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The sensate fibula osteocutaneous flap: Neurosomal anatomy

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Summary *Background:* Rapid return of oral sensation enhances quality of life following oromandibular reconstruction. For predictable reinnervation of flaps, a detailed knowledge of their nerve supply is required. This study was designed to investigate the cutaneous nerve supply of the fibula osteocutaneous flap.
Methods: We dissected thirty-seven fresh cadaveric specimens to better understand the cutaneous innervation of the typical fibula flap that would be used in oromandibular reconstruction. In addition, ten volunteers were enlisted for nerve blocks testing the cutaneous innervation of the lateral aspect of the lower leg.
Results: The lateral sural cutaneous nerve (LSCN) is generally considered to be sole cutaneous innervation to the lateral aspect of the lower leg; however, our analysis of the cadaveric specimens revealed dual innervation to this region. We identified a previously unnamed distal branch of the superficial peroneal nerve, which we have termed the *recurrent superficial peroneal nerve* (RSPN).

Given the cadaveric findings, both the LSCN and the RSPN were tested using sequential nerve blocks in 10 volunteers. An overlapping pattern of innervation was demonstrated.
Conclusions: The lateral aspect of the lower leg has an overlapping innervation from the LSCN and the newly described RSPN. The overlap zone lies in the region of the skin paddle of the fibula flap. The exact position of the neurosomal overlap zone (N.O.Z.E.) may be an important factor in reestablishing sensation in the fibula's skin paddle following free tissue transfer.

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Introduction

Oromandibular reconstruction has historically posed a significant challenge to the reconstructive surgeon. The mandible contributes to the lower third of the facial skeleton and plays an integral role in both the function and overall aesthetics of the face.[1] Current reconstructive efforts focus more on optimizing functional outcomes, such as articulation, mastication, and deglutition, while, at the same time, minimizing discomfort and deformity. These reconstructive goals remain the same regardless of the etiology of the defect.[2]

Sensation plays an integral role in the many functions of the oral cavity, including mastication and deglutition.[3] In order to adequately chew and manipulate food to its proper position in the oropharynx, a network of neuronal pathways must be intact. Not only do these pathways assist in the intake of food, but they also aid in oral continence and oral hygiene by limiting the pooling of saliva. Articulation also relies on a functioning sensory system. Intraoral tactile perception and sensory feedback channels provide the basis for proper enunciation. It would appear, therefore, that a sensate flap should provide the ideal construct in oromandibular reconstruction following excisions from the tongue, lower lip and anterior floor of mouth.

The return of near-normal intraoral sensation following reinnervation of fasciocutaneous and osteocutaneous flaps is well established; and shown to be far superior to controls in which reinnervation did not take place.[4–15] One such study by the lead author examined reconstruction of the tongue and floor of the mouth in patients who had undergone partial glossectomy for squamous cell carcinoma.[5] Radial forearm flaps were transferred to the oral cavity to reconstruct the tongue and anterior floor of mouth. Half were reinnervated using the lateral antebrachial cutaneous nerve as the donor and the lingual nerve as the recipient. The rest were not. The reinnervated flaps were found to have return of sensibility of the same order as that of the normal (contralateral) tongue as measured by monofilament pressure, static and two-point discrimination. This level of sensation was superior to that in forearm flaps prior to elevation. Sanger referred to the phenomenon as 'sensory upgrading,'[16] a finding corroborated by Yu in a series of reinnervated anterolateral thigh flaps used for tongue reconstruction.[11,12] He too achieved a near-normal sensory return. Furthermore, he gamely went on to demonstrate a 'functional improvement' as a result of re-innervating his flaps.

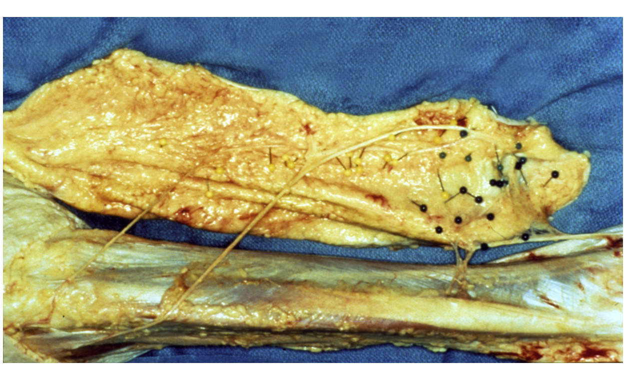

Figure 1 Cadaveric dissection of lateral sural cutaneous nerve (LSCN) proximally (left) and recurrent superficial peroneal nerve (RSPN) distally (right). Skin from the lateral calf has been removed and sensory dermal end-points marked with pins (RSPN in dark).

The standard of care for oromandibular reconstruction in most major institutions is the vascularized fibula free flap.[17,18] Its advantages, include: a segmental blood supply to facilitate multiple osteotomies; a relatively thin skin paddle with a large surface area; a reasonable ease of harvest; an unrivaled length of bone; an acceptable donor-site morbidity, and an advantageous remoteness from the reconstruction site. The fibula can provide up to 24 cm in length of free bone graft, and can be osteotomized in such a fashion as to mimic the general curvature of the mandible. Furthermore, the bone can easily accommodate implantable dental prostheses.[18] To these advantages we would now like to add: *reliable reinnervation of the skin paddle*.

In a study by Wei et al., five patients underwent reconstruction using a fibula osteo-septocutaneous reinnervated flap based upon the lateral sural cutaneous nerve (LSCN).[19] Three patients had return of touch and temperature sensation over the fibula skin paddle within six months of surgery. However, the authors concluded that innervation by the lateral sural cutaneous nerve (LSCN) is inconsistent. Additionally, their use of preoperative local anesthetic blocks was unreliable in delineating the anatomic territory of the nerve. Further investigation into the anatomy of the lower leg may help to broaden our knowledge of its innervation and possibly optimize patient outcomes. The purpose of this study is to delineate the sensory supply to the fibula skin paddle and better understand the territory supplied by the LSCN. A detailed, prospective assessment was therefore carried out on both cadaveric and living human subjects.

Materials and methods

Cadaveric dissection

Thirty-seven human cadavers were randomly selected for dissection of the lower legs. Using 3.5-loupe magnification, the LSCN (also known as the *lateral cutaneous nerve of the calf*) was identified in the popliteal fossa.[20] The LSCN pierces the fascia of the lateral calf at an average of six centimeters posterior to the center of the fibular head, and then enters into the subcutaneous tissue to supply cutaneous innervation to the calf. The nerve was then traced distally through the subcutaneous tissues until its terminal branches were visualized entering the dermis. These terminal dermal branches were each marked with a mapping pin placed through the overlying skin as they entered the dermis and could not be dissected further. The septocutaneous perforators of the peroneal vessels were then likewise identified and similarly marked with pins of a different color (Figure 1).

The common peroneal nerve gives rise to the both the superficial and deep peroneal nerves. The superficial peroneal nerve (SPN) originates between the peroneus longus muscle and the fibula. At this location, the superficial nerve was identified and traced distally, where it