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Superficial circumflex iliac artery perforator flap's imaging, anatomy and clinical applications in oral maxillofacial reconstruction

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ABSTRACT

Purpose: To assess the feasibility of superficial circumflex iliac artery perforator (SCIP) flap for oral maxillofacial reconstruction and evaluate computed tomography angiography (CTA) and color Doppler sonography (CDS) in mapping superficial circumflex iliac artery (SCIA) and its perforators.
Material and methods: Fifteen patients were carried out surgery. Perforator identification and the relationship between SCIA, deep circumflex iliac artery (DCIA) and superficial inferior epigastric artery (SIEA) were performed preoperatively and intra-operatively.
Results: The relationship between SCIA, DCIA and SIEA was depicted and subdivided into type 1 (8/15), type 2 (2/15), type 3 (2/15), type 4 (2/15) and type 5 (1/15). Surgical procedures and SCIP flap anatomy were described. 14/15 of the SCIP flaps survived and one with necrosis.
Conclusions: The SCIP flap is a reliable, thin and pliable flap with hidden donor site morbidity for oral maxillofacial reconstruction. CTA and CDS are valuable methods for preoperative assessment of the perforator's location and type.

1. Introduction

Free flaps transfer for oral maxillofacial reconstruction should not only eliminate the dead space but also provide satisfactory contours and restore the original oral functions. The size and depth of the defect, involvement of the adjacent structures, available donor site, and the preference of the surgeons all play important roles on choosing a suitable flap. In recent years, oral maxillofacial defect reconstruction with a variety of vascularized free flaps (Nouraei et al., 2015) has been reported.

The free radial forearm flap has been widely used for oral maxillofacial reconstruction due to its constant anatomy, pliability, and hairlessness. However, its drawbacks of sacrificing 1 main trunk vessel, tendon exposure, limitation in flap volume, and poor esthetic contour occur frequently at the donor site (Richardson et al., 1997; Soutar and McGregor, 1986).

The groin flap, based on the superficial circumflex iliac artery (SCIA), has gained popularity in 1970s (Daniel and Taylor, 1973). Koshima (Koshima et al., 2004b) first presented the superficial circumflex iliac artery perforator (SCIP) flap used for extremities reconstruction in 2004. It can be harvested without the excision the deep fascia or muscle and primary defatting, and thus has overcome the inherent drawbacks of the conventional groin flap. In the past decades, this flap has been used for reconstructions of the limbs (Hong et al., 2013), penis (Koshima et al., 2006; Yoo et al., 2012), external auditory canal (Iida et al., 2013a), and head and neck defects (Green et al., 2013).

With significant variation in the vascular anatomy of the inguinal region, detail anatomical knowledge and preoperative mapping of vascular supply are essential in SCIP flap candidates. Various kinds of diagnostic tools are available for this purpose,

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including hand-held acoustic Doppler (Yu and Youssef, 2006), color Doppler sonography (Rozen et al., 2008), digital subtraction angiography, computed tomographic angiography (Cina et al., 2013) and magnetic resonance angiography (Smit et al., 2010). These tools all present both advantages and disadvantages, and to date none of these techniques is generally accepted as the gold standard.

Computed tomographic angiography has been predominantly used as a noninvasive and effective mean in the planning of perforator flaps in breast reconstruction with deep inferior epigastric artery (Rozen et al., 2008), and also has been applied in anterolateral thigh flap (Yang et al., 2013). These studies revealed a high sensitivity and specificity of computed tomographic angiography compared with intraoperative findings.

The aim of this study was to introduce the anatomy of the SCIA and the application of the SCIP flap in oral maxillofacial reconstruction, and to evaluate the role of preoperative computed tomographic angiography and color Doppler sonography in identifying perforator location, SCIA course, and the relationship between the SCIA, deep circumflex iliac artery (DCIA), and superficial inferior epigastric artery (SIEA).

2. Material and methods

2.1. Patients

From January 2014 to November 2014, a total of 16 consecutive patients (8 males and 8 females), scheduled for SCIP flap transfer, were recruited. In 1 patient, the donor site was abandoned because of the insufficient availability of perforating vessels. In this case, it was decided intraoperatively to use a forearm radial flap instead of a SCIP flap. In 15 patients, a perforator flap operation was actually carried out. The clinical details of the remaining patients was summarized in Table 1.

