Article published online: 2022-12-22

Dual Venous Drainage for the Free Latissimus Dorsi Muscle Flap—Using the Serratus Vein Tributary—Making Virtue of a Necessity

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Indian J Plast Surg 2022;55:351–356.

Abstract

Background Most flap failures in the lower limb are on account of venous congestion. Literature shows a decrease in the incidence of venous failure when two veins are anastomosed. The thoracodorsal pedicle of the latissimus dorsi free flap affords the possibility of a single venous anastomosis. The lack of a second venous outflow could result in venous congestion in the distal limits of the flap, particularly when long flaps are required for large defects or when the recipient veins are smaller in diameter.

Methods We describe a consecutive series of 11 cases of latissimus dorsi flaps for leg and foot defects with a mean defect size of 310 cm^2, where the serratus anterior vein was used as a second venous outflow channel to ensure maximal venous drainage.

Results There were no re-explorations for anastomotic causes. Only one case had partial distal muscle necrosis. There was a delayed anastomotic blowout due to infection resulting in amputation in one case. There was no partial distal muscle necrosis in nine of the ten cases.

Conclusion Using the serratus vein as a second venous outflow is of use in reducing incidence of venous occlusion and distal muscle necrosis and can be specially indicated for large flaps and venous diameter discrepancy.

Keywords

- free latissimus dorsi muscle flap
- venous congestion
- lower limb trauma
- serratus vein
- second venous anastomosis

Introduction

Before the advent of the anterolateral thigh flap, the latissimus dorsi muscle has been the donor flap of choice for coverage of moderate to large defects in the lower limb. It offers a large surface area, a long consistent pedicle, and ease of harvest.

The dominant pedicle of the type V latissimus dorsi muscle flap contains—one artery and one vein in 96% cases. Average diameter of the thoracodorsal artery is 2.7 mm (1.5–4 mm), of the vein is 3.4 mm (1.5–4.5 mm), and the pedicle length is 9.3 cm (6.0–16.5).[1]

Culliford et al[2] analyzed a cohort of 588 lower limb free flaps with an overall failure rate of 9%; they ascribed venous congestion as the most common cause of flap failure—32% venous causes as against 14% arterial causes, in 50 re-explored cases.

Free flaps like gracilis, anterolateral thigh flap, and radial forearm flap permit double venous anastomoses. In the case of the latissimus dorsi flap, there is but a single vein. A type V

article published online December 22, 2022

DOI https://doi.org/10.1055/s-0042-1759497.
ISSN 0970-0358.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

muscle (Mathes and Nahai) with a secondary pedicle, the venous drainage of the distal and outermost part is usually drained by thoracolumbar and posterolateral intercostal pedicles. This makes the distal most part of the free latissimus dorsi muscle flap prone to venous congestion, especially when a skin paddle is not included in the flap harvest.[3]

Necrosis of the distal most part of the muscle can manifest as loss of flap leading to exposure of critical part of the defect or as skin graft loss over the muscle.

In 1997 Shigehara et al[4] described a case where the pedicled latissimus dorsi musculocutaneous flap was used based only on the serratus pedicle for coverage of a free fibular flap for shoulder reconstruction, with complete flap survival; the serratus arterial branch had retrograde flow to nourish the flap.

This allowed us to consider the serratus vein as an outflow tract and used the same for a second venous anastomosis in free latissimus dorsi flaps.

This technique was adopted in a consecutive series of lower limb defect reconstruction using the latissimus dorsi muscle flap with the intention to decrease the unfavorable consequences of distal necrosis due to venous congestion, in spite of a patent venous anastomosis. Our own data of lower limb latissimus dorsi muscle flaps revealed a distal partial necrosis rate of 9%.

Materials and Methods

In total, 11 consecutive cases of free latissimus dorsi muscle flaps for coverage of lower limb defects resulting from acute trauma were included. The conditions that needed to be met were as follows:

1. Defect size greater than 200 cm^2.
2. Discrepancy of greater than 30% in caliber between the donor and the recipient vein.

