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Venous superdrainage using superficial circumflex iliac vein in deep circumflex iliac artery perforator flap with iliac crest for oromandibular reconstruction

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Abstract. The deep circumflex iliac artery perforator flap with iliac crest (DCIAPF) is considered a favourable single-flap option for oromandibular reconstruction. The aim of this study was to evaluate the effectiveness of venous superdrainage using the superficial circumflex iliac vein (SCIV) in the DCIAPF for oromandibular reconstruction. The data of 22 patients (12 female, 10 male) aged 10–76 years (median 53 years) who underwent simultaneous oromandibular reconstruction with a DCIAPF were reviewed retrospectively. Eleven patients received the DCIAPF with SCIV for superdrainage (group A) and another 11 patients received the conventional single-pedicled DCIAPF flap (group B). No flap loss occurred in either group. Venous congestion due to relative venous insufficiency was significantly more frequent in group B ($P = 0.045$). There was no significant difference in the incidence of partial flap necrosis and wound dehiscence, or in the total operation time between the two groups. Superdrainage using the SCIV has the potential to reduce the incidence of venous congestion due to relative venous insufficiency in DCIAPF used for oromandibular reconstruction.

Key words: perforator flap; iliac crest; mandibular reconstruction; microvascular reconstructio; craniomaxillofacial surgery.

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The classic deep circumflex iliac artery (DCIA) flap, first introduced by Taylor et al. in 1979[1], is not used very frequently for oromandibular reconstruction because of the problems caused by the presence of the 'obligatory muscle cuff' and the tethering of the skin to the bone. Many modifications have been proposed for reducing the bulk of the flap and improving manoeuvrability[2–5]. At Peking University School and Hospital of Stomatology, the iliac crest is harvested along with the internal oblique muscle and the deep circumflex iliac artery perforator—the DCIA perforator flap

Table 1. Characteristics of the patients who received the DCIAPF with SCIV for superdrainage (group A) and the patients who received the conventional single-pedicled DCIAPF flap (group B).

Characteristics	Group A	Group B
Sex (*n*)		
Male	7	3
Female	4	8
Age (years)		
Median	55	50
Range	32–76	10–71
Histology (*n*)		
Squamous cell carcinoma	8	9
Adenoid cystic carcinoma	2	1
Mucoepidermoid carcinoma	1	0
Osteosarcoma	0	1

DCIAPF, deep circumflex iliac artery perforator flap with iliac crest; SCIV, superficial circumflex iliac vein.

(DCIAPF)—and the terminal part of the DCIA is used as a musculocutaneous perforator during oromandibular reconstruction. This modification is based on the perforator angiosomes reported by Bergeron et al.[5], Zheng et al.[6], and Zheng et al.[7]. The DCIAPF is an effective single-flap option for oromandibular reconstruction after oncological resection because of the adequate bone component, the satisfactory soft tissue, the constant location of the perforator, and the limited donor site complications. However, we have observed venous congestion in the skin islands of the DCIAPF, which is probably due to poor venous drainage in areas of the flap. To improve the venous drainage of the DCIAPF, we perform a technique involving use of the superficial circumflex iliac vein (SCIV) for venous superdrainage. The aim of this retrospective study was to examine the efficacy and safety of oromandibular reconstruction using the DCIAPF with SCIV for superdrainage.

Materials and methods

Patient characteristics

Patients undergoing simultaneous oromandibular reconstruction with a DCIAPF at Peking University School and Hospital of Stomatology, China between December 2015 and August 2017 were included in this retrospective study. Patients were eligible for inclusion only if (1) a segmental mandibulectomy had been performed, with simultaneous oromandibular reconstruction with a DCIAPF; (2) the perforators and SCIV of the DCIAPF were clearly seen on Doppler images; and (3) oral soft tissue reconstruction for a defect 4 × 5 cm or larger was required (as these patients would require larger flaps and would be most likely to benefit from venous superdrainage). Twenty-two patients (12 female, 10 male; age range 10–76 years, median age 53 years) met these criteria and were divided into two groups: group A ($n = 11$) comprised patients who received the DCIAPF with SCIV for superdrainage and group B ($n = 11$) comprised patients who received the conventional single-pedicled DCIAPF. Table 1 summarizes the characteristics of the patients in the two groups. This study was approved by the Ethics Committee of Peking University School and Hospital of Stomatology and was conducted under the guidance of international ethical standards (IRB number: PKUSSIRB-20183811). Written informed consent was obtained from all patients.

