Serratus Anterior Venous Tributary as a Second Outflow Vein in Latissimus Dorsi Free Flaps

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ABSTRACT

The latissimus dorsi (LD) flap is a large and reliable myocutaneous flap with a consistently long vascular pedicle. However, the limitation of the thoracodorsal pedicle is that it has only one draining vein for anastomosis. We describe a simple technique of recruiting the tributary vein to the serratus anterior and using it as a second draining vein to alleviate congestion in lower limb reconstruction. The serratus anterior venous tributary segment is cut back to an avalvular segment which averages 5 mm in length. Provision of an additional venous outflow to the flap enabled a second venous anastomosis to the short saphenous vein ($n = 1$), the long saphenous vein ($n = 2$), a deep vein ($n = 1$), and to a deep vein via a vein graft ($n = 1$), respectively. Five patients with degloving injury of the lower extremity of sizes 150 cm^2 (10×15 cm) to 260 cm^2 (10×26 cm) underwent successful reconstruction using the LD muscle flap with the serratus anterior tributary vein as a second outflow vein. This serratus anterior venous tributary serves as a useful second outflow channel for alleviating venous congestion during lower limb reconstructive surgery and should be routinely preserved as a lifeboat.

KEYWORDS: Latissimus dorsi, serratus anterior vein, venous congestion

Venous congestion is the commonest cause of lower limb free flap failure.[1,2] One method of reducing the occurrence of venous congestion in lower extremity free flaps is to have multiple venous outflow channels. The lower extremity has deep and superficial veins from which two or three good recipient veins may be chosen. These veins must be untouched by trauma, infection, and have large caliber. Flaps with multiple veins such as the anterior lateral thigh and radial forearm lend themselves well to this technique.

The latissimus dorsi (LD) flap with its large expanse of muscle is a workhorse flap for lower extremity reconstruction.[3,4] Anatomical studies have shown that 96% of the thoracodorsal system consist of a single artery and vein. Only 4% of the thoracodorsal veins present as two venae comitantes. When a recipient vein drains poorly, venous congestion occurs and this can lead to thrombosis and flap failure. Common steps taken to rectify the situation include revising the anastomosis or switching veins, both of which prolong ischemic time.

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We propose the use of the serratus tributary vein as a second venous outflow in such situations.

OPERATIVE TECHNIQUE

The LD flap is outlined and elevated in the usual fashion until the pedicle is visualized. The serratus tributary is then identified, mobilized, and divided, 1.5 cm from its branching point (Fig. 1).

The flap is revascularized by end-to-side anastomosis to the posterior tibial or anterior tibial artery, depending on the quality of the vessel. Two recipient veins are routinely prepared, and the better vein is chosen for anastomosis to the thoracodorsal vein. It should be of large caliber, and have good backflow after saline infusion. The vein is usually a deep vein, the long or short saphenous vein. Anastomosis is done end-to-end and once completed, the tourniquet is released and the flap's circulation is checked.

After an initial passage of desaturated blood, the color of the blood in the thoracodorsal vein should be pinkish. Temporary venous hold-up is relieved by rewarming, topical papaverine, and adventitial release.

Occasionally, venous congestion can develop. This manifests as ballooning of the thoracodorsal vein and darkening of the blood within it. This indicates its inability to cope and in this situation, we do not hesitate to cut back the serratus anterior tributary till venous blood drains (Fig. 1A, B). For this to happen, the vein has to be shortened to an avalvular stump, which measures on average 5 mm. We then prepare it for a second venous anastomosis, which is accomplished with 10/0 nylon using the back-wall up technique.

During the flap inset, proximal LD is used as a roof to cover the site of vessel anastomosis. This ensures tension-free closure over the vessels and that the lie of the vessels is not disturbed.

PATIENT SUMMARIES

Five patients underwent reconstruction of lower limb defects with a free LD myocutaneous flap, incorporating the serratus anterior venous tributary as a second vein for drainage. The patients ranged from 22 to 46 years of age. The size of the flap ranged from 150 cm^2 (10×15 cm) to 260 cm^2 (10×26 cm) (Table 1). All five free LD flaps survived completely and all the patients recovered uneventfully.