During elevation of the latissimus dorsi flap (harvested as a muscle only flap), care was taken to harvest a length of the serratus anterior pedicle and clip the artery and vein separately using hemostatic clips.

After completion of the primary anastomosis, and confirmation of a patent venous anastomosis by the milking test, the clip on the serratus anterior vein was released to check for venous outflow. This vein was then anastomosed to the other venae comitantes directly (►**Fig. 1**).

When there was no efflux of blood on account of proximity to valve in the serratus vein, the vein was resected back to an avalvular segment; on resumption of venous outflow the second anastomosis was done using the other recipient vein; in the event where the reach to the second vein was inadequate, a short vein graft was harvested, and used to bridge the gap.

Results

All 11 patients were males ranging from 18 to 55 years with mean age of 29.7 years. The size of the defects ranged from 200 to 525 cm^2 with mean surface area of 310 cm^2 (►**Table 1**).

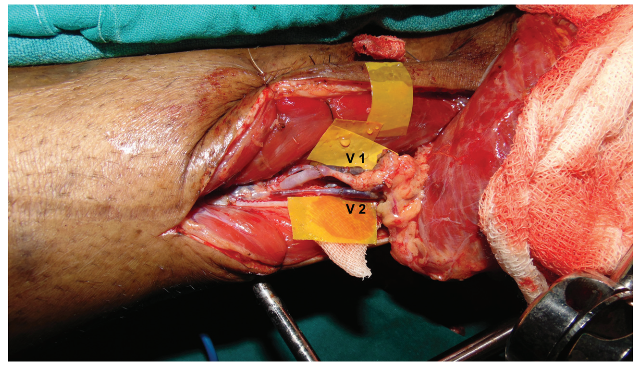

Fig. 1 Image showing anastomosis of two veins to anterior tibial veins—V1 vein of the latissimus dorsi pedicle and V2 vein of the serratus branch.

The donor artery was anterior tibial artery in seven cases and posterior tibial artery in four cases; all the arterial anastomoses, except one, were done end to end. All the venous anastomoses were done to either venae comitantes of the anterior or posterior tibial artery. In three out of 11 cases, the serratus vein anastomosis required the use of an interposition vein graft on account of trimming back to an avalvular segment.

There were no re-explorations for anastomotic compromise in the postoperative period. One patient had documented distal muscle necrosis needing debridement; the resulting wound needed secondary skin grafting. One more patient had skin graft loss over the middle portion of the muscle without any muscle necrosis but the wound healed with dressings. Two of the 11 cases had a donor site hematoma and seroma, respectively needing operative drainage.

Ten of 11 cases had an ultimate successful outcome of flap and wound coverage. There was one patient who had an anastomotic blowout on the 19th day due to infection with subsequent flap loss needing an above knee amputation. Only one of the 10 had a distal partial muscle necrosis.

Discussion

There could be many causes for partial necrosis (usually manifesting at the distal limits of the flap)—extension beyond known territory, suturing under tension, or hematoma. Inadequate venous drainage from the farthest end of the flap is also of importance in lower limb defects.

Damming of venous blood in the latissimus dorsi muscle was anticipated in long flaps for large defects or when there was more than a 30% difference in diameter between the thoracodorsal vein and the recipient veins; venous drainage works on the principle of "vis a tergo."

Cormack and Lamberty[3] stated that venous congestion in muscle-only latissimus dorsi flaps is more frequent than when a flap with a skin paddle is harvested, probably on account of alternative flow pathway via the skin. The lower and medial parts of the muscle preferentially drain through the intercostal and lumbar venous systems and *not easily* via the thoracodorsal system. Valves within the veins *may prevent* adequate drainage of the inferior end of the muscle

Table 1 Clinical and outcome details of the cases where Serratus vein was used as second venous drainage.

