Craniofac Res. 2024; 3(2):89-93. Received: 2024-05-17 / Accepted: 2024-06-26

Profunda femoris artery flap as an option in tongue reconstruction. A technical note

Colgajo de la arteria femoral profunda como opción en la reconstrucción de la lengua. Una nota técnica

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SHAN OH, HUENTEQUEO MC, SCHNEEBERGER HP, ZHOU QX. Profunda femoris artery flap as an option in tongue reconstruction. A technical note. *Craniofac Res. 2024; 3(2)*:89-93.

ABSTRACT: Reconstruction of the tongue following ablative surgery is a well-documented technique that shows significant improvement in swallowing, speech, and quality of life. Free flaps, such as the anterolateral thigh, forearm, rectus abdominis, and latissimus dorsi flaps, are the most commonly used in tongue reconstruction. Additionally, in recent years, the profunda femoris artery perforator flap (PAP flap), discovered by Argentine surgeon Claudio Angrigiani in 2000, has gained recognition in head and neck reconstruction, particularly for tongue reconstruction. This article aims to present a technical note focused on the application of the PAP flap in tongue reconstruction.

KEY WORDS: profunda femoris artery perforator, deep femoral artery, free flap, tongue reconstruction, microvascular reconstruction.

INTRODUCTION

The immediate reconstruction of patients with tongue cancer has been extensively studied and practiced over the past decades (Buchbinder & St-Hilaire, 2003; Vincent *et al*., 2019). This has resulted in a paradigm shift and significantly improved patients' quality of life by largely restoring tongue functionality. Such improvements have been evaluated through the assessment of tongue strength, swallowing, and speech, as well as other indirect measures such as appetite and body muscle index (Ihara *et al*., 2021). The current standard goal is reconstruction using free flaps, with salvage achieved through local and regional flaps, such as the pectoralis major muscle flap, buccinator flap, or facial artery flap (Buchbinder & St-Hilaire, 2003).

Free flaps are the preferred choice for reconstructing defects caused by partial glossectomies involving more than one-third of the tongue, hemiglossectomies, glossectomies, or defects involving a significant portion of the floor of the mouth (Vincent *et al*., 2019). For smaller or thinner defects, the radial artery flap or forearm flap is commonly used, while for larger or thicker defects, the anterolateral thigh flap is most frequent. Less common options include the rectus abdominis or latissimus dorsi flaps (Vincent *et al*., 2019). In recent years, the deep femoral artery flap, discovered in 2000 by Argentinean Claudio Angrigiani and known as the PAP or Profunda Femoralis Artery Perforator flap, has also gained recognition.

The Profunda Artery Perforator (PAP) flap has served as an alternative to the Deep Inferior Epigastric Perforator (DIEP) flap in breast reconstruction since Allen *et al*. published the initial reconstructions utilizing the PAP flap in 2012 (Allen *et al*., 2012). Following several studies focusing on head and neck reconstruction, Fernández-Riera *et al*. published a study

in 2017 proposing the PAP flap as the primary option for hemiglossectomy reconstruction. This study underscored its merits, such as the concealed donor site scar, reliable anatomy of its perforators, and pliability (Fernández-Riera *et al*., 2017).

In recent years, the application of the PAP flap has been increasingly scrutinized due to its outstanding outcomes in comparative studies with the anterolateral thigh flap, showing enhancements in certain aspects (Largo *et al*., 2021; Ismail *et al*., 2024). Notably, its use as a chimeric flap combined with the gracilis muscle for dynamic tongue reconstruction has been emphasized. The objective of this article is to present a technical note on the utilization of the deep femoral artery flap.

TECHNICAL NOTE

Flap Characteristics

The PAP flap is primarily based on the larger caliber perforator, which is, on average, located approximately 7.5 cm from the inguinal crease (Fig. 1C) (Fernández-Riera *et al*., 2017; Kehrer *et al*., 2018; Heredero *et al*., 2020). We aim to identify all possible perforators, with the first one typically being found around 4–6 cm from the inguinal crease. The versatility of this flap allows for both horizontal and vertical designs. The vertical flap can measure up to 24 cm in length, with an average length of 12 cm, and an average width of 7 cm, up to 14 cm. The thickness ranges from 0.5 to 4 cm, with an average of 1.9 cm. The length of the pedicle varies between 8 and 15 cm, with an average of 11.5 cm, and most of the perforators are musculocutaneous (Largo *et al*., 2020).