CASE REPORTS

Case 1

A 25-year-old Chinese woman sustained a Gustilo 3B left ankle open fracture with a soft tissue defect of 10×15 cm exposing the medial malleolus and the posterior heel (Fig. 2A–D). Stabilization of the fracture was achieved with an external fixator. Open reduction and internal fixation was subsequently performed with plates and screws. A latissimus muscle flap was harvested to resurface the defect. The serratus anterior pedicle was dissected and the serratus anterior venous tributary was raised with the flap. The thoracodorsal artery was anastomosed end-to-end to the posterior tibial artery, while the thoracodorsal vein was anastomosed to the venae comitantes. After a single venous anastomosis was performed, the donor vein ballooned up and the flap was congested. The serratus anterior venous tributary was cutback to a length devoid of valves and the serratus anterior vein stump was anastomosed to the short

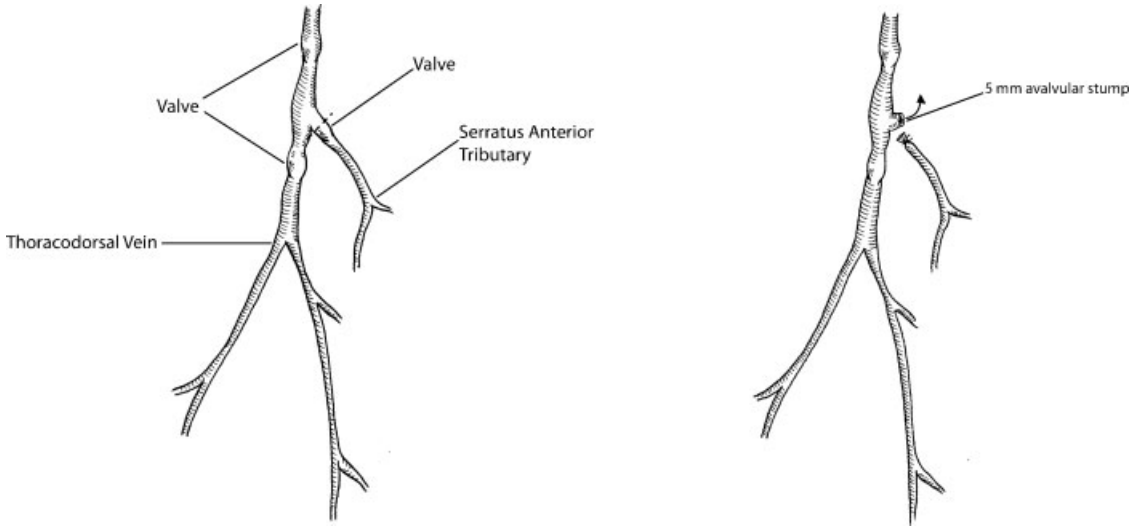

Figure 1 Diagram of thoracodorsal vein with serratus anterior tributary. (Stippled line indicates cut back to avalvular segment, leaving a 5-mm side branch). The venous stump is reangled orthogradely by 45 to 60 degrees to facilitate anastomosis to the recipient vein.