S. no	Age	Recipient site	Defect size (cm)	Arterial anastomosis	Vein diameter mismatch	Vein Graft	Remarks
1	23	Sole of the foot	25 × 12	Posterior tibial artery	YES	NO	Uneventful healing
2	24	Gr IIIb lower third leg with dorsal foot	35 × 15	Anterior tibial artery	NO	YES	Graft loss with secondary healing
3	34	Skin loss distal third leg and foot	30 × 15	Anterior tibial artery	YES	NO	Donor site seroma; needing drainage
4	33	Dorsal foot	25 × 12	Anterior tibial artery	YES	NO	Uneventful healing
5	18	Gr IIIb lower third leg with dorsal foot	20 × 12	Anterior tibial artery	YES	NO	Uneventful healing
6	23	Dorsal foot	18 × 15	Posterior tibial artery	NO	NO	Uneventful healing
7	30	Skin loss distal third leg and foot	20 × 10	Anterior tibial artery	YES	NO	Partial distal necrosis; Graft loss needing regrafting
8	54	Sole of the foot	25 × 15	Posterior tibial artery	NO	YES	Uneventful healing
9	44	Near total amputation Gr IIIb lower third leg fracture.	20 × 17	Posterior tibial artery	NO	YES	Anastomotic blowout at day 19 due to infection followed by flap loss resulting in above knee amputation.
10	32	Dorsal foot	20 × 10	Anterior tibial artery	YES	NO	Donor site hematoma; needed drainage
11	30	Skin loss distal third leg and foot	20 × 12	Anterior tibial artery	YES	NO	Uneventful healing

into the thoracodorsal system. This causes distal partial necrosis.

The serratus branch stump could be utilized to augment the venous drainage of the muscle thus help prevent damming up of venous blood downstream; this could decrease distal partial necrosis in lower limb latissimus dorsi flaps.

The flow pathway following serratus vein anastomosis has been depicted diagrammatically (►**Fig. 2**).

The serratus branch has been exploited as an arterial inflow source in flow-through reconstructions as described in case reports by Ozkan et al[5] and Taylor et al.[6]

We have a previous experience of using the serratus artery as an inflow pathway in three complex defects that needed the "flow through" concept to salvage the lower limb in acute trauma (►**Fig. 3**).

Fisher et al[7] demonstrated reverse flow in the serratus branch after ligation of the thoracodorsal pedicle, albeit focusing on the arterial aspect, with a view to extending the indications for pedicled latissimus dorsi flap-based breast reconstruction.

Labosky[8] describes a technique of selective catheterization of the serratus tributary to circumvent venous congestion in free latissimus dorsi flaps; the adoption of this technique caused a reduction in venous occlusion from 38 to 0%.

Chun and Sterry[9] report, albeit, a single case, where serratus-based pedicled latissimus dorsi flap needed venous supercharging by anastomosing one lumbar perforator vein

