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Reconstruction of complex soft-tissue defects around the knee joint with distally based split vastus lateralis musculocutaneous flap: A new technique

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Summary *Aims:* The aim of this study was to report our experience of using distally based spilt vastus lateralis musculocutaneous flaps for soft-tissue defects around the knee joint — a new technique.
Material and methods: Cadaver dissection studies were conducted in three cadavers to demonstrate perforators entering the lower third of the vastus lateralis muscle arising from the superior lateral genicular artery. Its application in eight clinical cases for the reconstruction of soft-tissue defects around the knee joint is reported.
Results: Seven out of eight flaps survived well without any flap loss. One flap with a skin island measuring 12 × 20 cm suffered a loss of 2 cm distally. This was later treated with skin grafting. Six out of eight donor sites were closed primarily. Six patients achieved full functional range of motion by 3 months. One patient had a 10° limitation of knee extension. One patient had foot drop due to primary injury and walks with a limping gait.
Conclusions: This flap is a new reconstructive option for knee defects. It can reach distally up to the tibial tuberosity and does not require an intraoperative change of position. The donor site can be closed primarily and is hidden inside the clothing. The function of the knee is not affected as the majority of the muscle is kept in continuity.

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Introduction

Complex soft-tissue defects around the knee joint are a challenge to reconstructive surgeons. In the presence of complex situations such as extensive degloving injuries around the knee, infections, exposed joint cavity, exposed tendons and exposed prosthesis, the goals of reconstruction are to provide stable soft-tissue cover and to achieve full function of the joint.[1,2]

Multiple options such as local fasciocutaneous flaps, gastrocnemius muscle flaps, perforator flaps and free microvascular flaps are available for periarticular knee defects. Most local flaps such as fasciocutaneous flaps and muscle flaps may share a common zone of injury. This limits the available options for reconstruction to distally based anterolateral thigh (ALT) flaps and free microvascular flaps.

The distally based ALT flap was described first by Zhang in 1990.[3] This flap is not a popular choice because of its unreliable venous drainage and need for venous supercharging.[2,4–6] The distally based vastus lateralis muscle was first described by Wang et al.[7] in 1999. A study by Wang et al. demonstrated three arteries from the superior lateral genicular artery penetrating the distal part of the muscle.

To the best of our knowledge and based on an extensive search of the literature, a distally based split vastus lateralis musculocutaneous flap has not yet been described. We share our experience of this flap for the reconstruction of complex soft-tissue defects around the knee joint.

Cadaver dissections

Before undertaking clinical cases, cadaver dissection studies were conducted in fresh 48-h-old cadavers. Cadavers were injected with methylene blue dye in the femoral artery before dissection. Bilateral dissection in three cadavers confirmed a connection between the lateral superior genicular artery and the descending branch of the lateral circumflex femoral artery (DLCFA) near the periarticular anastomosis of the knee joint.

Three constant intramuscular perforators at 3, 7 and 10 cm from the superolateral border of the patella were found on the axis of the line joining the superolateral border of the patella and the anterior superior iliac spine (Table 1).

Vascular anatomy of the thigh

The vastus lateralis is a muscle of the lateral compartment of the thigh with a pedicle from the DLCFA, which also supplies the musculocutaneous perforator to the overlying skin — a well-known territory of the ALT flap.[8,9]

Three cutaneous perforators in the territory of the ALT flap were named as Perforators A, B and C from the proximal to the distal part. Perforator B is the most highly audible perforator in the 3-cm-diameter circle drawn centred at the midpoint of the line joining the superolateral border of the patella and the anterior superior iliac spine. Perforator A is proximal to Perforator B, and Perforator C is distal to perforator B.[9]

The DLCFA descends in the vastus lateralis muscle as far as the knee joint and anastomoses with the superior lateral genicular artery in the geniculate anastomosis. Three constant musculocutaneous perforators arising from the superior lateral genicular artery enter the vastus lateralis muscle at 3, 7 and 10 cm above the superolateral border of the patella. This forms the basis for the distally based split vastus lateralis musculocutaneous flap. Venous drainage of the flap is by a pair of venae comitantes of the DLCFA.[3] After raising the flap, it was easily possible to cover knee defects up to and including the tibial tuberosity.

Table 1 Perforator locations in cadaveric dissections.

Cadaver	Side of thigh	Communication site from superolateral margin of patella		
		First perforator	Second perforator	Third perforator
A	Right	3 cm	7 cm	10 cm
	Left	3 cm	7.2 cm	10.2 cm
B	Right	2.7 cm	7 cm	9.8 cm
	Left	2.8 cm	6.8 cm	10.2 cm
C	Right	3.3 cm	7.1 cm	10 cm
	Left	3.2 cm	6.9 cm	9.8 cm
Average		3 cm	7 cm	10 cm

Operative procedure

Markings

A straight line was drawn connecting the anterior superior iliac spine and superolateral margin of the ipsilateral patella. A circle with a diameter of 3 cm was drawn at the midpoint of this line. Cutaneous perforators were marked with the help of a handheld Doppler of an 8-MHz probe in the above-mentioned circle.[9] Planning in reverse was done taking a pivot point at 10 cm from the knee joint as derived from the author's cadaveric dissections and as described by Pan SC et al.[10] The skin island is marked so as to include Perforator B (of the ALT flap territory) in the flap. A tongue-shaped skin extension was marked from the distal margin of the flap till the pivot point so as to get closure without tension and to achieve full primary closure over the pedicle of the flap (Figures 1, 2 and 3).

Surgical technique

Considering the area of flap harvest, the use of a tourniquet was not possible and hence flap markings were infiltrated with adrenaline in normal saline (1:100,000).

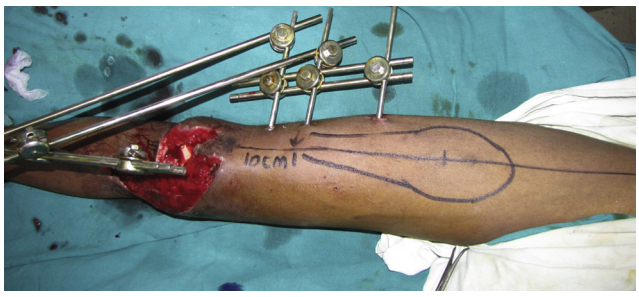

Figure 1 Preoperative knee joint defect with flap markings showing pivot at 10 cm.