Table 1 Patient Data

						Anastomosis			
Case	**Age**	**Gender**	**Defect**	**Defect Size**	**Flap**	**Artery**	**Vein**	**Vein Stump Length**	**Results**
1	25	F	Lower 1/3 of leg involving posterior medial aspect of leg	10 × 15 cm	LD muscle flap with SSG	Thoracodorsal artery end-to-end to posterior tibial artery	Thoracodorsal vein end-to-end to venae comitantes; Serratus anterior vein stump end-to-end to short saphenous vein	5 mm	Flap survived. Recovery uneventful.
2	34	F	Dorsal half of the proximal left foot	13 × 17 cm	LD muscle flap with SSG	Thoracodorsal artery end-to-side to the posterior tibial artery	Thoracodorsal vein end-to-end to the long saphenous vein; Serratus anterior vein stump end-to-end to the deep vein via a vein graft	5 mm	Flap survived. Recovery uneventful.
3	46	M	Proximal 2/3 of the plantar foot	10 × 26 cm	LD muscle flap with SSG	Thoracodorsal artery end-to-side to the posterior tibial artery	Thoracodorsal vein end-to-end to the short saphenous vein; Serratus anterior vein stump end-to-end to the long saphenous vein	5 mm	Flap survived. Recovery uneventful.
4	40	M	Proximal 2/3 of the plantar foot	9 × 20 cm	LD muscle flap with SSG	Thoracodorsal artery end-to-side to the posterior tibial artery	Thoracodorsal vein end-to-end to the venae comitantes; Serratus anterior vein stump end-to-end to the venae comitantes	4 mm	Flap survived. Recovery uneventful.
5	22	M	Right distal plantar and heel	7 × 25 cm	LD muscle flap with SSG	Thoracodorsal artery end-to-end to dorsalis pedis artery	Thoracodorsal vein to venae comitantes; Serratus anterior vein stump end-to-end to long saphenous vein	4 mm	Flap survived. Recovery uneventful.

LD, latissimus dorsi; SSG. split skin graft.