Flap Harvesting

The positioning of the patient is crucial in this procedure and depends on both the surgeon's preference and the chosen flap orientation. For a vertical flap, the patient can be positioned with the leg bent in a frog-leg or lithotomy position. For a horizontal flap, especially if extensive, the lithotomy position is recommended for better posterior visibility; we use an intermedial position between these two positions (Fig. 1A). Several anatomical structures must be considered, including the adductor longus (AL), gracilis (G), adductor magnus (AM), and the great saphenous vein. The key focus is locating the AL muscle, originating from the pubic tubercle. This muscle can be identified by palpating and pressing from front to back at the tubercle level; the first muscle palpated is the AD, and 2 to 3 fingers posteriorly, the gracilis muscle is located, marking the anterior incision site (Fig. 1B). The skin paddle is placed over the perforators, prioritizing the one with the largest caliber. The incision is made on the anterior part of the skin paddle, targeting the G muscle. Dissection up to the fascia is performed using an electrobistoury, followed by careful fascia dissection with scissors and a 22 blade. During this stage, care must be taken to avoid damaging the perforators near the fascia around the G muscle. Upon identifying the muscle, it is separated anteriorly. Next, the perforators adjacent to the AM muscle are located (Fig. 2). Upon locating the perforator, we initiate a careful dissection of the adductor magnus (AM) muscle, which we must traverse, directing towards the muscle's depth in a medial direction towards the deep femoral artery. This dissection can be performed over the muscle using scissors, bipolar diathermy, or a harmonic scalpel. We ligate each collateral vessel of the perforator and proceed until we visualize the deep femoral artery or obtain a sufficient caliber and length (Fig. 3).

Fig. 1. A. Our Position between Frog leg position and lithotomy position. B. frog position of the leg and vertical flap design and landmarks: anterior incision is 2-3 fingers posterior to the anterior margin of the aductor longus over the gracilis muscle. C. Distance between the perforator and the inguinal crease.

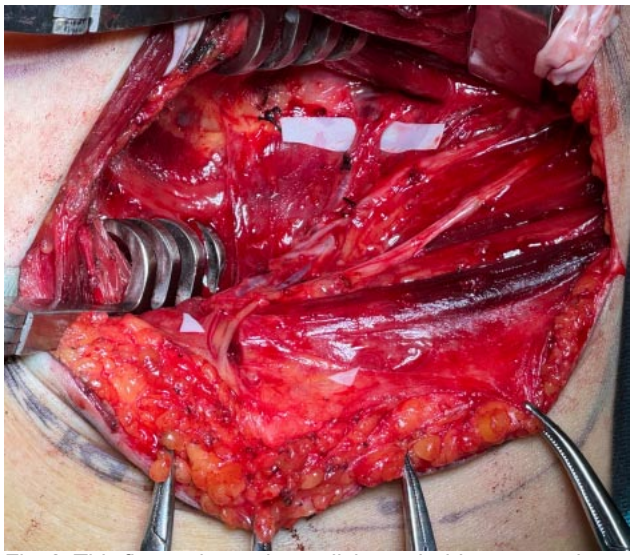

Fig. 2. This figure shows the pedicle, and white arrows shows the perforator close to the skin.

During this process, an automatic spreader or long spreaders, such as Langenbeck retractors or similar instruments, are employed to separate the muscles. Once the desired separation is achieved, we divide the pedicle and secure the perforator with a 3/0 non-absorbable suture or a vascular clip (Fig. 4A). Hemostasis is then verified, and closure is performed in layers, suturing the muscles separately in the case of musculocutaneous perforators, and then suturing between the muscles. Subsequently, we place drains between the muscles, positioning one above and one below, before suturing the fascia and completing the procedure with a primary skin closure using non-absorbable sutures.

Flap Insetting

The flap insetting into the tongue is performed as per-standard procedures for tongue reconstruction, and it depends on

