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Additional venous anastomosis in free profunda artery perforator flap transfer using the posterior accessory saphenous vein

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KEYWORDS
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Abstract *Background:* The profunda artery perforator (PAP) flap has recently been widely used for head and neck as well as breast reconstruction. Although this flap has various advantages, its vascular pedicle is relatively smaller and shorter than that of other workhorse flaps such as the anterolateral thigh flap. The posterior accessory saphenous vein (pASV) is a branch of the great saphenous vein, which runs in the posteromedial aspect of the thigh and can be included in the PAP flap. Here, we present the anatomical characteristics of the pASV and feasibility of its use in PAP flap transfers.
Patients and methods: An anatomical study of the pASV was conducted in nine lower extremities of five patients using ultrasonography. Several landmarks such as point A (the point where the pASV crosses the posterior border of the adductor longus muscle), point B (the point where the pASV merges with the great saphenous vein) and the inguinal crease, were marked. Distribution of the pASV was plotted, and several distances were measured. On the basis of the anatomical study, nine free PAP flap transfers were performed.
Results: In the anatomical study, the mean diameter of the pASV was 3.4 and 4.9 mm at points A and B, respectively. The mean available length of the pASV was 9.4 cm. In clinical cases, all flaps completely survived. No flap-related complication was observed. The pASV was included in the PAP flap in eight cases. The mean length of the harvested pASV was 8.6 cm, and the

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mean diameter was 3.3 mm. Indocyanine green angiography showed effective drainage using the pASV alone.
Conclusions: The use of the pASV can be an effective option, particularly for head and neck reconstruction, and its application in various types of reconstructive surgery can be widened.

Introduction

The profunda artery perforator (PAP) flap has recently been widely used for head and neck as well as breast reconstruction because of its various advantages including concealed donor site scar and abundant hairless skin and soft tissue.[1-5] However, its vascular pedicle is relatively smaller and shorter than that of other workhorse flaps such as the anterolateral thigh (ALT) flap. Small veins are often difficult to be anastomosed, particularly in head and neck reconstruction.

The posterior accessory saphenous vein (pASV) is a branch of the great saphenous vein, which drains the posteromedial aspect of the thigh. Therefore, it can be included in the PAP flap anatomically. Here, we present the anatomical characteristics of the pASV and clinical application of its use in PAP flap transfers.

Patients and methods

Anatomical study

Nine lower extremities of five patients (four males and one female) were examined using ultrasonography. First, the pASV was identified in the subcutaneous fat tissue above the adductor longus (AL) muscle. Then, the distribution of the pASV was plotted proximally to the merging point of the great saphenous vein (GSV). Point A (the point where the pASV crosses the posterior border of the AL), point B (the point where the pASV merges to the GSV) and the inguinal crease were marked (Figure 1). Locations of the pASV were evaluated by measuring the following: distance A (the distance from the inguinal crease to point A), distance B (the distance from the inguinal crease to point B), distance C (the distance between the points perpendicular to points A and B along the inguinal crease) and the length of pASV (the length from point A to point B). Diameters of the pASV at points A and B were also measured.

Clinical application

On the basis of the anatomical study, nine free PAP flap transfers were performed from June 2017 to May 2018. Of the total patients, four were males and five were females, with an average age of 65 (range, 40–83) years. Seven of the nine patients underwent head and neck reconstruction, one underwent breast reconstruction and one underwent scar contracture release. The flap was vertically designed in all cases. The follow-up period ranged from 4 to 19 (mean, 9) months. Clinical data are summarised in Table 2.

Operative techniques

Preoperative ultrasonography and CT angiography were performed to evaluate vascular locations and size. Indocyanine green (ICG) lymphography was also performed preoperatively by subcutaneously injecting ICG below the knee to minimise the risk of lymphedema.