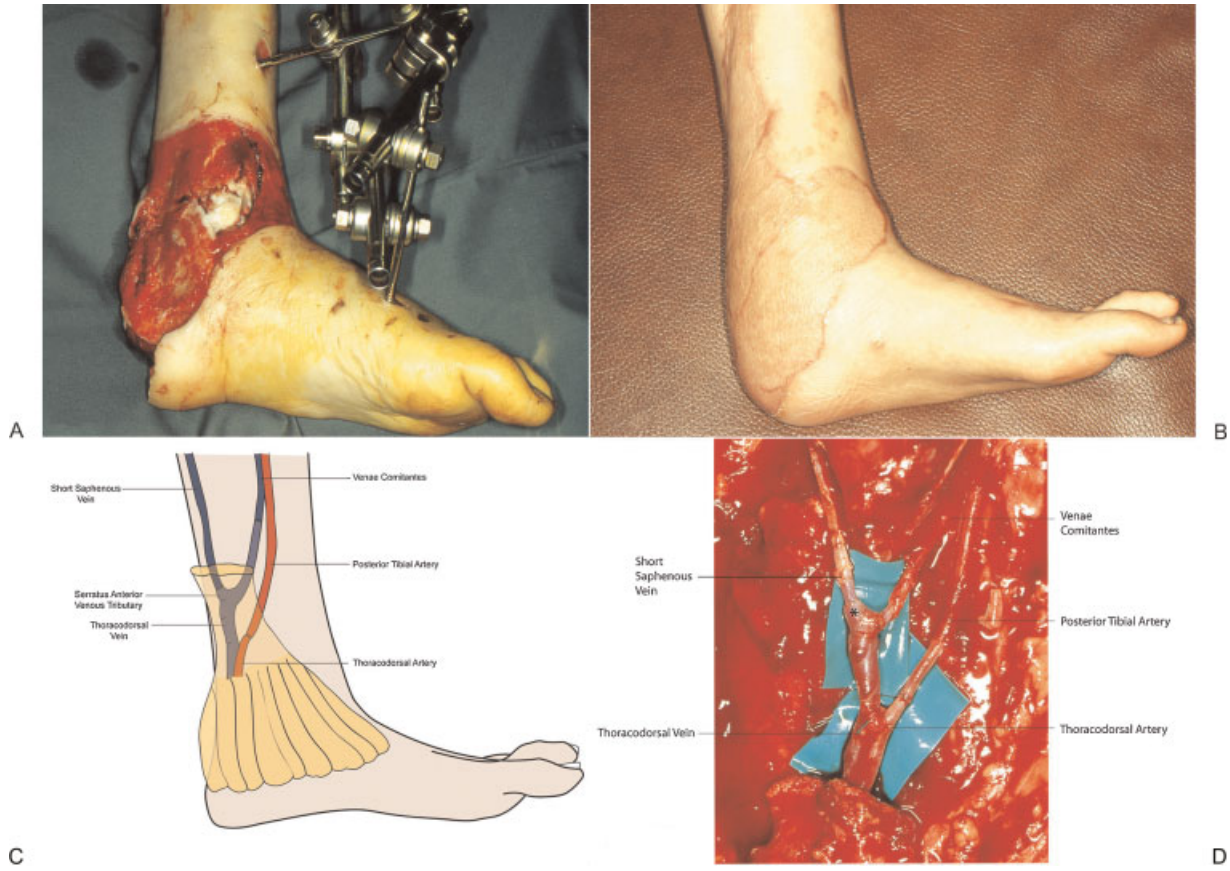

Figure 2 (A) Case 1. Ankle defect exposing medial malleolus and posterior heel. (B) Postoperative result after coverage of defect with 10 × 15 cm latissimus dorsi (LD) muscle flap with split skin graft (SSG). (C) Illustration of microsurgical anastomosis of LD flap to posterior tibial vessels. (D) Anastomosis. (*) denotes anastomosis of serratus anterior tributary stump to short saphenous vein. The other venous anastomosis is to the venae comitantes.

saphenous vein. The resultant vein stump was 5 mm long. The LD flap was pink and perfusion was good after completion of the anastomosis. Split thickness skin graft was harvested from the ipsilateral thigh to cover the muscle. The donor site over the back was closed primarily.

The postoperative course was uneventful. The donor wounds were healed in 10 days and the skin graft took well. The patient recovered and was able to walk after another 3 weeks.

Case 2

A 34-year-old Chinese woman sustained a degloving injury of the left foot after being rolled over by a car (Fig. 3A–D). There was full thickness skin loss measuring 13 × 17 cm over the dorsum of the foot up to the level of the ankle exposing the extensor tendons and the ankle joint. A latissimus muscle flap was harvested to resurface the defect. The thoracodorsal artery was anastomosed end-to-side to the recipient posterior tibial artery, while the thoracodorsal vein was anastomosed to the long saphenous vein. Swelling of the recipient vein and venous congestion of the flap was noticed after completion of the first venous anastomosis. Due to the extensive injury, the venae comitantes did not have sufficient length to reach the LD pedicle. Consequently, the serratus anterior vein stump was cut back and anastomosed to the venae comitantes via a vein graft. The second venous anastomosis alleviated the venous congestion.

The patient recovered uneventfully. Her donor sites healed well and she was able to ambulate without crutches after 4 weeks. A postoperative picture (Fig. 3B) shows a satisfactory aesthetic, as well as, functional result 5 years after her surgery.

DISCUSSION

Avoiding venous thrombosis is a prerequisite to free flap success in the lower extremity. In an analysis of 50 free flap failures in the extremity, Culliford et al showed that venous thrombosis was the predominant cause (32%), followed by infection (18%), arterial thrombosis (14%), and hematoma (8%).[2] The overall failure rate in 588 patients was 8.5%, a figure that conforms to established standards worldwide.

