MEDIAL SURAL ARTERY PERFORATOR FLAP FOR TONGUE AND FLOOR OF MOUTH RECONSTRUCTION

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Abstract: Background. The radial forearm flap is frequently considered the first choice for tongue reconstruction, but the disadvantages of donor site morbidity are well known. The search for another thin skin flap as an alternative has led to the application of the medial sural artery perforator flap.

Methods. We used 12 medial sural artery perforator flaps to reconstruct tongue and floor of mouth following cancer ablation. We paid attention to the major perforator (vein ≥ 1 mm) as the vascular relay.

Results. Most flaps were raised with a single perforator. The size of the skin paddle varied from 9 cm × 5 cm to 14 cm × 12 cm. The mean thickness of the flap was 5.2 mm. We reexplored 1 patient for venous insufficiency and could not salvage the flap.


Keywords: perforator flap; tongue reconstruction; medial sural artery perforator flap; floor of mouth reconstruction; endoscope

Adequate speech and swallowing are dependent on tongue shape, size, and mobility. These functions may be profoundly disturbed by glossectomy, which is effective in achieving local control of tongue malignancy. Reconstruction of tongue and floor of mouth after such resections, with the aim of achieving an appropriate level of oral function, remains a major challenge for the reconstructive surgeon. Early reconstruction attempts were aimed at resurfacing the defect with split-thickness skin grafts, local mucosal flaps, and regional flaps. These methods result in contracture of scars and fail to provide the tissue bulk and pliability for functional recovery. The pectoralis major musculocutaneous flap is simple to design, easy to dissect, and reliable, especially when neotongue bulk is beneficial, such as after subtotal or total glossectomy.1 Disadvantages are tethering of the pedicle, limiting flap pliability and tongue motion, and excess bulk. As a result, free tissue transfer has become standard for tongue reconstruction. Various flaps have been used for this purpose. The fascio-
cutaneous flap has evolved as the workhorse for tongue reconstruction.\textsuperscript{1,2}

The radial forearm flap is successful for intraoral lining restoration when bulk is not required, but it commonly leads to a conspicuous donor site scar as primary closure is almost never possible. Sacrificing a major artery to the hand is another major drawback.\textsuperscript{3} In search of an alternative free flap donor site, we explored the use of the medial sural artery perforator flap. The perforator flap from the medial aspect of the upper calf, first described by Cavadas et al\textsuperscript{4} in 2001, provides suitable thickness for resurfacing shallow defects of the distal limbs. This is the first report of the use of the medial sural artery perforator flap for tongue and floor of mouth reconstruction after cancer ablation. As a thin flap is used, the reconstructive site attains both aesthetic and functional refinement in a single stage. This flap is able to reduce the morbidity at the donor site, and its vascular pedicle is also long and provides multiple recipient vessel choices in the neck region. We used the free medial sural artery perforator flap to treat 12 patients, and experience obtained from the management of these cases formed the basis of this report.

**PATIENTS AND METHODS**

Since 2002, we have carried out 32 transfers of the free medial sural artery perforator flap in distal limb and intraoral reconstruction.\textsuperscript{5,6} Of these, 12 transfers were used for tongue and floor of mouth restoration after resection of squamous cell carcinomas between June 2003 and February 2006. All patients underwent hemiglossectomy or subtotal glossectomy and received a concomitant functional neck dissection. The series included 11 men and 1 woman, and the mean age of the patients was 56.6 years (range, 40–77 years). We paid attention to the major perforator (vein \( \geq 1 \text{ mm} \)) of the medial sural vessels, as the vascular relay for the skin flap.

**Operative Technique.** After general anesthesia, the patient is placed in a supine position. The hip joint is maintained in a posture of abduction and slight external rotation, and the knee joint in a flexion posture. This permits the convenience of flap harvesting from the medial aspect of the upper calf and allows a simultaneous 2-team approach in most situations. The emergent point of the perforator is defined first using a handheld Doppler. The size of the flap is determined by the introral defect to be repaired, and the perforator is placed on the center of the skin paddle. The handheld Doppler is not always reliable when the intramuscular descending branches of the medial sural artery run superficially near the deep fascia. In such a case, the sounds of the muscular branches rather than the cutaneous perforators are enhanced. This is a drawback in flap design. We use the 4-mm endoscope with 30° angle to confirm location and size of the cutaneous perforator. After final identification, we relocate the flap template if it is necessary.

