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Septocutaneous thoracodorsal artery perforator flaps: a retrospective cohort study



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KEYWORDS

perforator flap;
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Summary *Background:* This study aimed to investigate the versatility of septocutaneous thoracodorsal artery perforator (TDAP-sc) flaps in various areas in the body and the running pattern of septocutaneous perforators.

Methods: This retrospective cohort study included 20 consecutive patients who underwent reconstruction of an oncological defect with a TDAP-sc flap from May 2014 to January 2018. Fifteen flaps were free, and the remaining five were pedicled. Surgical details and postoperative complications were investigated.

Results: The flap size ranged from 13 × 6.5 to 22 × 15 cm. The defect location was the upper extremity in eight patients, the head and neck in six, the lower extremity in four, and the trunk in two. The septocutaneous perforator arose from the thoracodorsal vessels proximal to the serratus anterior branch in 10 (50.0%) patients, from the thoracodorsal vessels distal to the serratus anterior branch in six (30.0%), and from the serratus anterior branch in four (20.0%). All flaps completely survived, except the one with partial necrosis. The scapula was simultaneously harvested based on the angular branch in three patients who underwent mandibular reconstruction.

Conclusions: The TDAP-sc flap can be a versatile option for various types of reconstruction if a dominant septocutaneous perforator is present. Prevalence of a dominant TDAP-sc is estimated at approximately 50%. However, this flap can be harvested without tedious intramuscular

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dissection, and the two-team approach is possible during tumor resection. The presence of a dominant septocutaneous perforator can expand indication of the TDAP flap.

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Introduction

The use of thoracodorsal artery perforator (TDAP) flaps has become common in every area in the body.¹⁻⁴ Thinness and a low rate of donor site morbidity are the main advantages of the TDAP flap over the latissimus dorsi musculocutaneous flap.^{5,6} The anatomy of the musculocutaneous TDAP is relatively constant.⁷⁻⁹ Previous studies have shown that a dominant musculocutaneous perforator derives most frequently from the descending branch of the thoracodorsal artery.^{7,8} However, the harvest of the musculocutaneous TDAP flap requires a tedious intramuscular dissection of the perforator because of many side branches and proximity to the thoracodorsal nerve.

The presence of the septocutaneous perforator from the thoracodorsal vessels has been reported by several authors.⁸⁻¹³ This type of perforator has a circummuscular course without penetrating the latissimus dorsi muscle. Therefore, the use of a TDAP-sc flap can make tedious intramuscular dissection unnecessary and facilitate TDAP flap harvest. This procedure can also eliminate damage to the latissimus dorsi muscle and the thoracodorsal nerve. In this retrospective cohort study, we analyzed our clinical experience with 20 TDAP-sc flaps that were used for the reconstruction of various oncological defects.

Materials and Methods

This study was conducted according to the STROBE guidelines for cohort studies. We studied 20 consecutive patients who underwent transfer of a TDAP-sc flap for the reconstruction of an oncological defect from May 2014 to January 2018 at the National Cancer Center Hospital, Tokyo, Japan. There were 11 male and nine female patients with a mean age of 62.5 years (range: 41-82 years). There were 15 free flaps and five pedicled flaps.

Surgical technique

The presence and location of TDAPs were investigated by color Doppler ultrasonography preoperatively. If a large septocutaneous perforator was found with color Doppler ultrasonography, elevation of the TDAP-sc flap was attempted. The TDAP-sc flap is usually designed including the septocutaneous perforator at the proximal third or quarter of the flap. We used this eccentric design not because we attempted to increase the pedicle length, but because a dominant septocutaneous perforator usually has a long suprafascial course after emerging from the anterior border of the latissimus dorsi muscle (Figure 1). The first incision was made on the posterior border of the flap when the patient was in the lateral decubitus or prone position and on the

anterior border when the patient was in the lateral position. The dominant septocutaneous perforator was examined along the anterior border of the latissimus dorsi muscle. Once the dominant septocutaneous perforator was secured, the dissection of the vascular pedicle was straightforward. There were three types of origin of the TDAP-sc as follows: from the thoracodorsal vessels proximal to the serratus anterior branch (proximal-TD type), from the thoracodorsal vessels distal to the serratus anterior branch (distal-TD type), and from the serratus anterior branch (SA type) (Figure 2). After completing dissection of the pedicle, the entire periphery of the flap was incised, and the flap was elevated based on the perforator (Figure 3) (Video 1).