Harvest of the DCIAPF with and without the SCIV

The anatomy of the terminal cutaneous perforators and SCIV was clarified using a Doppler flowmeter before surgery (Fig. 1). For the surgery, the patient was placed in the supine position under general anaesthesia. The DCIAPF was synchronously elevated using the ablative procedure. A skin flap of appropriate size and shape was raised by retrograde dissection from the terminal musculocutaneous perforator of the deep circumflex artery, including the perforator. The incision started 2 cm above the midpoint of the line between the anterior superior iliac spine and the pubic tubercle and extended up to the upper border of the skin paddle, which was centred on the perforator. The skin paddle was then elevated towards the iliac crest, immediately above the external oblique muscle. The SCIV was usually found in the fat layer near the inferior border of the skin paddle. This approach allows identification of the perforator that emerges from the external oblique muscle anteriorly. The dominant perforator was meticulously dissected free through the abdominal muscles down to the parent

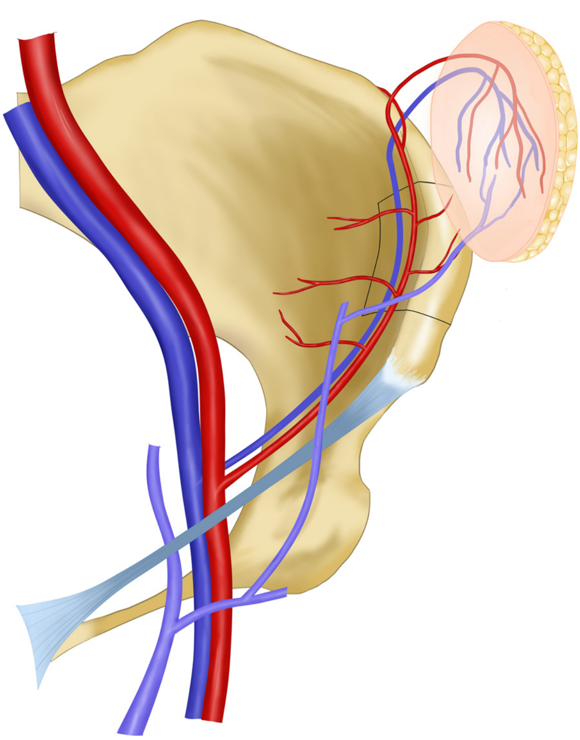

Fig. 1. Schematic presentation of the deep circumflex iliac osteocutaneous flap with the superficial circumflex iliac vein.

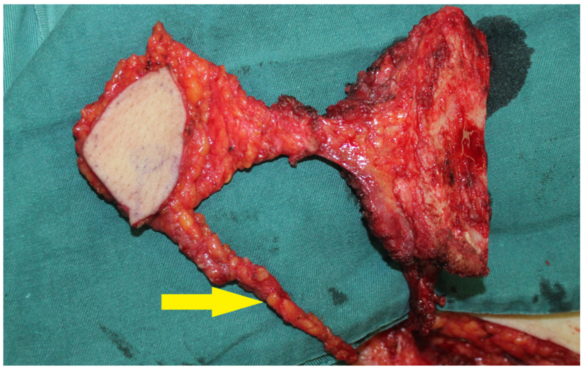

Fig. 2. Harvested deep circumflex iliac artery perforator flap with the superficial circumflex iliac vein (yellow arrow).

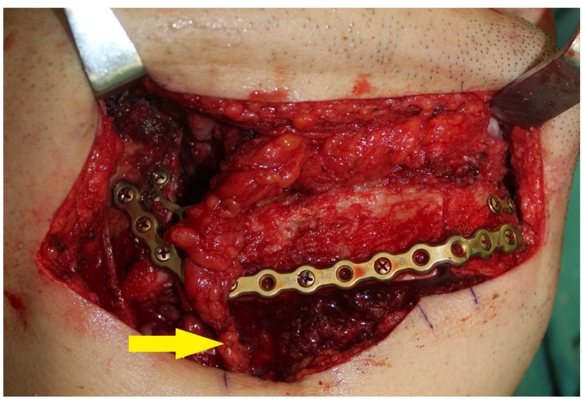

Fig. 3. Oromandibular reconstruction. Deep circumflex iliac artery perforator flap and superficial circumflex vein (yellow arrow) were included in the skin flap and anastomosed to the recipient vessels as superdrainage.

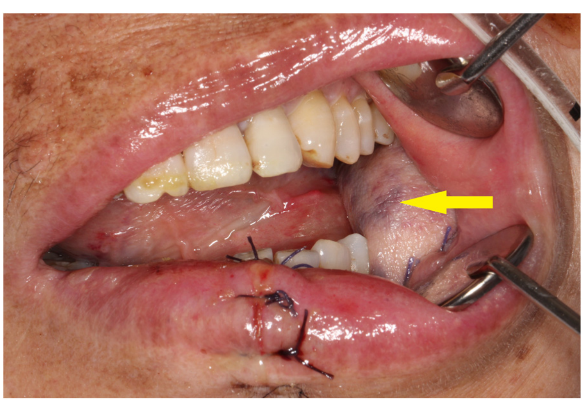

Fig. 4. A purple halo around the puncture without being aggravated (yellow arrow) was considered diagnostic of venous congestion due to relative venous insufficiency.