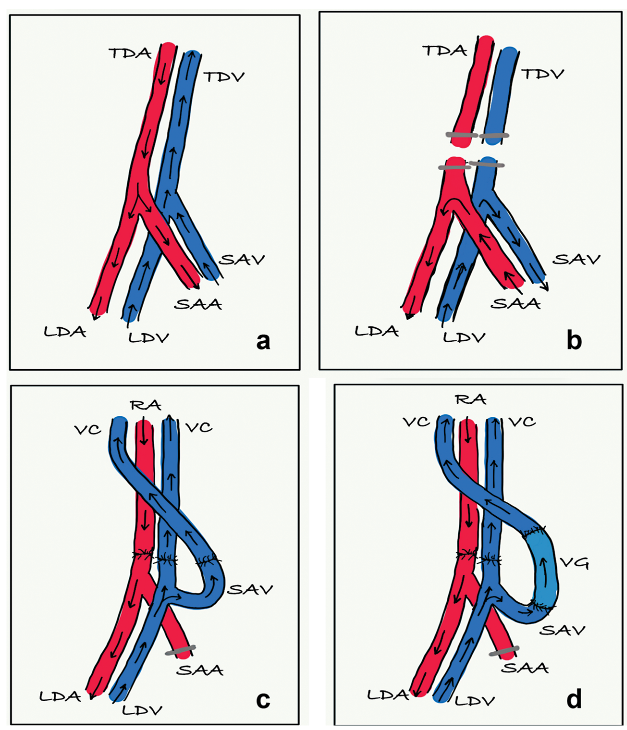

Fig. 2 Schematic representation of change in flow direction in the serratus branch, (**a**, **b**) before ligation of the thoracodorsal pedicle; (**c**, **d**) serratus vein anastomosed to recipient veins with or without a vein graft, respectively. LDA/LDV, artery and vein to latissimus dorsi; SAA/SAV, artery and vein to serratus anterior; TDA/TDV, thoracodorsal artery artery and vein; VC, venae comitantes; VG, vein graft.

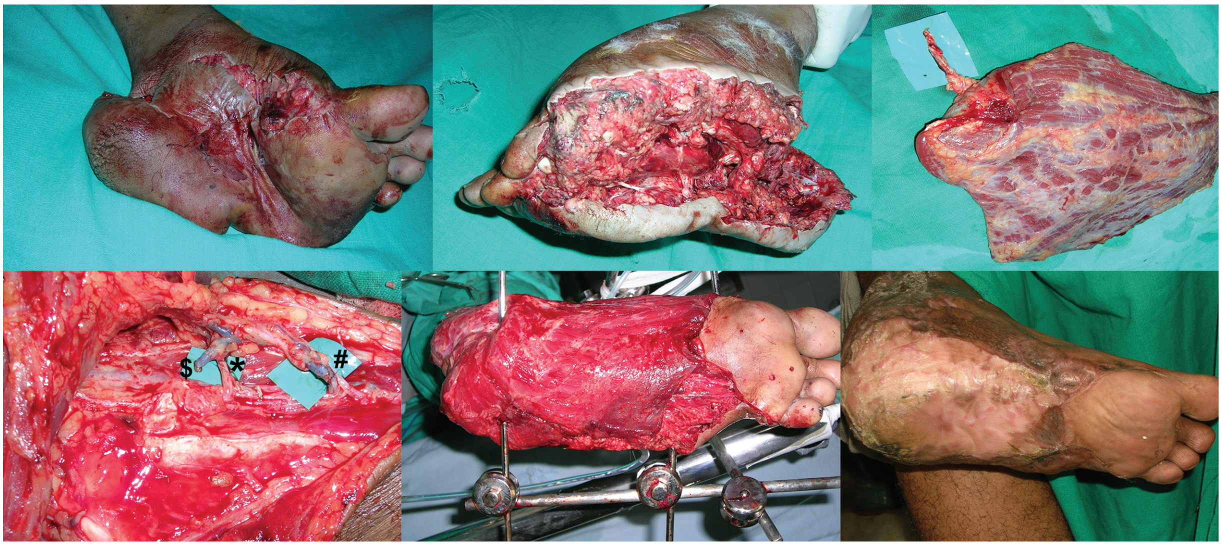

Fig. 3 Images showing use of the serratus arterial branch for flow through purpose; #, the anastomosis of thoracodorsal pedicle to recipient vessels; *, the serratus artery to the artery to the foot; $, the ligated serratus vein.