Evaluation

The medical records of the 20 patients were analyzed for the following variables: sex, age, defect location, patient's position during harvesting the flap, flap size, number of perforators, origin of the perforator, transfer with or without the scapula, inclusion of the lateral thoracic vein, method of donor site closure, and postoperative complications.

Results

The patients' characteristics and surgical details are shown in Table 1. The defect was in the upper extremity in eight patients, the head and neck in six, the lower extremity in four, and the trunk in two. All pedicled TDAP-sc flaps were used for shoulder reconstruction.

The flap was harvested in the lateral decubitus position in 12 patients, the supine position in five, the prone position in two, and the lithotomy position in one. Five of the six head and neck cases did not require a positional change during the operation. The flap size ranged from 13 × 6.5 to 22 × 15 cm. The flap was harvested with one septocutaneous perforator in 19 patients and with two septocutaneous perforators in one patient. The origin of the dominant septocutaneous perforator was the proximal-TD type in 10 (50.0%) patients, the distal-TD type in six (30.0%), and the SA type in four (20.0%) (Figures 4 and 5). The scapula was simultaneously harvested based on the angular branch in three patients who underwent immediate mandibular reconstruction. The lateral thoracic vein was used as a second drainage vein in three free flaps. The donor site was closed primarily in 17 patients and with a skin graft in three patients.

Wound complications

No anastomotic failure or exploration of the flap in the operating room occurred postoperatively. Partial necrosis of the

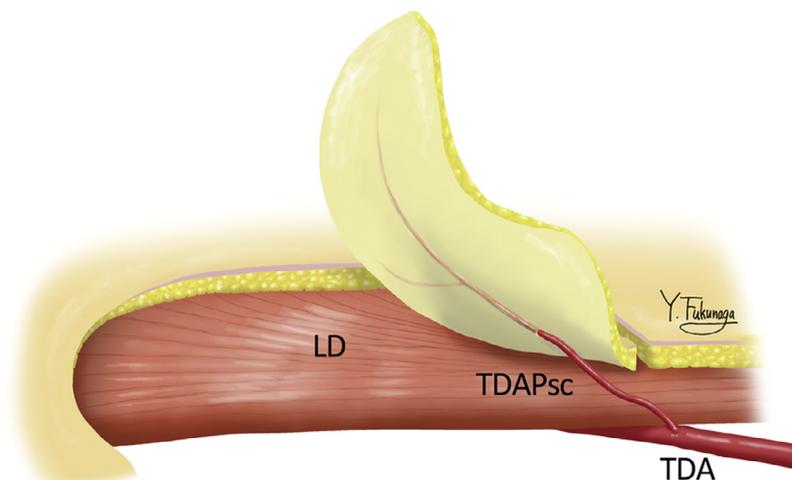


Figure 1 Diagram showing the typical running pattern of the septocutaneous thoracodorsal artery perforator. The perforator usually has a long suprafascial course after emerging from the anterior border of the latissimus dorsi muscle. TDA: thoracodorsal artery, LD: latissimus dorsi muscle, TDAPsc: septocutaneous thoracodorsal artery perforator.