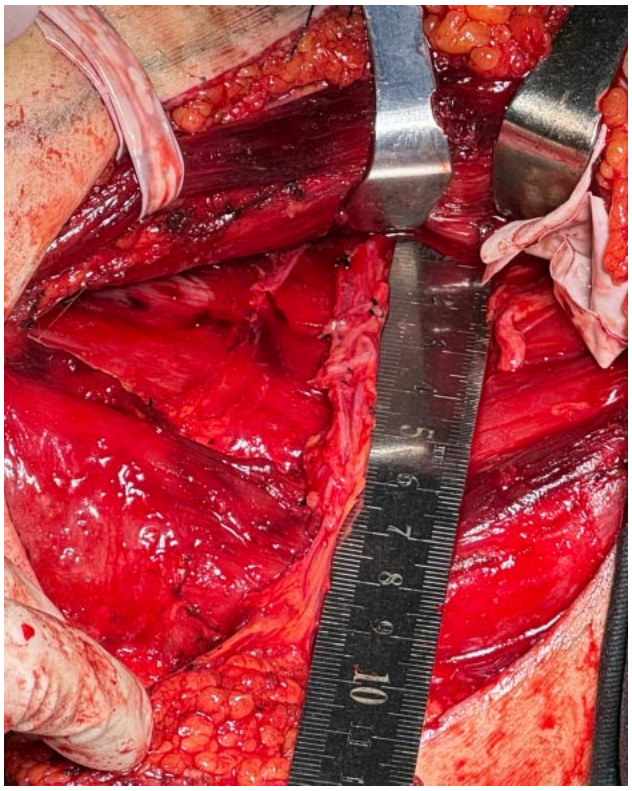

Fig. 3. Length of the pedicle.

the type of defect present. Initially, anastomosis is carried out, with the facial artery and vein being the preferred vessels. The procedure starts with the artery, followed by the vein. Subsequently, the skin paddle is positioned, ensuring that the longest section is aligned parallel to the tongue's length. Suturing commences from the base of the tongue, proceeding to the medial and lateral regions in a posterior-to-anterior direction (Fig. 4B), and concludes at the tip of the tongue and the anterior region of the mouth floor, prior to closing the mandibular swing. Postoperative controls are similars to ALT flap or others (Fig. 4C).

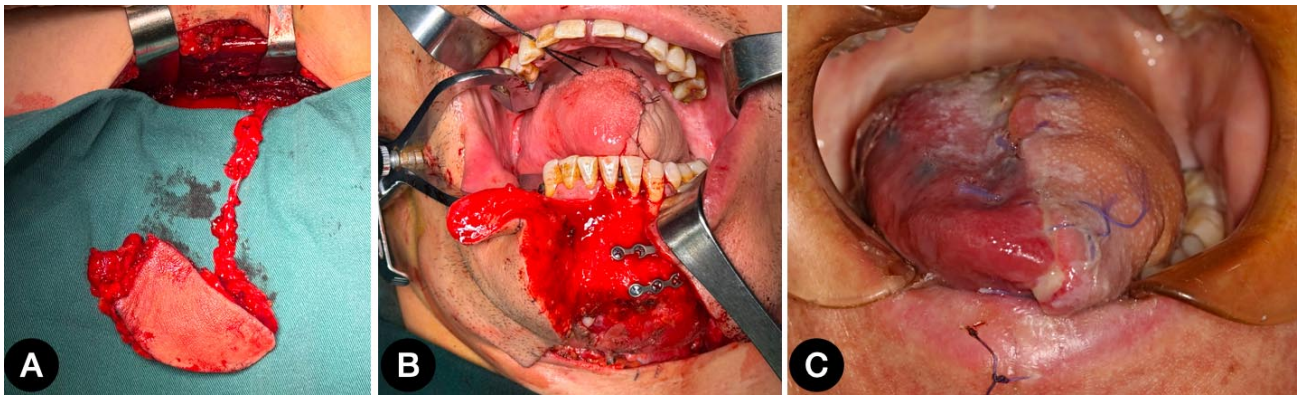

Fig. 4. A. This figure shows the flap and its Skeletonized pedicle. B. Flap insetting. C. Postoperative control: 10 days.

Pearls an pitfalls

The PAP flap dissection is a reliable technique owing to the constant nature of its perforators. It is crucial to distinguish the PAP flap from the medial circumflex artery, which directs blood flow to the gracilis muscle and traverses this muscle to the skin; the location of PAP flap perforators is posterior to this perforator. Another key point is to avoid dissecting the great saphenous vein, which is situated anteriorly to the flap dissection. Although this vein can be incorporated as a secondary vein in some cases, it is generally unnecessary to dissect it. In situations where less experienced surgeons encounter this vein, they should proceed in a posterior direction.

The PAP flap can also be utilized as a chimeric flap. The first option is to use certain perforators that supply the AM muscle, which is beneficial when additional volume is needed for reconstruction. The second option involves combining the PAP flap with the gracilis muscle for dynamic reconstructions. For this combination, it is important to identify perforators that facilitate this method; otherwise, the medial circumflex artery can be considered as an alternative option.