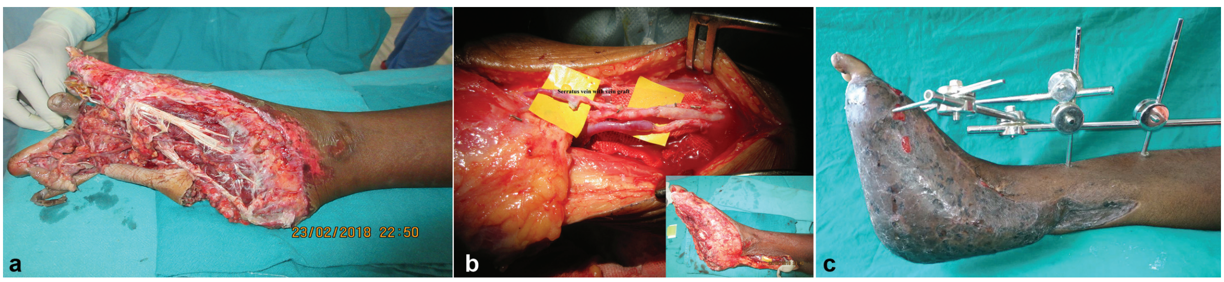

Fig. 4 (**a**) Large defect following complete degloving of the sole of foot. (**b**) Serratus vein anastomosed to one posterior tibial venae comitantes with a vein graft. (**c**) Healed wound with no evidence of distal muscle necrosis.

to the lateral thoracic vein (in breast reconstruction), implying reverse flow may not occur in the venous pathway.

Goh et al[10] report the use of serratus vein as an additional outflow in five lower limb defects, and recommend it as a useful method to tackle the problem of venous congestion after the primary anastomosis has been done; they use the observation of ballooning of the thoracodorsal vein as an indicator for the second venous anastomosis.

There was distal necrosis in only one of the 10 successful cases in our series. This could be because of better venous drainage by doing a second outflow vein (►**Figs. 4**, **5**); it probably causes a reduction in re-exploration. This study being only a retrospective cohort study, statistical conclusions cannot be derived.

Ahmadi et al[11] based on a meta-analysis of 300 pooled cases stated that dual vein outflow is beneficial; a smaller vein size and mismatch contribute to venous congestion. Compared with single-vein flaps, two venous anastomoses were associated with reduction in partial flap failures, and in fact, any flap failure—specifically for muscle flaps.

It could be cogently argued that the possibility of a double vein anastomosis exists only in the anterolateral thigh type flap, gracilis or rectus abdominis muscle flap, implying the above data cannot be extrapolated to the latissimus dorsi which is essentially a flap with one vein.

Stranix et al[12] specifically highlights this issue of a greater rate of complications with the one vein latissimus dorsi flap than with the two vein rectus abdominis flaps. They concluded that two venous anastomoses in muscle flaps correlated with more than a fourfold reduction in flap complications including flap failure. A greater than 1 mm mismatch between vein diameter also correlated strongly with a higher flap failure rate.

Heidekrueger et al[13] in his study with gracilis and anterolateral thigh flaps concluded that single vein flaps can be reliably performed in the lower extremity, but on parsing the data, we find that when the lower limb data are extracted, nearly similar numbers 84.7 and 77.2% were one and two vein anastomosis—hence regardless of the conclusions of the adequacy of single venous anastomosis, there is an inherent bias toward a double vein anastomosis in lower limb reconstruction.

Thoracodorsal vein is a thin-walled vein which has a propensity to expand into a varicosity when flow in the recipient vein is poor due to size discrepancy. Using the serratus anterior vein permits possible augmentation of the venous outflow of the latissimus muscle flap.

