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T-Anastomosis in microsurgical free flap reconstruction: an overview of clinical applications

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Summary In free flap transfer, the recipient vessel is often sacrificed to provide the pedicle anastomosis. As the recipient vessel is likely necessary for distal circulation, preserving its patency is also important, especially in the extremities of aged or chronic vasculopathy patients, such as those with diabetes. If a reliable proximal branch is included in the T-shaped pedicle preparation, the pedicle can be interposed between two ends of the recipient vessel, thus allowing for T-anastomosis. This technique can be used to preserve recipient flow as well as for other clinical purposes depending on the recipient vessel condition. T-anastomosis was planned in cases that required the recipient flow to be preserved, for example, if peripheral vasculopathy was present. Various clinical applications of T-anastomosis have been performed, such as preserving recipient flow, preserving donor flow, rebuilding deficient vascular flow, balancing and dispersing blood flow or pressure, chimeric patterns, reusing a pedicle in the staged reconstruction or a combination of the above. Vascular systems with reliable proximal branches of the proper diameters, such as subscapular or lateral circumflex femoral vessels, appear to be good source vessels for the T-shaped pedicle. The T-anastomosis was used in 45 cases for single and dual purposes. The dominant recipient vessel was preserved in 11 extremity reconstructions, and a single remnant recipient vessel was saved in six traumatic extremities and four chronic vasculopathy patients. The recipient vessels that were selected for preserving the flow included the posterior tibial ($n = 21$), anterior tibial ($n = 8$), radial ($n = 3$), ulnar ($n = 2$) and other arteries. The source vessel of the latissimus dorsi or anterolateral thigh perforator flap was most often used for preparing the T-shaped pedicle. T-anastomosis of the pedicle in the free flap transfer is another reliable option for preserving recipient flow. In addition, the anastomosis is quite useful in difficult recipient sites and for many purposes, such as chronic diabetes or traumatic vascular injury. With this technique, a single recipient vessel can be reused in a staged reconstruction. In perforator flaps, the concentrated

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flow through a narrow perforator pedicle with a small diameter can be dispersed until the autoregulation of new flow distribution in the flap is stabilised.

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Vascular anastomosis is probably one of the most important factors in deciding the flap outcome after microsurgical reconstruction. One of three different methods – end-to-end, end-to-side or side-to-side anastomosis – is selected based on recipient vascular conditions. Small modifications to these types of anastomoses and various devices for microvascular anastomosis have also been introduced,^{1–3} and T-graft or T-interposition of pedicle is introduced as another option for dealing with difficult end-to-side anastomoses.⁴ When the flap pedicle is harvested, the proximal source vessel often has several branches with a reliable diameter. Because the proximal branch usually has a diameter similar to the main pedicle, it can be included in the pedicle to allow for interpositional placement in a T shape between two ends of the recipient vessels. This technique, 'T-anastomosis', is quite useful in various clinical purposes.

Patients and methods

Materials and methods

Patients scheduled for microsurgical reconstruction in the extremities were routinely examined with a colour duplex ultrasound to confirm a dominant vascular flow and validate the existence of any endovascular disease. The recipient vessel was selected based on this ultrasound probe before the operation. T-anastomosis was planned in cases where sacrificing a dominant vessel was inevitable or where only one vessel remained. As a rule, T-anastomosis was done in both arterial and venous anastomosis; however, venous anastomosis was optional.

The anatomy and diameter of the proximal branching structure of a subscapular or lateral circumflex femoral vessel are quite reliable. Because of this, one branch could always be included in order to prepare the T-anastomosis pedicle. A proximal branch can be used because it usually has a diameter similar to the main source vessel in the pedicle, but it needs to be long enough to allow for easy anastomosis. A circumflex scapular artery was often selected from the subscapular system, as well as a transverse or long descending branch from the lateral circumflex femoral system.

The T-shaped end of the pedicle was interpositioned between each end of the divided recipient vessels, and two end-to-end anastomoses were made. Either the main pedicle or its branch was selected for the proximal anastomosis depending on the diameter of the recipient vessel. After the proximal end-to-end arterial anastomosis, the resulting circulation to the flap was immediately confirmed before starting the distal arterial anastomosis. In the case of a perforator, the flap, which usually has a smaller-sized pedicle, was sometimes congested due to the flow load converging at the small perforator pedicle, and T-anastomosis of the pedicle is useful for balancing between the flap and the distal circulation.

Clinical applications

Preserving recipient flow

T-anastomosis is basically recommended for preserving the recipient vessel flow, especially in extremity reconstruction. Both the upper and lower extremities have dual arterial supplies – for example, the radial and ulnar arteries, or anterior and posterior tibial arteries. Sometimes, after confirmation of reliable distal flow, one of them must be sacrificed for use as the flap recipient vessel in microsurgical reconstruction. Recipient flow is better preserved, however, by making a T-anastomosis. This is especially useful in patients with diabetes, chronic vasculopathy or traumatic loss of one dominant vessel, because distal perfusion of the lower extremity is crucial in these patients (Figure 1).

Preserving donor flow

The donor vessel can also be preserved with T-anastomosis when the free flap is harvested. When the proximal pedicle of a thenar flap requires a sufficient diameter, radial artery is sometimes included for matching the recipient vessel. In this case, the small segment of radial artery is included in the T-shaped pedicle. As the radial artery is also important for distal flow in the hand, the remaining proximal and distal stumps of the radial artery can be approximated and reanastomosed. This can only be done if the flap is harvested such that only a small segment of the radial artery is included in the pedicle (Figure 2).

Rebuilding deficient vascular flow

A longitudinal loss in a vascular conduit due to an electrical or crushing injury to an extremity can be repaired with a long-vein graft. As an alternative, a T-anastomosis can be used as a flow-through pattern to rebuild the defective vascular conduit by harvesting a pedicle with a long branch (Figure 3).

Balancing and dispersing blood flow or pressure

When the entire blood flow from a recipient artery is concentrated on the pedicle of the flap after end-to-end anastomosis, the flap is prone to congestion, especially if a large perforator flap is used, or if there is a size discrepancy in the vascular anastomosis. Blood flow and pressure can be dispersed to both the flap and the distal recipient vessel by a T-anastomosis until the flow equilibrates. Therefore, T-anastomosis should be considered when a large perforator flap is planned, or if there are risks of venous drainage (Figure 4).

Chimeric pattern

A chimeric pedicle anastomosis composition is a modification of the T-anastomosis. Any reliable branch of the pedicle can be used as a recipient vessel in combination with another free flap. Doing so is quite useful in three-dimensional reconstruction, especially in head and neck.

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