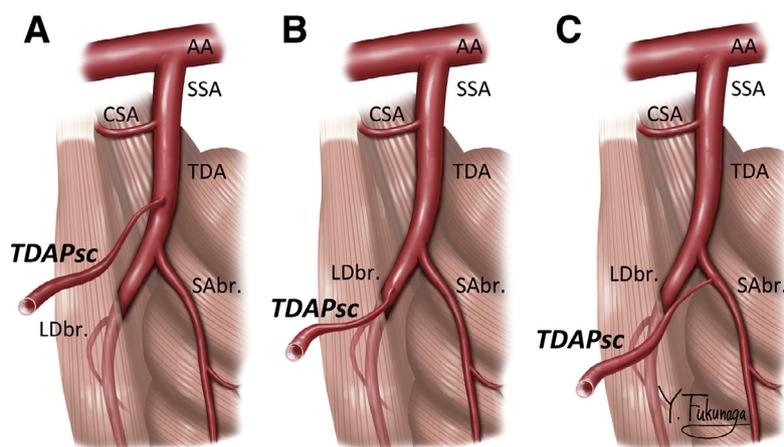


Figure 2 Variations of the origin of the septocutaneous thoracodorsal artery perforator. (A) Origin from the thoracodorsal vessels proximal to the serratus anterior branch (proximal-TD type). (B) Origin from the thoracodorsal vessels distal to the serratus anterior branch (distal-TD type). (C) Origin from the serratus anterior branch (SA type). AA: axillary artery, SSA: subscapular artery, CSA: circumflex scapular artery, TDA: thoracodorsal artery, LD br.: latissimus dorsi branch, SA br.: serratus anterior branch, TDAPsc: septocutaneous thoracodorsal artery perforator.

free TDAP-sc flap occurred in one patient. In this case, we did not include the lateral thoracic vein into the flap, and the distal third of the flap suffered from necrosis because of arterial insufficiency. The flaps completely survived in the remaining patients. Surgical site infection occurred in two patients who underwent head and neck reconstruction. A hematoma at the recipient site and an orocutaneous fistula occurred in one patient each. No donor site complications occurred.

Case reports

Case 1

An 82-year-old man presented with myxofibrosarcoma of his right arm. Wide excision of the tumor resulted in an 18 × 16-cm skin defect around the elbow. A 24 × 14-cm free TDAP-sc flap was harvested from the ipsilateral back. The lateral thoracic vein was also included in the flap. The thora-

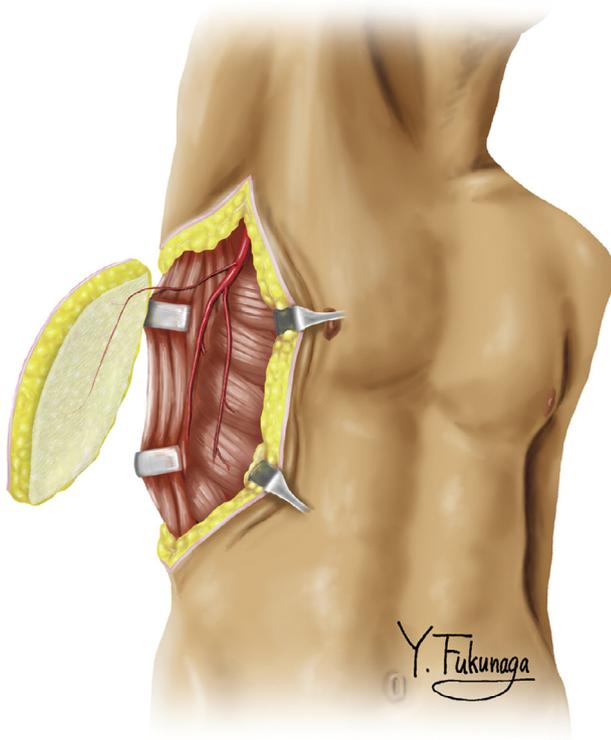


Figure 3 Diagram of the septocutaneous thoracodorsal artery perforator flap.