The flaps were elevated in a frog-leg position, as previously reported,[6] and vertically designed in all cases to include the pASV in the cranial part of the flap. First, an incision was made on the anterior border of the flap design and posteriorly dissected under the fascia. The pASV was easily identified in the subcutaneous tissue in the proximal region of the flap design. PAP was also identified above the AM in the middle of the flap design. Intramuscular dissection was performed until the length of the pedicle was sufficient. After flap elevation, perfusion was confirmed with ICG angiography and the pin-prick test. By temporarily clamping the comitant veins of the PAP, the pASV was left as the sole drainage route of the flap, and perfusion was evaluated by the flap colour, the pin-prick test and ICG angiography (Movie 1). The flap was then transferred to the defect, and microvascular anastomoses were performed. The donor site was primarily closed.

Results

Anatomical study

Collected data are summarised as follows and are shown in Table 1: distance A: 7.2 (range, 6–8.5) cm; distance B: 7.3 (range, 6–9) cm and distance C: 1.2 (range, 0.5–2) cm. The mean available length of the pASV was 9.4 (range, 8–10) cm. The mean internal diameters were 4.9 (range, 3.9–7.0) mm and 3.4 (range, 2.5–5.4) mm at points B and A, respectively. The pASV had a branching around the posterior border of the AL in all cases.

Clinical application

Clinical data are summarised in Table 2. The flap size ranged from 15 × 7 cm to 22 × 14 cm. The AM muscle was included in three cases. The mean length of the PAP pedicle was 8 cm, and diameters of the PAP artery and vein were 1.8 and 2.1 mm, respectively.

The pASV was included in the PAP flap in eight cases. The mean length of the pASV was 8.6 cm, and the mean diameter was 3.3 mm. ICG angiography showed an effective drainage of the entire flap solely using the pASV. Distance

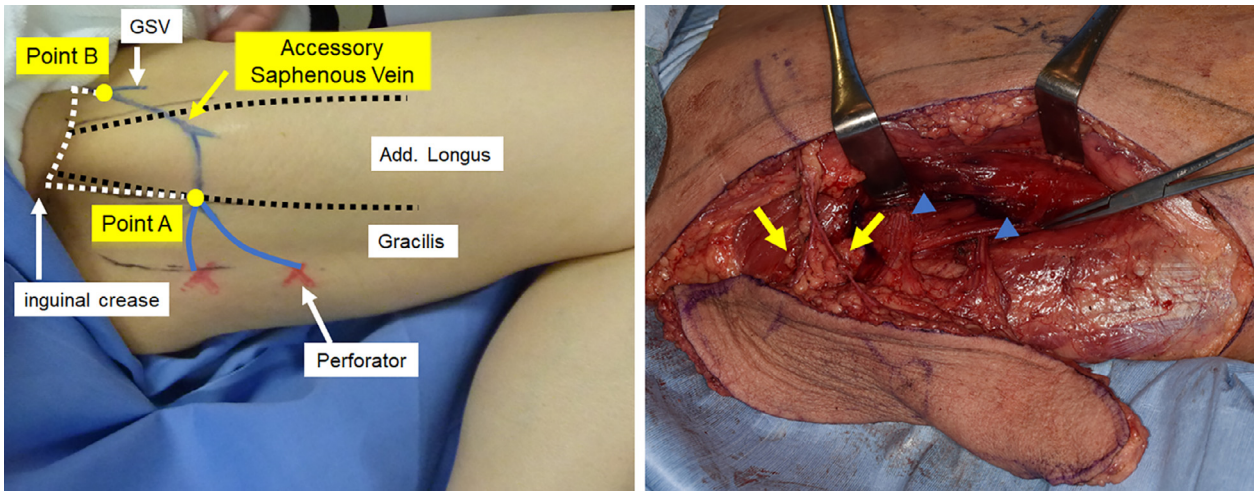

Figure 1 (a) Anatomical study of the pASV showing the relationship between the PAP and the adductor longus muscle. The inguinal crease was first marked, and the distribution of the pASV was plotted using ultrasonography. Point A: The point where pASV crosses the posterior border of the adductor longus. Point B: the point where pASV merges with the great saphenous vein. Distance A: the distance from the inguinal crease to point A. Distance B: the distance from the inguinal crease to point B. Distance C: distance between the points perpendicular to points A and B along the inguinal crease. Length of pASV: the length from point A to point B. (b) Distribution of profunda artery perforators and pASVs in the PAP flap. pASV has several branches distal to Point A. Some of them run obliquely in the posteroinferior direction and the others run in the posterior direction. Yellow arrow: Branches of pASV, Blue arrowhead: Profunda artery perforators.