DISCUSSION

Free flaps are the primary choice for tongue reconstruction following glossectomies, whether partial, total, or hemiglossectomies. In contrast, local or regional flaps, such as the pectoralis major, supraclavicular, or facial artery flaps, are typically reserved for salvage surgeries or patients with poor-quality recipient vessels (Buchbinder & St-Hilaire, 2003). The anterolateral thigh flap and the radial forearm free flap, also known as the "Chinese flap," are the most commonly utilized flaps in tongue reconstruction, contingent upon the required volume. The anterolateral thigh flap can provide tissue for medium to large defects and offers the potential for chimeric flaps. However, one of its drawbacks is the variability in the location of its perforators and its anatomical structure (Rosti *et al*., 2024). Another frequently used flap is the rectus abdominis flap, which can provide a substantial amount of tissue if needed, but can also be dissected to create a thinner flap. Nevertheless, the scar is more visible with this flap (Vincent *et al*., 2019).

The development of free flaps has advanced significantly, leading to the use of more complex flaps that depend on their perforators rather than solely on a primary or medium-caliber artery. For instance, the superficial circumflex iliac artery perforator flap, or SCIP flap, stands in contrast to the anterolateral thigh flap by having minimal fatty tissue and being suitable for reconstructions requiring less volume. Furthermore, the caliber and length of this flap's perforator are smaller compared to those of the anterolateral thigh flap (Chang, 2023). The PAP flap is one of the soft tissue flaps with greater potential in head and neck defect reconstruction. Its primary attributes include pliability, a substantial volume with a high fat content, and versatility in donor site selection. A vertical flap up to 24 centimeters in length can be harvested, or alternatively, a horizontal flap can be utilized, which, although smaller, effectively conceals the scar near the inguinal crease. Another notable advantage is the consistent anatomy of its perforator, typically located approximately 7.5 cm from the inguinal crease and readily identifiable via Doppler ultrasonography. The PAP flap has been proposed as an alternative to the anterolateral thigh flap, with studies showing no significant differences in speech between the two, but a significantly higher success rate in swallowing with the PAP flap compared to the anterolateral thigh flap (Ismail *et al*., 2024). Fernandez-Riera and colleagues even present it as the first choice flap in their study, over the more commonly used anterolateral thigh flap, due to its pliability, softer surface, and less aesthetic sequelae from the donor site than its counterpart. Heredero *et al*., in a study of 10 cases, obtained similar results with suprafascial flaps to achieve thinner flaps with less fat content, based on the high fat content in this area, particularly in patients with a higher body mass index (Heredero *et al*., 2020). The PAP flap also offers the option for chimeric flaps, incorporating muscle from the AM for added volume or using the gracilis muscle for dynamic reconstruction, such as providing tongue mobility and reconstructing adjacent structures like the floor of the mouth if required. It has additionally been employed for post-total parotidectomy facial reanimation and reconstruction of surrounding structures (Ciudad *et al*., 2019).

In terms of flap harvesting, the PAP flap may present moderate difficulty. Compared to the anterolateral thigh flap, the dissection must be deeper; however, the constant anatomy of its perforators does not pose significant difficulties for harvesting. Based on recent publications in tongue reconstruction and its success in breast reconstruction over a decade ago, the PAP flap appears to be a viable alternative to the commonly used anterolateral thigh flap. Recent studies

show comparable results in tongue reconstruction when comparing both flaps, with one article even demonstrating better outcomes in swallowing. Despite the promising results indicated by both clinical experience and new publications and compared with years of research on the anterolateral thigh flap, it is scientifically premature to claim the superiority of the PAP flap, given the extensive research on the anterolateral thigh flap.

Conflict of Interest: The authors declare that they have no conflicts of interest.

SHAN OH, HUENTEQUEO MC, SCHNEEBERGER HP, ZHOU QX Colgajo de la arteria femoral profunda como opción en la reconstrucción de la lengua. Una nota técnica. *Craniofac Res. 2024; 3(2)*:89-93.

RESUMEN: La reconstrucción de la lengua tras una cirugía ablativa es una técnica bien documentada que muestra una mejoría significativa en la deglución, el habla y la calidad de vida. Los colgajos libres, como el anterolateral de muslo, el de antebrazo, el recto abdominal y el latísimo del dorso, son los más utilizados en la reconstrucción lingual. Además, en los últimos años, el colgajo de la arteria femoral profunda, descubierto por el argentino Claudio Angrigiani en el año 2000 y conocido como colgajo 'PAP' (Profunda Femoris Artery Perforator), ha ganado reconocimiento en la reconstrucción de cabeza y cuello, particularmente en la reconstrucción de la lengua. Este artículo tiene como objetivo presentar una nota técnica enfocada en la aplicación del colgajo PAP en la reconstrucción lingual.

PALABRAS CLAVE: Arteria femoral profunda, colgajo libre, reconstrucción de la lengua, reconstrucción microvascular.

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