With the aid of an inflated tourniquet without limb exsanguination, 2 separate incisions, about 2 cm in length, are made over the anterior border of the medial gastrocnemius muscle. The endoscope is passed under the subcutaneous tissue and deep fascia with the aid of skin retractor and muscle depressor from 1 incision, and a dissect scissor from another (Figure 1). Thus, we can easily localize perforators sprouting from the medial gastrocnemius muscle to the overlying deep fascia because of the loose areolar tissue lying between the deep fascia and the muscle (Figure 2). If the size of the perforator vein is appropriate, the remaining boundaries of the flap can be incised through the deep fascia, and the flap is further detached from the muscle. If there are multiple small cutaneous perforators to supply the medial calf and a reliable...
cutaneous perforator is absent, we can decide at an early stage to instead harvest the anterolateral thigh flap or the radial forearm flap. Therefore, we do not leave a longitudinal incisional scar on the medial calf.

The next step involves intramuscular retrograde dissection of the perforator under loupe magnification. Within the medial gastrocnemius muscle, the main trunk of the medial sural vessels usually divides into 2 major branches, running longitudinally between the muscle fiber bundles and giving off musculocutaneous perforators to the overlying skin. The medial sural artery of the major branch, about 1 to 2 mm in diameter, is usually accompanied by 2 venae comitantes, 1 of which tends to be larger than the other, measuring up to 3 to 4 mm in diameter. Such dimensions allow easy microanastomosis with most of the recipient vessels in the neck. Usually, the superior thyroid artery and branches of the internal jugular vein are the choices. If the skin territory of the flap includes the posterior midline of the calf, the lesser saphenous vein from the proximal flap boundary can be preserved as another source of venous outflow. Red loop: the medial sural vessels; blue loop: the lesser saphenous vein. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

When the floor of mouth including the mylohyoid complex is resected during cancer ablation, additional bulk tissue volume is needed to eliminate dead space. A chimeric medial sural artery perforator flap, combining the fasciocutaneous flap and the medial gastrocnemius muscle flap supplied by different perforators, is versatile for tongue and floor of mouth restoration and prevents the orocutaneous fistula (Figure 4).

We fold the flap longitudinally to fit the dorsal and ventral edges of the residual tongue. The donor-site defect of the upper calf can be closed directly when the skin elasticity is enough and the width of the skin flap is less than 5 cm. A large donor-site defect must be covered with a split-thickness skin graft. One of these patients was presented in Figure 5.

FIGURE 2. Under the endoscope, a perforator sprouting from the medial gastrocnemius muscle to the overlying deep fascia can be easily localized. DF, deep fascia; MG, medial gastrocnemius muscle. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

FIGURE 3. If the skin territory of the flap includes the posterior midline of the calf, the lesser saphenous vein from the proximal flap boundary can be preserved as another source of venous outflow. Red loop: the medial sural vessels; blue loop: the lesser saphenous vein. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

FIGURE 4. A chimeric medial sural artery perforator flap is composed of the fasciocutaneous flap and the medial gastrocnemius muscle flap supplied by different perforators. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]
FIGURE 5. (A) A 50-year-old man had a squamous cell carcinoma on the right ventral aspect of his tongue, T2N0M0. A right hemiglossectomy involving the floor of mouth was performed. (B) We paid attention to the major perforator (vein ≥ 1 mm) of the medial sural vessels, as the vascular relay for the skin flap. (C) A medial sural artery perforator flap, 9 cm × 5 cm in size, was based upon a single major perforator. (D) The flap was folded to fit the residual tongue and the floor of mouth. (E) The neotongue attained good contour and mobility. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]
RESULTS

Patients' clinical data were summarized in Table 1. Most flaps were safely raised with a single perforator, and 1 flap included 2 perforators with similar diameters. The perforators emerged in an area between 8 and 12 cm from the popliteal crease and between 0 and 6 cm from the posterior midline of the leg. The pedicle length of the flap was controllable and an 8- to 10-cm section could be readily obtained. The cutaneous part including the deep fascia on the medial calf was thin (Figure 6) and the mean thickness of the flap was 5.2 mm (range, 4–8 mm). The size of the flap varied from 9 cm × 5 cm to 14 cm × 12 cm. The donor defects were resurfaced with split-thickness skin grafts in 9 patients and were simply closed in the remaining 3 patients. We reexplored 1 patient for venous insufficiency which happened on the fifth day after operation, and we could not salvage the flap. In 1 patient, a reliable perforating vessel was completely missing, and we instead harvested another medial sural artery perforator flap from the contralateral calf.