Table 1 Anatomical study of the accessory saphenous vein.

Case no.	Distance A (cm)	Distance B (cm)	Distance C (cm)	Length (cm)	Diameter 1 (mm) (at point B)	Diameter 2 (mm) (at point A)
1	7	7	1	9	3.9	2.7
2	8.5	6.5	2	9	4.7	2.5
3	7	7.5	1	8	6.4	2.8
4	7	7	2	9	4.8	3.1
5	7	9	1.5	10	5.3	5
6	7	9	0.5	10	7	5.4
7	6	7	1	10	3.7	2.5
8	8	7	1	10	4.5	4
9	7	6	0.5	10	4	3
Average	**7.2**	**7.3**	**1.2**	**9.4**	**4.9**	**3.4**

A was 8.3 cm on average. Regarding microvascular anastomosis, double venous anastomoses were performed in eight cases and triple venous anastomoses were performed in one case. The pASV was used in seven cases.

All flaps completely survived. No flap-related complication was observed. Other complications included aspiration pneumonia in one case and brachial plexus palsy in one.

Case reports

Case 1

A 66-year-old man presented with tongue cancer and underwent hemiglossectomy and neck lymph node dissection. A 16 × 7 cm free PAP flap was designed on the left medial thigh based on preoperative markings of the pASV and PAP (Figure 2) The pASV, with a diameter of 3.0 mm, was found in the subcutaneous tissue at a point 8 cm distal to the inguinal crease and was proximally dissected at 5 cm. A part of the AM muscle was included in the flap to fill a submandibular defect. The flap was then transferred to the defect, and microvascular anastomoses were performed. The pASV was anastomosed to the internal jugular vein (IJV).

The postoperative course was uneventful, and the flap completely survived. Five months after surgery, the patient had a normal diet and no donor site morbidity was observed (Figure 3).

Case 2

An 83-year-old woman presented with buccal mucosal carcinoma. Wide resection of the tumour, marginal resection of the mandible and neck lymph node dissection were performed. A 15 × 7 cm free PAP flap was elevated from the left medial thigh. The pASV was identified at a point 7 cm distal to the inguinal crease and was proximally dissected at 9 cm. The flap was then transferred to the defect, and

Table 2 Summary of the clinical cases.

No.		Diagnosis	Procedure	Flap size (cm)	Length of PAP (cm)	Diameter of PAP (A/V, mm)	Length of pASV (cm)	Diameter of pASV (mm)	Distance A (cm)	Microvascular anastomosis	Recipient vessels	Recipient vein of ASV	Complications	Follow-up (mo.)
1	40F	Breast cancer	Breast reconstruction, removal of tissue expander	23 x 7	6	2.0/2.0	-	-	-	1A2V	TDA, TDV, TDV	-	-	19
2*	83F	Buccal mucosal. ca.	Wide resection, marginal resection of mandible, ND, PAP	15 x 7	10	1.2/2.0	9	2.5	7	1A3V	FA, FV, EJV, EJV	EJV	-	12
3	78F	Lower gingival ca.	Segmental resection of mandible, reconstruction plate, PAP	18 x 6	8	1.2/3.0	8	4	7	1A2V	STA, CFV, IJV	IJV	-	12
4	59M	Maxillary ca.	Total maxillectomy, PAP	22 x 14	10	2/1.5/1.0	8	4	9	1A2V	STpA, STpV, STpV	-	-	6
5	69F	Hypopharyngeal ca.	Partial pharyngectomy, neck dissection, PAP	17 x 6	6	1.2/2	10	2.5	11	1A2V	STA, IJV, CFV	CFV	-	8
6	61M	Oral floor ca.	Marginal resection of the mandible, ND, PAP	21 x 8	8	2.5/2.0	12	3.5	9	1A2V	STA, CFV, MTV	MTV	Aspiration pneumonia	9
7*	66M	Tongue ca.	Hemiglossectomy, ND, PAP	16 x 7	5	2.0/3.0	5	3	8	1A2V	STA, IJV, EJV	IJV	-	5
8	53M	Burn contracture of axilla	Contracture release, PAP	21 x 10	8	2.0/2.0	8	4	8	1A2V	TDA, TDV, ciculflex scapular V	circumflex scapular	Brachial plexus palsy	6
9	76F	Middle pharyngeal ca.	Wide resection, ND, PAP	18 x 7	11	2.0/2.0	9	3	7	1A2V	STA, IJV, AJV	AJV	-	4