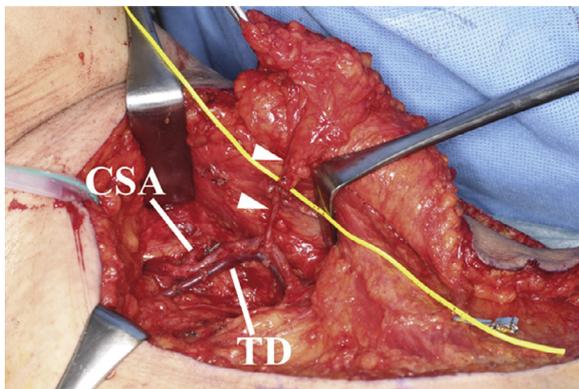


Figure 4 Intraoperative appearance of the proximal-TD type perforator (arrowheads) during harvesting of the left septocutaneous thoracodorsal artery perforator flap. The left side is craniad. CSA: circumflex scapular artery, TD: thoracodorsal vessel.

codorsal vessels were anastomosed to the radial vessels in a flow-through fashion, and the lateral thoracic vein was anastomosed to the cutaneous vein in an end-to-end fashion. After revascularization, the skin defect was closed with the flap in layers. The donor site was closed with a skin graft.

The postoperative course of the patient was uneventful. One year after the operation, the patient was free of disease, and the range of motion of his right elbow recovered fully (Figure 6).

Table 1 Patients' characteristics and surgical details

		No. of patients (%)
Sex	Male	11 (55.0)
	Female	9 (45.0)
Age (years)	40-49	4 (20.0)
	50-59	4 (20.0)
	60-69	5 (25.0)
	70-79	5 (25.0)
	80-89	2 (10.0)
Defect location	Shoulder	5 (25.0)
	Mandible	4 (20.0)
	Elbow	3 (15.0)
	Thigh	2 (10.0)
	Lower leg	2 (10.0)
	Cheek	2 (10.0)
	Back	1 (5.0)
	Perineum	1 (5.0)
Patient's position	Lateral decubitus	12 (60.0)
	Supine	5 (25.0)
	Prone	2 (10.0)
	Lithotomy	1 (5.0)
Flap type	Free	15 (75.0)
	Pedicled	5 (25.0)
Number of perforators	One	19 (95.0)
	Two	1 (5.0)
Origin of the perforator(s)	Proximal-TD	10 (50.0)
	Distal-TD	6 (30.0)
	SA	4 (20.0)
Inclusion of the scapula	Yes	3 (15.0)
	No	17 (85.0)
Inclusion of the lateral thoracic vein	Yes	3 (15.0)
	No	17 (85.0)
Wound complications	SSI	2 (10.0)
	Partial necrosis of the flap	1 (5.0)
	Hematoma	1 (5.0)
	Orocutaneous fistula	1 (5.0)

TD: thoracodorsal, SA: serratus anterior, SSI: surgical site infection.

Case 2

A 53-year-old man presented with a radiation ulcer of his lower back. He underwent radiation therapy (60 Gy) for the treatment of a giant cell tumor of the sacrum 19 years earlier. The tumor completely disappeared. However,

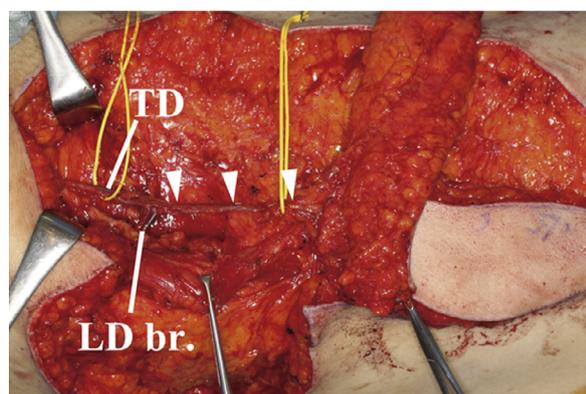


Figure 5 Intraoperative appearance of the distal-TD type perforator (arrowheads) during harvesting of the right septocutaneous thoracodorsal artery perforator flap.

