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Anatomic and high-resolution computed tomographic angiography study of the lateral femoral condyle flap: Implications for surgical dissection☆

Mohamed Morsy [a,b], Yoo Joon Sur [a,c], Osman Akdag [a,d], Amr Eisa [b], Tarek A. El-Gammal [b], Nirusha Lachman [e], Steven L. Moran [a,*]

[a] *Division of Plastic Surgery, Department of Surgery, Mayo Clinic, Rochester, MN, USA*
[b] *Department of Orthopedic Surgery, Assiut University Hospital, Assiut University, Assiut, Egypt*
[c] *Department of Orthopedic Surgery, Uijeongbu St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Uijeongbu, Republic of Korea*
[d] *Department of Plastic Reconstructive and Aesthetic Surgery, Selcuk University, Konya, Turkey*
[e] *Department of Anatomy, Mayo Clinic, Rochester, MN, USA*

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Summary *Background:* The lateral femoral condyle (LFC) flap is a vascularized bone flap based on the superior lateral genicular artery (SLGA). Harvest technique for this flap has not yet been demonstrated. The purpose of this study was to better delineate the blood supply to the bone and skin of this flap to allow for a safe and effective harvest.
Materials and methods: Twenty-three lower extremities were injected with latex or a mixture of latex and barium sulfate. The SLGA was identified and dissected, documenting the course, diameter, anatomical relations, length, and branches. In the mixture group, high-resolution CT scanning was performed prior to dissection. Two additional specimens were dissected to illustrate the harvest technique.
Results: The SLGA originated from the popliteal artery at an average of 44.3 mm proximal to the knee joint line. The SLGA had an average diameter of 1.9 mm at origin and length of 56 mm. It coursed posterior to the femur, reaching the lateral intermuscular septum (IMS), dividing into superficial (patellar) and deep (condylar) branches, which coursed toward and gave branches to the patella and the LFC, respectively. At least one (average 1.4)

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* Corresponding author. Division of Plastic Surgery, Department of Surgery, Mayo Clinic, 200 First Street SW, Rochester, MN 55905, USA. Fax: +1 507 284 5994.
E-mail address: moran.steven@mayo.edu (S.L. Moran).

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septocutaneous skin perforator >5 mm emerged and ran posterior to the IMS. 3D reconstructions of the CT scans were used to confirm anatomic findings and describe a standard harvest technique.
Conclusions: The SLGA has consistent anatomy, adequate length, suitable diameter at origin for microvascular anastomosis, and constant perforators to bone and skin. The LFC flap provides a useful alternative to flaps from the medial knee or iliac crest.

Introduction

Vascularized bone grafts comprise an important part of the reconstructive microsurgeon's armamentarium. They provide effective treatment for difficult situations including large bone defects and recalcitrant bony non-unions.[1–6] Vascularized bone grafts may be harvested from various donor sites including the fibula, iliac crest, rib, and scapula. The medial femoral condyle (MFC) flap was introduced as a corticoperiosteal flap on the basis of branches of the descending genicular artery (DGA)[7] and rapidly gained popularity, offering great versatility after expanding its use as a corticocancellous or an osteochondral graft.[8–12] The MFC flap offered an ideal treatment for a subset of smaller defects, non-unions, and avascular necrosis such as those in carpal bones.[10,13–17] The MFC flap can also be raised with a skin paddle when needed, depending on the skin perforators of the DGA or a muscle component based on the muscular branch.[18–21]

The lateral femoral condyle (LFC) was recently described as the donor site of a new bone flap based on branches of the superior lateral genicular artery (SLGA) that can provide an additional option for patients who are not candidates for MFC harvest.[11] Moreover, the LFC flap offers potential benefits as a composite graft including portions of muscle, fascia lata, and skin.[22]

There are a few studies looking at the anatomy of the SLGA, and these were performed primarily to evaluate skin flaps from the lateral distal thigh.[23–26] Only recently, after reporting the use of LFC bone flap,[11] was attention drawn toward the anatomy of the SLGA as an additional source of vascularized bone graft.[27–29] To the best of our knowledge, a harvest technique for the LFC flap has not yet been described in the literature. The purpose of this study was to address the detailed anatomy of the SLGA and to use this information to describe a standard, reproducible, and safe harvest technique for this novel vascularized bone graft. A clinical case is presented to demonstrate the feasibility of the proposed technique.

Methods

Twenty-three fresh cadaveric lower extremities were used after obtaining IRB approval for the study design by the Biospecimen Subcommittee. None of the extremities had any known history of previous trauma, disease, or previous surgery. Length of the extremities was measured from the anterior superior iliac spine (ASIS) to the medial malleolus. The femoral artery was identified proximally and cannulated, and the vascular tree was irrigated with saline until clear effluent was observed. Fifteen lower extremities were injected with ward's red latex (Ward's Science, Rochester, NY), and 10 were injected with a mixture of latex and barium sulfate. The barium sulfate was prepared as a suspension of powder with water at a ratio of 1:2 and then mixed with Ward's red latex at 1:2 ratio (suspension:latex). After injection, the lower extremities were left to cool at 4° for 24–48 h. In 13 latex-only injected specimens, a vertical incision was performed at the popliteal fossa. The SLGA was identified at its origin from the popliteal artery (PA), and we followed along its course. The diameter at origin, length, detailed course, branching pattern, and anatomical relations were documented. Each branch was further dissected, and its diameter and distribution were recorded. In particular, cutaneous branches were dissected up to their terminal branching points in the skin. These points were marked on the skin surface, and their location in relation to standard reference horizontal (the knee joint line) and vertical axes (a line joining the ASIS and the superolateral patella) were noted. Nutrient branches to the LFC were recorded, photographed, and sketched to formulate the vascular pattern supplying the LFC. Dissection was conducted under 3.5× loupe magnification, and all measurements were recorded using an electronic digital caliper, except for limb length, which was done using a measuring tape. All relevant steps of the dissection were photographed using a digital camera.

The 10 specimens injected with a mixture of latex and barium sulfate were scanned using a high-resolution CT scanner (127 SOMATOM® Definition FLASH, Siemens Healthcare, Forchheim, Germany). Three-dimensional reformats were created using software designed for 3D rendering (Syngo® 133 Multimodality Workplace, Siemens Healthcare, Forchheim, Germany), reviewed, and then used as a guide for the dissections that followed the above-stated protocol.

On the basis of the data collected form the present study, an easily applicable and safe harvest technique of a bone flap from the LFC was designed using the SLGA as the pedicle, and two latex-injected specimens were used to illustrate this.

Results

A total of 23 extremities (7 male and 16 female) were included in the anatomic study. The average age of the

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