DCIA. A small cuff of abdominal muscle was left attached to the perforator to help protect it from damage. The SCIV was dissected proximally and distally in the fat layer until a sufficient length was achieved. Once the DCIA perforator and the SCIV were isolated, the inferior border of the skin was incised to cater to the actual need, and the DCIAPF (with/without the SCIV) was elevated. Bone and DCIA were harvested in the usual manner (Fig. 2).

To avoid a ventral hernia, the donor site was directly sutured layer by layer. Patients were advised to wear a waist protector for at least 1 month and to maintain normal bowel movements.

Oromandibular reconstruction

The iliac bone was shaped and fixed to the remaining mandible. The skin island was used to reconstruct the soft tissue defect. The deep circumflex iliac vessels were anastomosed to the ipsilateral neck vessels. In group A patients, the SCIV was included in the skin flap and was anastomosed to the recipient vessel to provide superdrainage (Fig. 3). Heparin for the prevention of vascular embolism was used in all patients during the first 3 days postoperatively.

Outcome assessment

The outcomes examined included venous congestion due to relative venous insufficiency, venous congestion due to venous thrombosis, total and partial skin flap necrosis, wound infection, flap loss, wound dehiscence, and operation time. The appearance of blue or purple plaques on the skin flap and a purple halo around puncture without being aggravated was considered diagnostic of venous congestion due to relative venous insufficiency (Fig. 4). The appearance of blue or purple plaques on the skin flap and a purple halo around puncture with being aggravated or draining blood was considered diagnostic of venous congestion due to venous thrombosis.

Data were summarized as percentages and compared between the groups using Fisher's exact test. Statistical significance was set at $P < 0.05$.

Results

Surgery was technically successful in all patients. The width of the skin paddle ranged from 4 cm to 9 cm, and the length from 6 cm to 12 cm. The length of the bone component ranged from 6 cm to 12.5 cm. The length of the dominant perforators ranged from 4 cm to 7 cm, with calibres of approximately 1.0 mm. Primary closure without skin grafting was performed for all donor sites. Anatomical reconstruction of the contour of the mandible with sufficient length and vertical height was achieved in all patients. During the follow-up after surgery, no flap loss occurred in either group, and there were no serious donor site complications (e.g., hernia, bone fracture, or gait disturbance). Mild donor site pain was reported by three patients. Sensory deficits in the

Table 2. Treatment characteristics of the patients who received the DCIAPF with SCIV for superdrainage (group A) and the patients who received the conventional single-pedicled DCIAPF flap (group B).

Characteristics	Group A	Group B
Classification of the mandibular defect according to Urken[a]		
RB	2	1
BS	2	2
B	5	7
R	2	1
Length of iliac bone (condyle + ramus + body + symphysis) (cm)		
Median	8	8
Range	6–11	6–12
Height of iliac bone (cm)		
Median	2.5	2.5
Range	2–3	2–3
Number of perforators		
One	10	10
Two	1	1
Length of the perforating vessel (cm)		
Median	6	6
Range	4–7	4.5–7
Size of the skin paddle (cm)		
Median	7×8	6.5×8
Range	5×6 to 9×12	4×6 to 8.5×11
Recipient artery (for DCIA)		
Facial artery	4	4
Superior thyroid artery	6	7
Lingual artery	1	0
Recipient vein (for DCIV)		
Facial vein	8	5
Superior thyroid vein	2	2
Anterior jugular vein	1	0
External jugular vein	0	4
Recipient superdrainage vein (for SCIV)		
External jugular vein	10	0
Anterior jugular vein	1	0
Skin island orientation		
Intraoral	10	11
Extraoral	1	0
Operation time (minutes), mean $\pm$ SD	354 ± 51	344 ± 50
Complications of donor site		
Mild donor site pain	2	1
Sensory deficits	2	1

DCIA, deep circumflex iliac artery; DCIAPF, deep circumflex iliac artery perforator flap with iliac crest; DCIV, deep circumflex iliac vein; SCIV, superficial circumflex iliac vein; SD, standard deviation.
[a] RB, ramus-body; BS, body-symphysis; B, body; R, ramus.

distribution of the lateral femoral cutaneous nerve occurred after surgery in three patients; the symptom gradually subsided in two of them. Table 2 summarizes the treatment characteristics of the patients in the two groups.

Venous congestion due to relative venous insufficiency was significantly less common in group A than in group B ($P = 0.045$). The incidence of partial flap necrosis and wound dehiscence did not differ significantly between the groups ($P = 0.238$ and $P = 0.261$, respectively; Table 3). In both groups, wound dehiscence healed with regular dressing. The total operation time was longer in group A than in group B (354 ± 51 minutes vs 344 ± 50 minutes), primarily because the time to finish the anastomosis was longer; however, the difference was not statistically significant ($P = 0.885$).

