery perforator (LSGAP) flap.^[5]

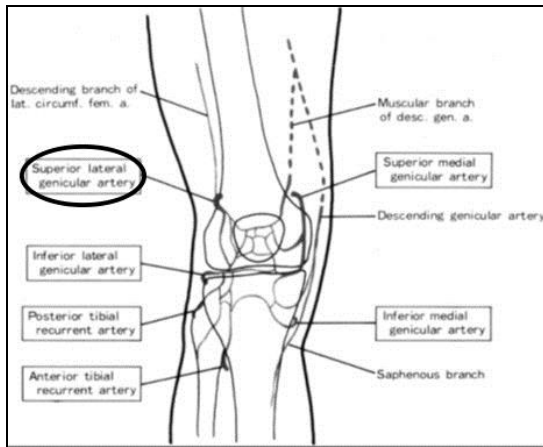


Fig 1. Vascular anatomy of the anterior aspect of the knee showing cutaneous perforators and their communication. (A. Hayashi and Y. Maruyama: Lateral Genicular Artery Flap, Grabb's encyclopedia of flaps, 3rd edition, 2009, chapter 479, page 1371)

From the anatomical point of view, the number of the lateral superior genicular artery perforators and their location are reliable and consistent. All the perforators can be located within 5 cm laterally and 7 cm proximally. The distance from the supero-lateral bony landmark of the patella was knowable to be at 5.3 cm which correlates to the location of the intermuscular septa between the vastus lateralis and the biceps femoris where perforators penetrate the fascia^[6-8, 11].

Thus, the main objective of this study was to study the reliability of the lateral superior genicular perforator (LSGAP) flap for reconstruction of the acute traumatic defects around the knee by presenting our experience with it in managing 20 cases in Kasr Al-Ainy University Hospital.

PATIENTS AND METHODS

This study was conducted in Emergency Department, during the period from July 2012 to April 2016. The purpose of this study was clearly explained in the Arabic language to all subjects before their enrollment to the study, and an informed consent form was signed by and obtained from all of those enrolled.

The inclusion criteria: All patients with popliteal soft tissue loss due to acute trauma who were vitally stable before beginning the surgery, hemodynamically stable with hemoglobin not less than 10.

Exclusion criteria included: patients with high popliteal artery injury or low femoral artery injury, patients who were vitally unstable, patients who undergone a major life-saving surgery or procedure, and patients with major fractures as pelvic fractures and spinal fractures, Mangled limb.

After assessing the patients in the primary surgery, and excluding a major life threatening event, a thorough limb examination was done. For lower limb trauma assessment, we conducted the following scoring systems to make a wise decision whether or not to operate.

- The Gustilo score first (Gustilo 1984). For the fracture
- The Mangled Extremity Severity Score (MESS) score (for vascularity of the limb)

Procedure in details:

All cases were done acutely after exclusion of major life threatening conditions. Anesthesia was achieved in 16 cases by combined spinal epidural anesthesia and in 4 cases by the general anesthesia. All cases received antibiotic 1 gm upon induction and 1 gm at the end of the operation. Tourniquet was used by elevating the pressure 100mmhg above the systole, remained maximum for 90 minutes then released.

Operative technique:

We first used the hand held Doppler in order to identify the site of the perforator. We outlined the skin island of the flap on the lateral aspect of the lower part of the thigh so that the distal end of the flap was covering the skin over the femur's lateral condyle, and the proximal end can be extended safely to a midpoint between the greater trochanter and the lateral condyle.

While the patient was in a lateral decubitus, we started the incision from the proximal point of the flap going distally. After that, we maintained the plane of dissection over the deep fascia within the loose areolar layer. Then, we carried down the dissection to the iliotibial tract for the safe dissection of the intermuscular septum between the short head of the biceps femoris and the vastus lateralis distal to the point 10cm above the knee joint. We identified the vascular pedicle just above the femur's lateral condyle.