The left side is craniad.

TD: thoracodorsal vessels, LD br.: latissimus dorsi branch.

a radiation-induced ulcer occurred at the affected skin 2 years earlier. He desired to undergo skin resurfacing because of intractable pain. Debridement of the ulcer resulted

in an 18 × 10-cm skin defect. A 24 × 9-cm free TDAP-sc flap was harvested from the right back with the patient in the prone position. The flap vessels were anastomosed to the branches of the right superior gluteal vessels. After revascularization, the skin defect was closed with the flap in layers. The donor site was closed primarily.

The postoperative course of the patient was uneventful. Nine months after the operation, the patient was free of recurrence of the ulcer, and his pain was almost completely relieved (Figure 7).

Discussion

Previous anatomical studies have shown that the septocutaneous thoracodorsal perforator can be found in 55-60% of cadavers. Heitmann et al. reported that a direct cutaneous branch originating from the thoracodorsal artery before the neurovascular hilus was present in 55% of specimens.⁸ Thomas et al. reported that the septocutaneous perforator arose from the thoracodorsal artery, which was identified near the lateral border of the muscle, in 60% of dissections.¹² However, the clinical use of the septocutaneous perforator has not been established yet, and little has been reported on the clinical application of TDAP-sc flaps.

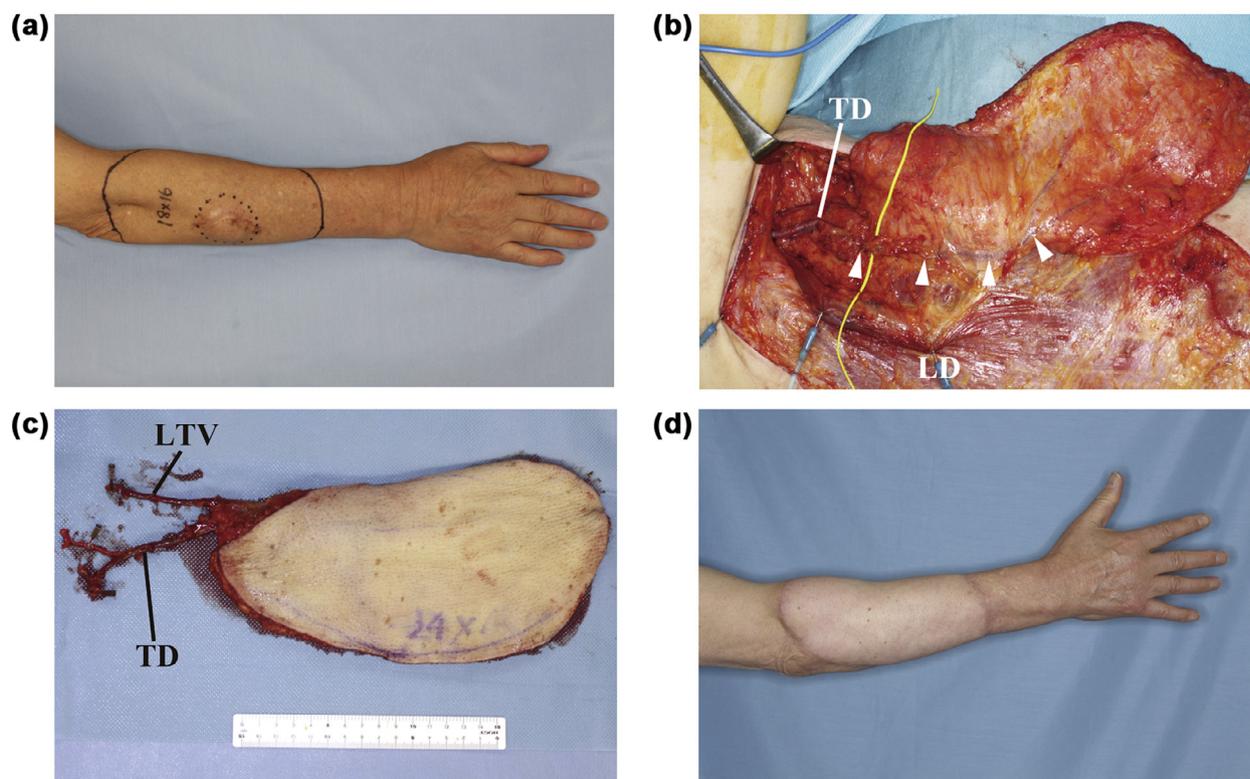


Figure 6 Case 1.

(A) Preoperative appearance of the patient.

(B) Intraoperative appearance during harvesting of the septocutaneous thoracodorsal artery perforator flap. The left side is craniad. Arrowheads show the septocutaneous thoracodorsal artery perforator.

TD: thoracodorsal vessel, LD: latissimus dorsi muscle.

(C) Harvested flap.

TD: thoracodorsal vessel, LTV: lateral thoracic vein.

(D) Follow-up appearance of the patient at 1 year.

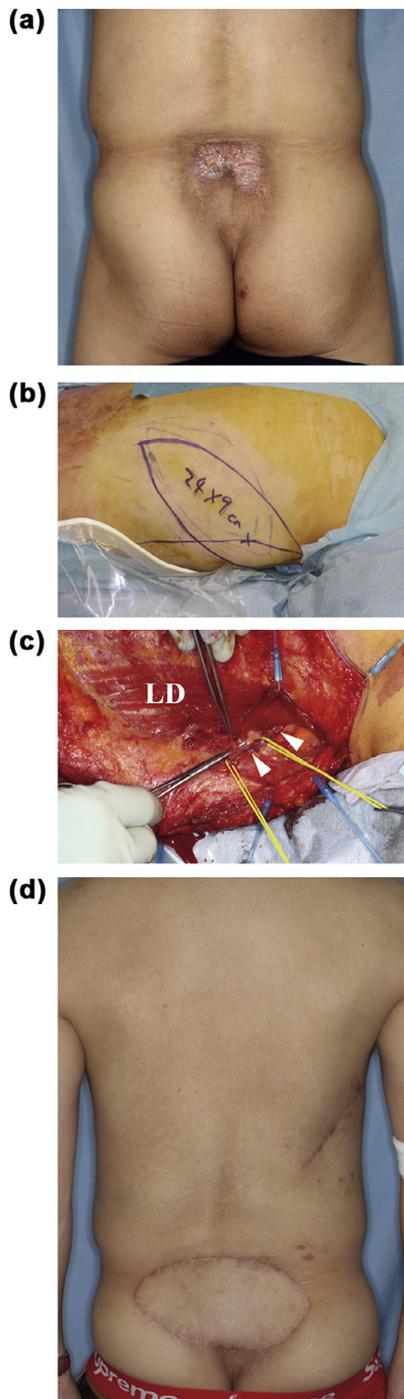


Figure 7 Case 2.

(A) Preoperative appearance of the patient.

(B) Design of the flap with the patient in the prone position. The right side is craniad.

(C) Intraoperative appearance during dissection of the septocutaneous thoracodorsal artery perforator (arrowheads). The right side is craniad.

LD: latissimus dorsi muscle.

(D) Follow-up appearance of the patient at 9 months.