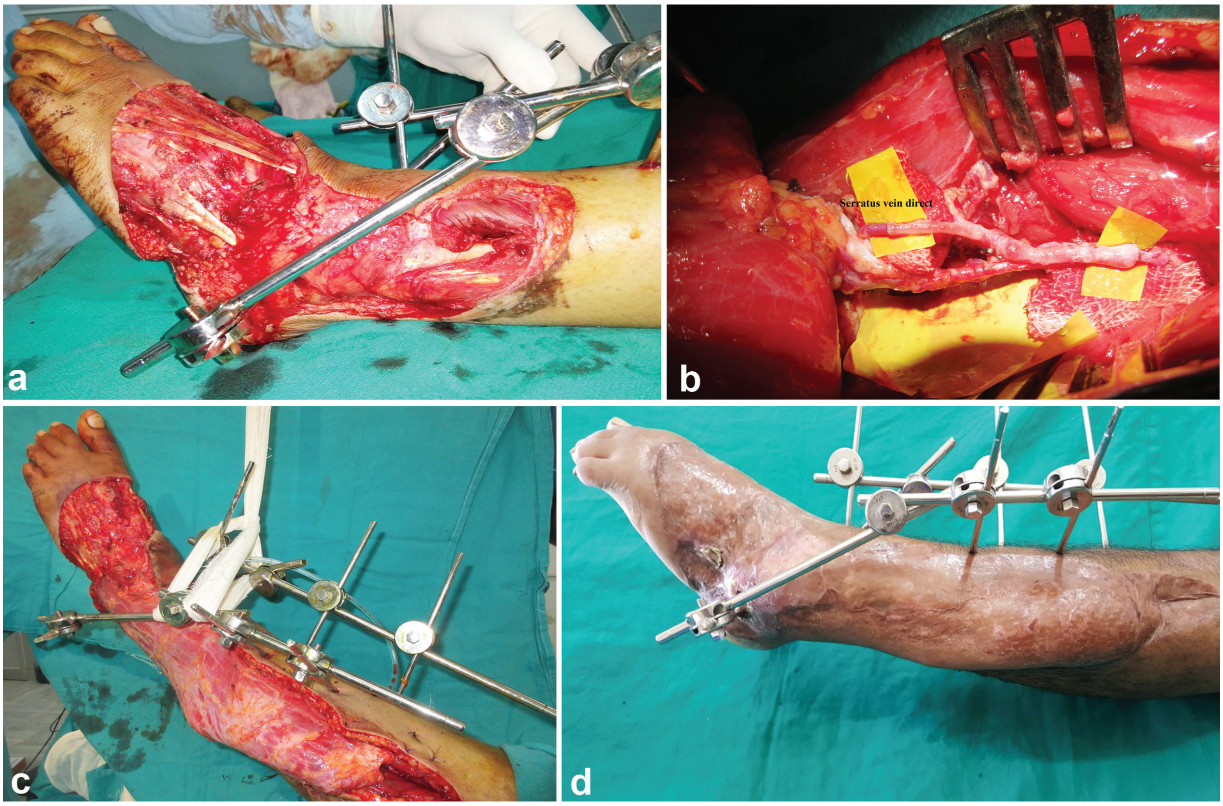

Fig. 5 (**a**) Large defect of anterolateral leg extending from lower third leg to the distal foot. (**b**) Serratus vein anastomosed direct to the anterior tibial venae comitantes as the second vein. (**c**) Anastomosis executed at the junction of middle and upper third leg on account of zone of trauma but complete survival of the distal muscle. (**d**) Completely healed wound over the critical part of the original defect.

It would be elegant if the veins accompanying the secondary pedicles were supercharged using other recipient veins distally—but it is difficult to find suitable veins in such large distal limb defects.

We would recommend our technique of venous outflow augmentation specifically in the setting of lower limb trauma, only when there is a size mismatch between recipient veins and the thoracodorsal vein and where the zone of injury forces a long distance from the chosen site of anastomoses to the distal most edge of the defect. We perceive the benefits of decreased re-explorations and decreased incidence of distal necrosis with adoption of this technique.

Conclusion

When the practice is to do two venous anastomoses in flaps with two donor veins, such a practice can also be extended to the latissimus dorsi muscle flap with our method. Preserving a length of the serratus pedicle intentionally during flap harvest permits a second venous outflow to decrease venous congestion and distal necrosis.

Conflict of Interest
None declared.

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