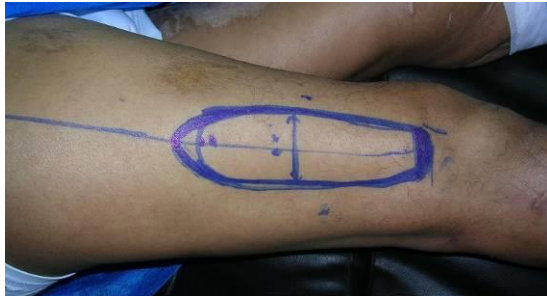


Fig. 2: Showing the drawing of the flap on a patient

This LSGAP flap island was then raised and mobilized to the defect. The arc of rotation of the flap could reach areas around the knee including the distal part of the thigh, the knee, and the popliteal fossa, and the proximal part of the lower leg, except the medial aspects of these regions.



Fig. 3: Showing the elevation of the flap

Patients were followed up for the flap viability, infection, hematoma and partial/complete flap failure. Removal of drain within 7 days and of sutures after 3 weeks. Patients were advised to do physiotherapy after removal of sutures if their bony conditions allowed. The follow-up period was three months.



Fig. 4: Showing the inset of the flap on a lower anterior knee defect and a rubber drain was put

Outcome measures

The primary outcome measure was the success of the flap in term of flap survival. Secondary outcome measure was the incidence of complications.

Statistical analysis

Descriptive statistical analyses were done where data were presented as (mean \pm SD) or median (range) for continuous variables and as frequency & percent for categorical variables. All statistical tests were done using a significance level of 95%. A value of $P < 0.05$ was considered statistically significant. SPSS software (Statistical Package for the Social Sciences, version 20.0, SPSS Inc, Chicago, IL, USA) was used for the statistical analyses.

RESULTS

Demographic data:

In this study, twenty cases were enrolled and followed up postoperatively over a three months period. Age ranged between 19-59 years with an average age 35.7. Sixteen (80%) cases were males and only 4 (50%) cases females. The mean Hemoglobin level was 10.5 ± 1.0 g/dl with a maximum of 11.5 and a minimum of 8.5. The baseline characteristics of subjects are shown in Table 1.

Smokers were not excluded in our study as this flap was used as an emergency measure to cover the popliteal area especially when there was exposed vessel or anastomosis or joints.

Characteristics of injury:

The majority of cases 12 (60%) had right lower limb injury while 8 (40%) had left side injury. Among the 20 patients, thirteen of them were associated with orthopedic fractures, seven with vascular injuries (all of them lower popliteal) and two with bilateral lower limb fractures. Associated far away trauma affections were four with upper limb fractures, five with rib fractures from which 3 requiring chest tube drainage. Details of the associated injuries were mentioned in Table 2.

Operative time and follow-up:

The mean operative time for the technique (plastic surgery team ONLY) was 3.4 ± 0.5 hours with a minimum of 2.5 and a maximum of 4.3 hours. Thirteen (65%) cases needed an intraoperative blood transfusion, as shown in Table 2.

The success of the flap:

Flap survival was seen in nineteen (95%) cases. Complete loss of the flap occurred only in one (5%) of cases and left for granulation tissue formation and skin graft. In eleven (55%) cases, the survived flaps were good, however, some problems were met. Distal necrosis occurred in four cases (20%); one of them was infected and treated medically, 2 left for granulation tissue formation and the last one was surgically debrided and grafted. Superficial epidermolysis occurred in two cases (10%); one of them was infected and also treated medically. Hematoma occurred only in one case (5%) in which the flap was saved after the evacuation of hematoma. For the donor site, sixteen cases had been closed primarily, four of them got infected and one gapped. The other four cases required skin graft from the start.