Discussion

The conventional iliac crest flap has insufficient soft tissue and is therefore not useful for oromandibular reconstruction after oncological ablation. Several, modifications have been suggested to overcome its limitations; for example, the DCIA flap with the internal oblique muscle (with the muscle being used to provide a natural oral lining[2]) and the DCIAPF.

Table 3. Comparison of complications between group A (superdrainage group) and group B (conventional group).

Complication	Group A ($n = 11$)	Group B ($n = 11$)	*P*-value
Venous congestion due to relative venous insufficiency, *n* (%)	0 (0%)	4 (36.4%)	0.045
Partial flap necrosis, *n* (%)	0 (0%)	2 (18.2%)	0.238
Wound dehiscence, *n* (%)	1 (9.1%)	3 (27.3%)	0.261

The DCIAPF has the following advantages: (1) it has a constant location of the perforator, which is present in 92–100% of cases[5–7]. The perforating vessel between the skin flap and the bone was sufficiently long enough to facilitate flap manoeuvrability. (2) It can provide skin flaps on a larger scale as well as a sufficient amount of bone. The exclusion of unnecessary muscular components from the DCIA flap reduces flap bulk; meanwhile, leaving different muscular layers of the abdominal wall in place helps reduce donor site morbidity. (3) The donor site can be closed directly without a skin graft or mesh.

The DCIAPF has greatly facilitated oromandibular reconstruction after oncological resection[7], but as with other flaps nourished by a perforator, venous congestion due to compromised flap circulation and partial skin flap necrosis may occur. In cadaver studies, Cormack and Lamberty[8] found that the average territory of the cutaneous supply of individual musculocutaneous perforators was 22 cm^2. Bergeron et al.[5] found that the average DCIA perforator vascular zone was 31 cm^2. In the present study patients, the skin flap size of most DCIAPFs was >31 cm^2, and so it was important to devise a method to improve skin paddle circulation.

Arterial supercharge and venous superdrainage can both be used to overcome reduced circulation[9–15]. The DCIA is the only parent vessel of the perforator that nourishes the skin island of the DCIAPF; therefore, using another artery for arterial supercharge of the skin island of the DCIAPF is not feasible. However, the SCIV, with its large calibre and sufficient length, is often found in the fat layer near the inferior border of the skin paddle, and so is a convenient option for use as a superdrainage vein in the DCIAPF. Zheng et al. were the first to suggest that the SCIV could be included in the DCIAPF during flap harvesting and anastomosed to improve venous drainage of the composite flap[6]. In the present study, obvious benefits of SCIV superdrainage were the decreased skin island complications such as venous congestion, partial flap necrosis, and wound dehiscence. Although the operation time was slightly longer in patients receiving superdrainage than in those receiving the conventional flap, the difference was not statistically significant.

Taylor et al. found that the adjacent venous territories (venosomes) of the superficial and deep systems were connected by oscillating veins, which are avalvular vessels that allow free flow between the valved channels of the superficial and deep systems[16]. The venous territories are defined by the oscillating veins just as the arterial territories are defined by the choke arteries[17]. The skin island nourished by the perforator of the DCIA originally has two venous drainages; SCIV superdrainage of the flap extends the reliable vascular territory and reduces the risk of congestion, especially beyond the perforator zone. Even if the perforator is injured during dissection, the SCIV will ensure sufficient venous drainage.

In the present study, there was no skin island loss in either group. It should be noted, however, that venous congestion is not the only cause of total skin flap loss; it can also be caused by arterial spasm, but that cannot be prevented by venous superdrainage.

The increased operation time in the superdrainage group could be regarded as a shortcoming of the technique. The use of a coupler might help reduce the time of anastomosis. However, for a surgery that takes about 300 minutes, an additional 10 minutes for anastomosis cannot be deemed to be considerable. Another drawback of the technique is that two separate suitable veins are needed for the anastomosis of SCIV superdrainage and the parent vein; this might be difficult in patients undergoing radical neck dissection.

In conclusion, superdrainage using the SCIV appears to be effective for reducing the incidence of venous congestion due to relative venous insufficiency. The operation time is slightly longer when SCIV superdrainage is performed. The incidence of partial flap necrosis and wound dehiscence were also reduced, but the study sample was too small to demonstrate statistical significance. Further large-scale well-controlled studies are needed to explore the clinical effects of SCIV superdrainage.

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Competing interests

None.

Ethical approval

This study was approved by the Ethics Committee of Peking University School and Hospital of Stomatology (IRB number: PKUSSIRB-20183811).

Patient consent

Informed consent was obtained from all patients.

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