ND: neck lymph node dissection, TDA: thoracodorsal artery, TDV: thoracodorsal vein, FA: facial artery, FV: facial vein, STA: superior thyroid artery, CFV: common facial vein, IJV: internal jugular vein, STpA: superficial temporal artery, STpV: superficial temporal vein, MTV: middle thyroid vein, EJV: external jugular vein, AJV: anterior jugular vein.

* Presented in the case report.

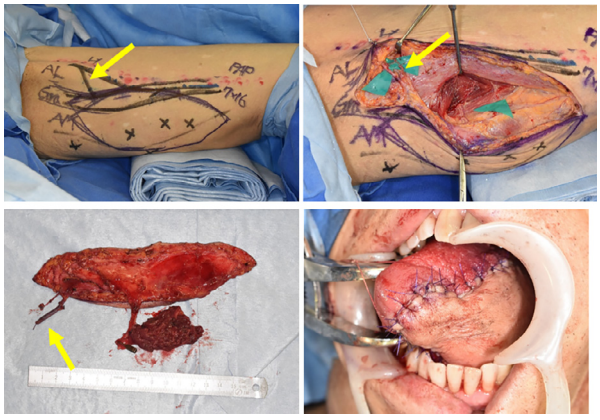

Figure 2 A 66-year-old man with tongue cancer. A free PAP flap was designed on the left thigh based on preoperative markings of the pASV and PAP. The pASV was found in the subcutaneous tissue 8 cm distal to the inguinal crease and dissected 5 cm proximally with a diameter of 3.0 mm. A part of the adductor magnus muscle was also included in the flap to fill a submandibular defect. The flap was then transferred to the defect, and microvascular anastomoses were performed. Arrows: posterior accessory saphenous vein.

Figure 3 Appearance at 5 months postoperatively. The patient had a normal diet, and no donor site morbidity was observed.

microvascular anastomosis was performed. The pASV was anastomosed to the external jugular vein (EJV) (Figure 4).

The postoperative course was uneventful, and the flap completely survived. Twelve months after surgery, the patient had a normal diet and no donor site morbidity was observed (Figure 5).

Discussion

The use of the PAP flap was first reported by Angrigiani et al. in 2001, and various advantages such as concealed donor site scar and abundant hairless skin and soft tissue were observed.[5] It has recently been widely used for various purposes, including breast, limb and head and neck reconstruction. The application of the PAP flap for head and neck reconstruction was first reported by Scaglioni et al. in 2015.[6] Fernandez-Riera has reported that the PAP flap should be considered as a first-line option for hemiglossectomy reconstruction.[2]

Failure rates of the PAP flap usage range from 0% to 9%.[4,6-8] Scaglioni et al. have reported that the flap survival

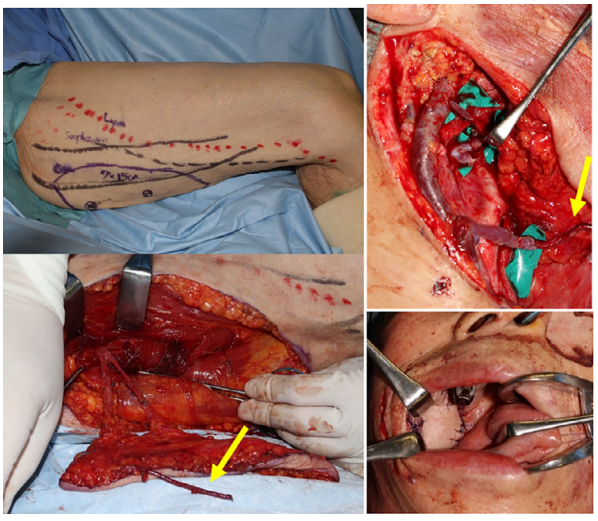

Figure 4 An 83-year-old woman presented with buccal mucosal carcinoma. A free PAP flap was elevated from the left thigh. The pASV was identified at 7 cm distal from the inguinal crease and dissected 9 cm proximally. The pASV was anastomosed to the EJV.