Table 1: Baseline characteristics:

Demographics	
Age, years mean \pm SD (range)	35.7 \pm 12.0 (19-59)
Gender, n (%)	
Male	16 (80%)
Female	4 (20%)
HB mean \pm SD (range)	10.5 \pm 1.0 (8.5-11.5)
Side, n (%)	
Right limb	12 (60%)
Left limb	8 (40%)
Associated injuries	
Associated vascular injury, n (%)	
Lower popliteal artery	2 (10%)
Popliteal trifurcation	2 (10%)
Popliteal vein plus lower popliteal artery	1 (5%)
Anterior tibial artery	1 (5%)
Posterior tibial artery	1 (5%)
Associated orthopedic injury, n (%)	
Fracture tibia	7 (35%)
Upper tibia	4 (20%)
Upper tibia and lower femur	1 (5%)
Tibial plateau	1 (5%)
Other associated remote injury, n (%)	
Fracture ribs	5 (40%)
Other lower limb fracture	2 (10%)
Fracture upper limb	4 (20%)

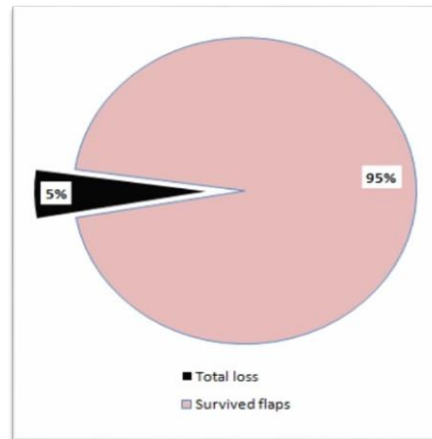


Fig. 5: Flap survival/Loss percentage

Table 2: Flap outcomes

	Number (%)
Total loss left for granulation tissue formation and skin graft	1 (5%)
Survived flaps	19 (95%)
Good	11 (55%)
Distal necrosis without ongoing clinical infection	3 (15%)
Distal sloughing plus infection treated by dressing	1 (5%)
Hematoma saved after evacuation of hematoma infection then good after treatment	1 (5%)
Superficial epidermolysis	1 (5%)
Superficial epidermolysis plus infection treated	1 (5%)

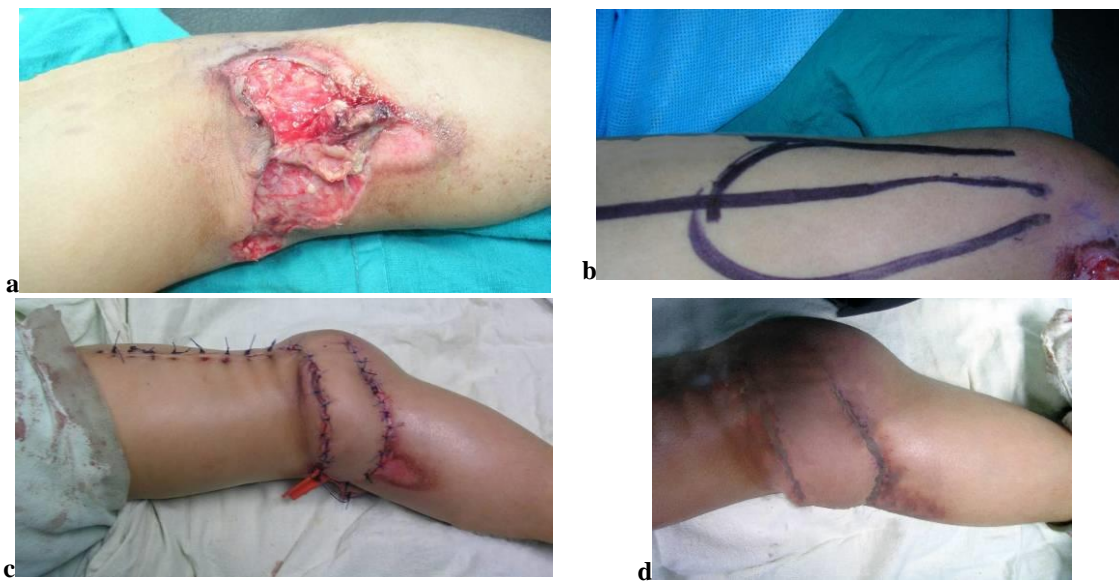


Fig. 6: shows a survived flap: a) post traumatic raw area in the popliteal region; b) The flap design; c) 1 week post operative just before drain removal showing survived flap and successful primary closure of the donor site; d) 2 months post operative (the flap is viable)