DISCUSSION

In tongue and floor of mouth reconstruction, fasciocutaneous flaps have always been preferred to any other kind of flap because of their thinness and pliability. By introducing a thin flap, the residual tongue can maintain maximum mobility in urging the tongue-flap complex to approximate the palate and pharyngeal wall, which facilitates better recovery of speech and swallowing. In the past, the radial forearm flap was frequently considered the first choice for intraoral reconstruction. However, the radial forearm flap in the donor area sacrifices a major artery, leaves a cosmetically unfavorable scar, and requires a long healing time in cases with complications of tendons exposure. Perforator-based fasciocutaneous flaps nourished by musculocutaneous perforating vessels, which are capable of capturing the same skin territory as the corresponding musculocutaneous flap, are becoming more popular.7–10 One of the

<table>
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<th>Case</th>
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<th>Flap size, cm</th>
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<th>Flap thickness, mm</th>
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Abbreviations: PC, popliteal crease; PM, posterior midline; M, male; F, female.
*Harvested from the contralateral calf.
main advantages of these flaps is less donor site morbidity and muscle sparing. However, thinning of the anterolateral thigh flap is required for intraoral application and can lead to impairment of flap circulation or direct injury of the perforator. The medial sural artery perforator flap from the medial aspect of the upper calf is primarily thin and seems more suitable for tongue and floor of mouth reconstruction.

Locating a reliable cutaneous perforator is the first step in flap design. Inaccurate localization of the cutaneous perforator may place the flap design outside the perforator location or limit the perfusion territory. In our series, the emergent point and size of the cutaneous perforator varied significantly. Preoperative handheld Doppler was not accurate in detecting cutaneous perforator of the medial sural artery perforator flap when the sounds of the muscular branches of the medial sural vessel rather than the cutaneous perforator were enhanced or the medial calf was supplied by multiple small cutaneous perforators rather than a reliable cutaneous perforator. We used the endoscope to confirm location and size of the cutaneous perforator for an accurate flap design.

Sequelae of the orocutaneous fistula may cause shrinkage and inferior displacement of the flap, limiting the final shape and motility of the reconstructive tongue.1 The chimeric medial sural artery perforator flap is composed of the gastrocnemius muscle flap and the fasciocutaneous flap, supplied by different perforators ultimately arising from the common “mother vessels—medial sural vessels.” This chimeric flap eliminates the need for additional microanastomosis in raising multiple flaps,11 and it is more versatile in fulfilling different demands of intraoral reconstruction than a thin fasciocutaneous flap or a bulky muscle flap. The gastrocnemius muscle portion of the chimeric flap can occlude the dead cavity of the floor of mouth for decreasing the occurrence of the orocutaneous fistula. The thin fasciocutaneous portion of the chimeric flap, on the other hand, can be folded easily to the residual tongue for restoring tongue shape and preserving as much range and coordination of tongue motion as possible.

The advantages of the medial sural artery perforator flap are as follows: (1) the flap is generally thin and has good pliability; (2) a vascular pedicle about 8 to 10 cm long can be obtained with dissection up to the main trunk of the medial sural vessels; (3) the diameter of the proximal end of the vascular pedicle provides multiple recipient vessel choices in the neck region; (4) the lesser saphenous vein from the proximal flap boundary can be carefully preserved as another source of venous outflow to the flap, just like the cephalic vein serving the radial forearm flap; (5) the donor site is far from the head and neck regions, and flap elevation can be performed simultaneously with tumor resection; (6) this flap preserves the medial gastrocnemius muscle and the major arteries of the leg to minimize donor site morbidity; (7) as all flaps are obtained from the upper calf, primary wound closure of the donor site may be achieved with a flap width up to 5 cm; and (8) a chimeric flap can be designed and elevated for different purposes.

The risk of necrosis of the medial gastrocnemius muscle is limited, because 1 major branch of the medial sural vessels is usually preserved and several secondary vascular pedicles, like communications between the lateral and medial heads of the gastrocnemius muscle, are also present.12 However, the search of a reliable perforator, the tedious process of intramuscular retrograde dissection of the perforator, hair growth of the neo-tongue, and an unsightly scar of the skin graft in the donor region are major concerns.

CONCLUSIONS
With advances in microsurgical techniques, a flap not only containing right components to fulfill functional and cosmetic requirements of the recipient defect but also showing low donor-site morbidity is required. The medial sural artery perforator flap permits high accuracy of tongue and floor of mouth restoration and also preserves the medial gastrocnemius muscle and the major arteries of the leg to minimize donor site morbidity.

REFERENCES
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