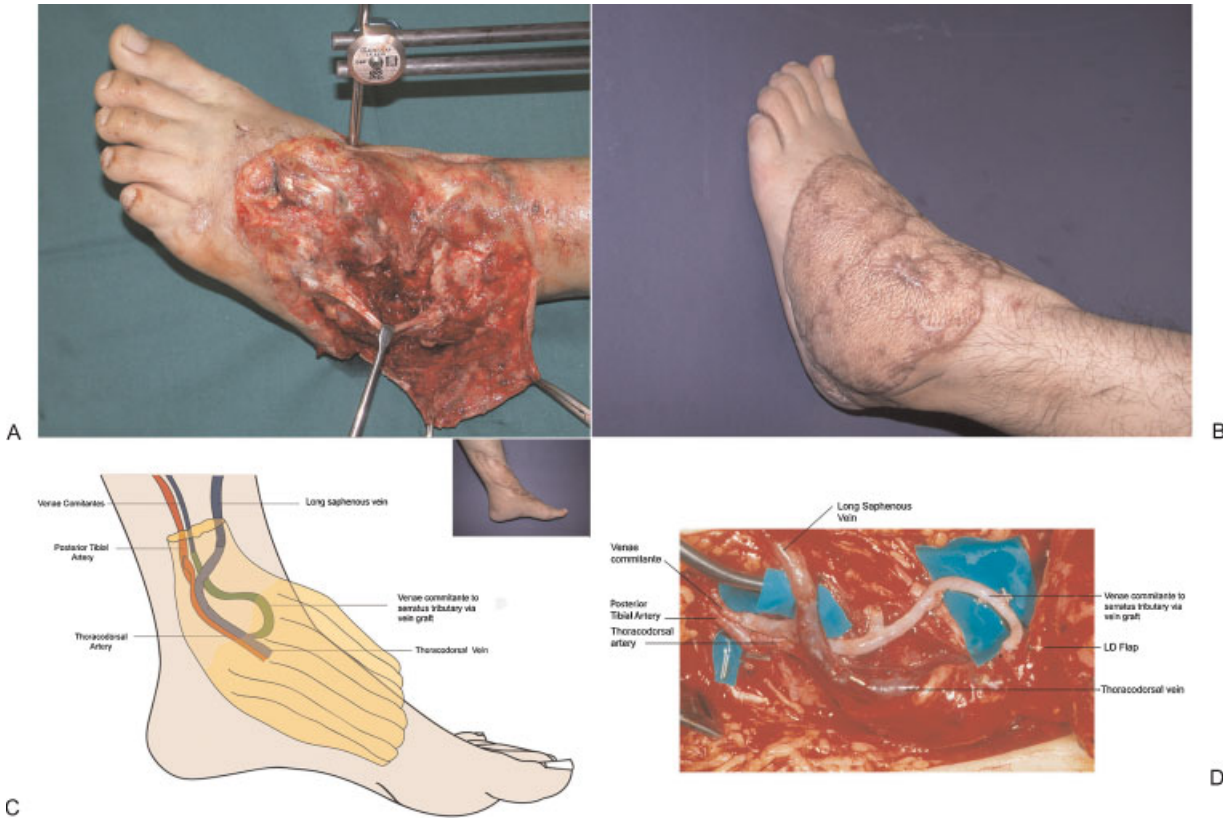

Figure 3 (A) Case 2. Degloving injury of the foot involving dorsum of foot exposing extensor tendons and ankle joint. (B) Postoperative result after reconstruction with a 13 × 17 cm latissimus dorsi (LD) flap. (C) Illustration of microsurgical anastomosis of LD flap to posterior tibial vessels. (D) Anastomosis. (*) denotes anastomosis of serratus anterior tributary stump to venae comitantes via a vein graft. The other venous anastomosis is to the long saphenous vein.

Factors that predispose to venous stasis in the lower extremity include inactivity of the calf pump, phlebitis, venous spasm, and caliber mismatch between donor and recipient veins.

One way of alleviating congestion is to have an additional vein to drain the flap. Barring a lack of recipient veins, a second venous anastomosis is easily accomplished with dual vein flaps such as the gracilis, anterolateral thigh, rectus abdominis, and radial forearm, to name but a few of the common workhorse flaps.

In a single vein flap such as the LD, preserving the serratus stump affords a readily available second outflow channel. Since it is a side branch, the second anastomosis is accomplished without occluding the main vein. Hence, flow is always maintained. Direct anastomosis to the second recipient vein is not always possible due to the short length of the vein stump. We used a vein graft in one case.

We have observed that the thoracodorsal vein is a thin-walled vein which has a propensity to expand into a varicosity when flow in the recipient vein is poor. If left unchecked, a clot quickly forms at the suture line and extends into the intramuscular venous network.

Of our five cases, three developed venous congestion on the table and the situation was instantaneously relieved by our technique. It eliminates the need to switch veins which incurs extra ischemic time.

Since the serratus stump is angled retrogradely, an attempt could be made to reangle the vein orthogradely by 45 to 60 degrees (Fig. 1B). Care must be taken not to kink it. For the same reason, the skin over the anastomosis is always closed tensionlessly with proximal LD muscle as a cover. This measure ensures that the lie of the vessels is not disturbed.

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