In the 15 patients, the median age of the patients was 50 years (range 23 to 67 years), and the follow-up period ranged from 2 to 10 months. The pathology revealed that most common tumor type was squamous cell carcinoma (n = 13), mucoepidermoid carcinoma (n = 1), and recurrence of mandibular osteosarcoma (n = 1). The defects included lower lip, tongue, cheek, retromolar, pharynx, mandibular, and maxilla. The clinical staging was performed according to the 2002 Union for International Cancer Control TNM Classification of Oral Malignant Tumors.

The present study was approved by the hospital's independent ethics committee (Shanghai, China), and all patients signed an informed consent agreement.

2.2. Preoperative imaging

All patients underwent computed tomographic angiography using a 64-multidetector row computed tomography scanner (Philips, Cleveland, OH, USA) between 2 days and 1 week before the surgery. A bolus of 100 ml of Ultravist 370 (Schering AG, Berlin, Germany) was given intravenously at a rate of 3 ml/s for contrast. Sections were obtained from the first lumbar vertebra to 10 cm below the pubic symphysis. No complications arose from the use of computed tomographic angiography. The images were processed into maximum intensity projection and 3-dimensional volume-rendered reconstruction using software (Philips Medical Systems, Veenpluis 4-6, 5684 PC, Best, the Netherlands). Image interpretation was performed on axial and 3-dimensional reconstructions.

The course of the SCIA, including its origin from the femoral, any points of bifurcation, the vessels patency location, and pulse of suitable perforators were also confirmed using color Doppler sonography with an Esaote Mylab30 Dopplex with 5 MHz–12 MHz probes (China, Shenzhen). The superficial and deep branches of SCIA were tracked. During tracing for the potential dominant perforator, the intensity was observed and marked. The body surface projection line of the branches of the SCIA and SCIP location were marked according to the blood signal.

2.3. Flap harvest

Tumor extirpations along with ipsilateral neck dissection were performed simultaneously. The skin paddle of the required dimensions was designed centered on the perforator of SCIA identified with preoperative computed tomography angiography and color Doppler sonography (Fig. 1). An initial incision was made in the medial border of the flap and the middle of the inguinal crease. The depth of the incision was made through the skin and subcutaneous tissue. Subcutaneous vein, i.e., the superficial circumflex iliac vein (SCIV), was often found in the fat layer. The SCIA is accompanied by concomitant vein and also often accompanied a cutaneous vein, which also runs parallel to the SCIA in the superficial layer of the fatty tissue. Small branches of perforator can be found in the subcutaneous fat tissue and can be traced back to the superficial or deep branch and the perforators were identified by cautious dissection. Once the perforator was determined, the other border of the flap was incised to elevate (Fig. 2). SCIA was dissected proximally and distally until a sufficient length was obtained.

Table 1
Patient characteristics and outcomes.

Case	Age/sex	Primary tumor	Tumor stage (TNM)	Defect area	Complications	Follow-up (months)	*Recurrence
1	31/M	SCC, OSF	pT2N1M0	R/lower lip	(−)	10	Absence
2	66/M	SCC	rT4N0M0	L/buccal	(−)	9	Lymphatic metastasis
3	65/M	SCC	pT3N0M0	L/tongue	(−)	7	Absence
4	23/F	MES	pT4aN0M0	L/retromolar	(−)	7	Absence
5	40/F	OS	rT4N0M0	R/mandibular with buccal and skin	(−)	7	Absence
6	63/F	SCC	pT2N2bM0	L/buccal	(−)	6	Absence
7	48/M	SCC	pT4bN0M0	R/pharynx	(−)	6	Absence
8	67/M	SCC	pT4aN0M0	L/bilateral lower lip and oral commissure	Artery spasm	6	Absence
9	60/F	SCC	pT3N1M0	L/buccal	(−)	6	Absence
10	60/F	SCC	pT2N0M0	L/maxilla and buccal	(−)	5	Absence
11	47/F	SCC	pT2N0M0	L/buccal and lateral oral commissure	(−)	5	Absence
12	43/F	SCC	pT1N0M0	R/tongue	(−)	4	Absence
13	53/F	SCC	pT1N0M0	L/tongue	(−)	3	Absence
14	48/M	SCC	PT2N0M0	R/tongue	(−)	2	Absence
15	50/M	SCC	pT1N0M0	R/tongue	(−)	2	Absence

F: female; M: male; SCC: squamous cell carcinoma; OSF: oral submucous fibrosis; MES: mucoepidermoid carcinoma; OS: osteosarcoma; pTNM: pathological TNM; rTNM: recurrence TNM; R: right; L: left; *Recurrence: recurrent disease in the follow-up time.