Kim et al. reported their experiences of 56 TDAP flaps, and 14 (25%) of them were TDAP-sc flaps.¹¹ They reported that the location and size of the septocutaneous perforator are more consistent than those of the musculocutaneous perforator. However, Mun et al. did not recommend the use of septocutaneous perforators because of variation in the perforator course, a shorter pedicle length, and relatively inferior perforator size.⁹

The current study showed that the TDAP-sc flap could be a versatile option for various types of reconstruction if a sizable septocutaneous perforator is present. We performed 40 TDAP flap transfers during the study period. Of them, 20 (50.0%) flaps were TDAP-sc flaps. This ratio is consistent with that reported in previous anatomical studies. However, the actual prevalence of a dominant septocutaneous perforator may be higher than our rate because we did not intend to find or use the septocutaneous perforator in earlier cases. Recently, the use of the septocutaneous perforator became the first choice when TDAP flap harvest was attempted. The musculocutaneous perforator is examined only when a dominant septocutaneous perforator is absent. To the best of our knowledge, previous studies have not discussed the running pattern of the TDAP-sc. We observed that the origin of the dominant septocutaneous perforator varied and there were three types. A novel finding of the current study is that the dominant septocutaneous perforator arose not from the main stem of the thoracodorsal vessels, but from the serratus anterior branch in 20.0% of cases. These results could be important in preoperative localization and intraoperative exploration of the septocutaneous perforator.

The main advantage of the TDAP-sc flap over the musculocutaneous TDAP flap is that it precludes tedious intramuscular dissection. An intramuscular dissection of the musculocutaneous TDAP is technically demanding because there are many tiny branches, and branches of the thoracodorsal nerve run along the side of this perforator. Another advantage of the TDAP-sc flap is that it can be harvested with the patient in the supine position. This feature enables the two-team approach during head and neck tumor resection. Additionally, the scapula based on the angular branch can be harvested simultaneously with the TDAP-sc flap without positional change. Another advantage of the TDAP-sc flap is that the lateral thoracic vein can be incorporated into the flap as an additional drainage vein. The lateral thoracic vein usually runs parallel and anterior to the TDAP-sc. Therefore, the design of the TDAP-sc flap usually includes the lateral thoracic vein. Double venous anastomosis using the thoracodorsal vein and the lateral thoracic vein can improve the safety of TDAP-sc flap transfer.^{14,15}

The main disadvantage of the TDAP-sc flap is that a sizable septocutaneous perforator is not always present. In such cases, conversion to the musculocutaneous TDAP flap or the latissimus dorsi musculocutaneous flap becomes necessary. Another disadvantage of the TDAP-sc flap is that no reliable size limit of the flap has been established yet, as well as for the musculocutaneous TDAP flap.¹⁶ In the current study, six large TDAP-sc flaps (≥ 20 cm long) completely survived. However, partial necrosis occurred in one case with a relatively small flap (14 × 7 cm). In this case, we elevated the flap on the basis of a relatively small perforator, which was thought to be the cause of partial necrosis. These results suggest that the survival area of the TDAP-sc flap

varies depending on the size of the perforator. Several perforators are encountered during dissection around the lateral border of the latissimus dorsi muscle, and the size of these perforators varies widely. We do not have strict criteria for selecting perforators, but we usually choose a large perforator with visible pulsation. A small flap can survive with a tiny perforator,¹⁷ but a large flap requires a dominant perforator. The presence or absence of a dominant TDAP-sc should be determined with preoperative color Doppler ultrasonography.

The main limitation of the present study is its small sample size. We are unable to draw a definite conclusion from only a series of 20 patients. Further studies are warranted to determine the prevalence and detailed anatomy of the TDAP-sc. Another limitation is the lack of a control group. A comparative study between the TDAP-sc flap and musculocutaneous TDAP flap is necessary to validate the superiority of the TDAP-sc flap.

Conclusions

The TDAP-sc flap can be a versatile option for reconstruction in many areas of the body if a dominant septocutaneous perforator is present. This flap can be harvested without tedious intramuscular dissection, and the two-team approach is possible during tumor resection. Further anatomical studies with this perforator are required to make this option more popular.

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Conflict of interest

none.

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none

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.bjps.2018.08.026](https://doi.org/10.1016/j.bjps.2018.08.026).

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