Figure 5 Appearance at 12 months postoperatively. The patient had a normal diet, and no donor site morbidity was observed.

rate for head and neck reconstruction was 95.6%.[6] Furthermore, Hunter has reported two flap losses in 22 free PAP flaps (9.1%) for breast reconstruction,[4] in addition to four cases that had been intraoperatively converted to other flaps because of the lack of adequate PAP vessels. Haddock et al. have reported a flap failure rate of 2.7% in breast reconstruction.[7] One of the reasons for these failures might be the pedicle of the flap, which is relatively smaller and shorter than that of other workhorse flaps such as the ALT flap. Ciudad has reported that the pedicle length of the PAP was 9 cm on average.[2] Haddock et al. have reported that the average size of the PAP pedicle was 1.9 mm.[3] Fernandez-Riera has reported that the average pedicle length was 8.4 cm, and the average diameters of the artery and its comitant veins were 2.0 and 2.3 mm, respectively, at its origin.[2] In contrast, the vascular pedicle of the ALT may be as long as 16 cm, and the diameter of the vein was 2.6 mm.[9] In head and neck reconstruction, the IJV is the most commonly used recipient vein. Therefore, a larger pedicle vein

contributes to a safer flap anastomosis and lower thrombosis incidence.

The pASV is a branch of the GSV and plays a role in the superficial drainage system at the posteromedial aspect of the thigh. Therefore, it can be included in the PAP flap by designing the flap in a vertical style. However, there are no previous reports on its anatomical locations and sizes. Our study showed that the pASV had a larger diameter than that of the comitant vein of the PAP, with a sufficient length. ICG angiography also showed that effective venous drainage can be achieved solely using the pASV in a PAP flap transfer through the clamping test. In this study, the AL was used as a landmark because it is easily palpable, and by using it, the location of the pASV can be estimated without ultrasonography.

The use of the pASV in free PAP flap transfer has two main advantages as follows: first, the pASV has a larger diameter than the comitant veins, which makes microvascular anastomosis easier and safer. Second, because the pASV is located in the proximal region of the flap, venous anastomosis of the pASV can be performed far from the arterial anastomosis site. These advantages are particularly useful in head and neck reconstruction because small veins are often ablated and large veins such as the IJV and EJV are selected as recipient veins; in addition, a longer pedicle is often necessary to reach the recipient vessels. Therefore, pASV could be chosen as the only draining vein of a PAP flap.

Double venous anastomoses have been acknowledged as a safer and more reliable procedure in free flap transfer. Turner has reported that double venous anastomosis in a radial forearm (RF) flap can improve success rates and minimise morbidity in head and neck reconstruction.[10] Ichinose et al. have reported that dual venous anastomosis in the RF flap showed lower venous thrombosis incidence than single venous anastomosis (2.1% vs. 10%).[11] In dual anastomoses, drainage using two independent venous systems showed lower thrombosis incidence than that using two veins of a single venous system (0.6% vs. 9.7%).[11] The PAP flap has a similar condition as the RF flap because two different venous drainage systems exist, namely, the cephalic vein as a superficial venous system and the radial venae comitantes as a deep system. Because the PAP flap has also two different venous drainage systems, dual venous anastomosis can be a fail-safe drainage procedure and contribute in preventing flap failure. On the basis of this concept, we always try to anastomose as many veins as possible.

Because the pASV consistently exists and can offer a longer and larger vein in the PAP flap, the use of the pASV can be an effective option to address the disadvantages of the PAP flap and can widen its application in various types of reconstructive surgery.

The limitation of this study is that in this case series, no pASV was anastomosed as the sole drainage route. Further research is necessary for confirming the validity of the use of ASV.

Conclusions

The feasibility and reliability of the use of the pASV in PAP flap transfer are presented. The use of the pASV can be an effective option, particularly in head and neck reconstruction, and it may widen indications for the application of PAP flaps.

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Informed consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.bjps.2019.09.013.

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