Fig. 7: shows a survived flap: a) post traumatic raw area in the popliteal region; b) 10 days post operative just after removal of drain and some sutures showing survived flap; c) 2 months post operative (the flap is viable)

DISCUSSION

As our body has over three hundred perforators, the surgical reconstructive options are considerably increased. The pedicled perforator flaps embody a reliable and suitable option for the surgical reconstruction of the soft tissue defects around the knee. They offer multiple advantages over alternative flaps such as limited donor site morbidity, reasonably fast dissection and elevation of the flap, and reliable territory of the skin. They allow the coverage of defects with a similar tissue, like with like. They can be useful in higher risks cases that may not stand the longer duration of the free tissue transfers. [1,5,13]

In the LSGAP flap, the morbidity of the donor site is minimal because the donor site can be closed primarily without functional impairment. The anatomy of the lateral superior genicular artery perforator is reliable and consistent resulting in an additional dependable flap option in our reconstructive armamentarium for the coverage of knee and popliteal defects. [5]

The LSGAP flap offers the surgical reconstruction of defects in difficult locations, without functional impairment and with minimal morbidity for the donor site. Alternatives like the

gastrocnemius muscle have many factors that made them more limited for the reconstruction of defects around the knee. These factors are the shortness of the pedicles, the poor cosmetic outcomes and the functional deficits [5]. In addition, the volume of its distal part is small, thus, sometimes it does not offer enough coverage for a large defect around the knee [14,15].

The anterolateral thigh flap is distally based from the knee or the popliteal region. It is too bulky to cover the defects around the knee, and donor site morbidity is a significant concern [16]. However, the LSGAP flap perforator is more versatile for coverage of the defects of these regions because it is closer than the former. [17]

Added to all these previously mentioned options, the cross-leg flap has multiple operative stages and a long period of immobilization. The random-pattern local skin flaps are limited in size and without distinct perfusion. In addition, despite the fact that the free flap offers the reconstruction successfully and a one-stage operation, its long operating time makes it not the best choice for those types of defects and acute circumstances [18].

Moreover, it is important to consider the bulk of the local muscle flaps. Although the flap using the sural artery perforator can offer flexible thin tissue for coverage of a knee defect, it has the disadvantage of the size limitation [19,20].

This case series study attempted to show benefits of LSGAP flap in covering of the defects around the knee that presented as acute post-traumatic cases.

In our study, twenty cases were thoroughly interviewed, investigated, treated and followed over a three months period. The majority of them were males. The study showed that the LSGAP flap is a reliable option in this acute traumatic indication.

Compared to our study, many research studies investigated the LSGAP flaps in defects around the knee. They ranged from case reports to case series design. One case report study showed that the flap has excellent viability and coverage [5]. Another case report showed that the flap is useful for covering anterolateral extended defects of the knee on the oncologic settings. [1] A retrospective analysis of the flap for soft-tissue reconstruction around the knee due to chronic ulcers, a pressure ulcer and defect after resection of a malignant tumor, showed no flap loss in all cases, partial loss at the distal tip in some cases, and primary closure of donor site in all cases. [21]

Another case series study showed the reliability of the lateral genicular artery flap in fifteen patients with soft tissue defects around the knee due to post-burn contracture, trauma, and infection. The study showed excellent results in fourteen cases, and one patient had a necrosis of distal tip of the flap. [12]

CONCLUSIONS

Finally, we conclude that for reconstruction of soft tissue defects around the knees, the LSGA flap a suitable option. It showed high rate of flap survival with a good clinical outcome and considerable low adverse events rate. In our practice, we noted that we need a classification system for the assessment of trauma of soft tissue alone and ability of its reconstruction. All scoring systems were either bone, vascular, but no scoring system for the soft tissue per se.

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