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Chang's Technique of Sequential End-to-Side Microvascular Anastomosis

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Abstract

Free flap is now a routinely performed operation and an essential part of reconstructive surgery. End-to-Side (ETS) anastomosis is an assistant dependent microvascular procedure that remains to be technically challenging with steep learning curve. This is a novel technique created by the senior author of this paper. It is a technique of sequential ETS micro-venous anastomosis using widely available vessel loops and an additional single vascular clamp. The surgical technique is described in detail, and in-depth literature review has been conducted and presented. The vessel loop provides superior protection to the vessel over vascular clamps, and achieves equisegmental internal jugular vein occlusion for sequential (proximal to distal) venous anastomosis. Utilising a second single vascular clamp with the maneuver described reveals and maintains an accessible position to the posterior wall of the anastomosis, which enables the surgeon to operate independently with this unique technique.

Introduction

End-to-End (ETE) microvascular anastomosis is the first-line option for most microsurgeons in free flap surgery. It is less technically demanding and also surgical assistant independent. However, due to frequent encounter of vessel calibre mismatch for both width and thickness, as well as the presence of vessel depleted recipient regions [1] due to surgical ablation, trauma or pre-operative radiotherapy, End-to-Side (ETS) microvascular anastomosis can serve as an excellent alternative option.

In contrast to ETE anastomosis, ETS anastomosis is technically more challenging with steeper learning curve. It is also a difficult operation to be performed independently. In head and neck surgery, the trunk of internal jugular vein (IJV) is commonly preserved. Thus, instead of searching for suitable veins for ETE venous anastomosis, ETS anastomosis to IJV is a more reliable approach. ETS is also recommended in the event of significant size discrepancy. Direct venous drainage of pedicle veins into a vein with greater calibre, such as IJV, may result in more desirable outcome compared to ETE anastomosis between two veins with significant size discrepancy [2].

Objectives

This paper aims to describe a novel technique of sequential ETS micro-venous anastomoses using three vessel loops for IJV occlusion and a single vascular clamp to retract and hold the anastomoses sites in position, thus gaining access to posterior wall and perform the operation independently.

Procedure

Two pedicle veins from a donor anterolateral thigh flap were isolated from the vascular bundles up to 3 cm in length from their point of ligations. A single microvascular clamp was applied on each pedicle vein to prevent venous backflow that may disrupt the microsurgical field. Main trunk of internal jugular vein (IJV) was also isolated from its surrounding connective tissues. Three 5 cm vessel loops (blue) were used for two segmental IJV occlusions (proximal and distal), using right angle forceps for their guided pass to create figure of 8 configurations. Each vessel loop was then retracted with mosquito forceps as soon as the appropriate tension was set for segmental IJV occlusion (Figure 1). Limited adventitiectomy was performed at the end of each pedicle vein as well as IJV surface

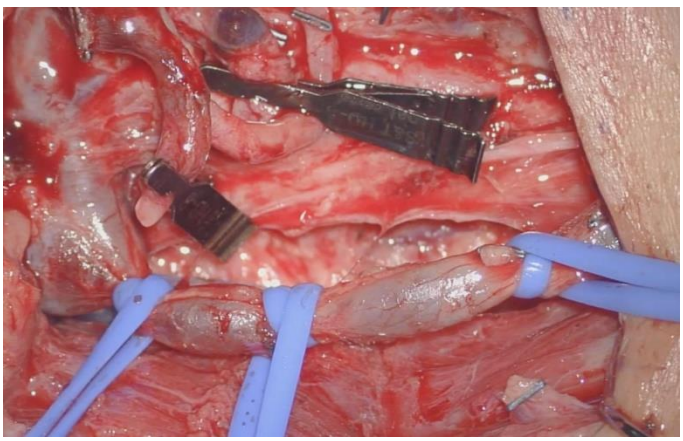

Figure 1. Using Vessel Loops x 3 to occlude venous drainage back to IJV and provide 2 IJV segments for End-to-Side Anastomosis.

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under the microscope to prevent unintentional plication of venous adventitia into lumen of the anastomosis site.

The aim was to set a slight tension between pedicle veins and IJV in the anastomoses design to avoid vessel redundancy, and consequently prevent vessel kinking. Once the adequate tension was set, a parallel incision was made over the proximal segment of occluded IJV sized to the diameter of the pedicle vein. Two anchor sutures were placed over 3 and 9 o'clock of the IJV (Figure 2). Continuous looping technique was used from right to left for the anterior wall anastomosis (Figure 3).

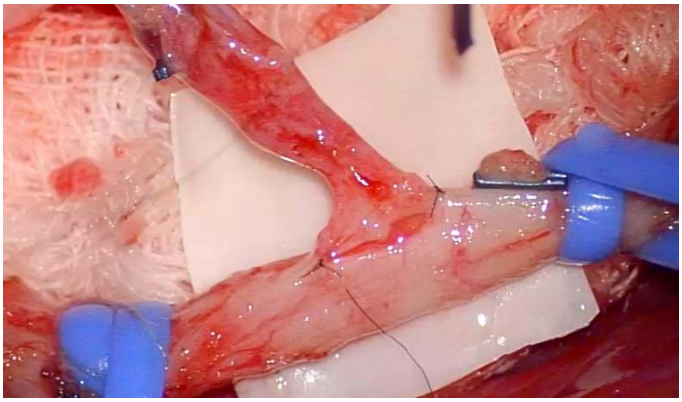

Figure 2. Two anchoring sutures placed over 3 and 9 o'clock.

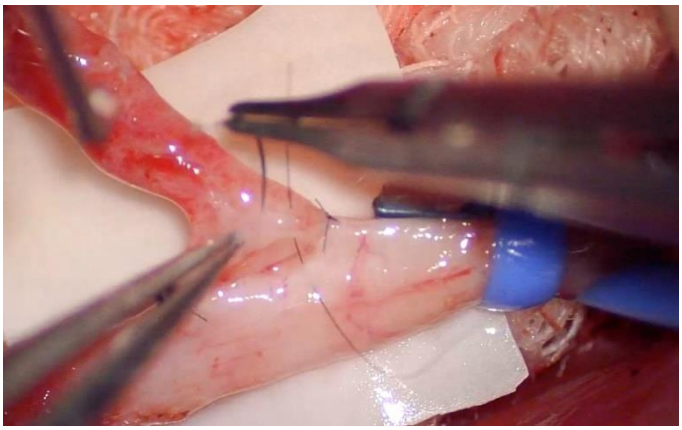

Figure 3. Demonstrating right to left continuous looping technique used for anterior wall anastomosis.

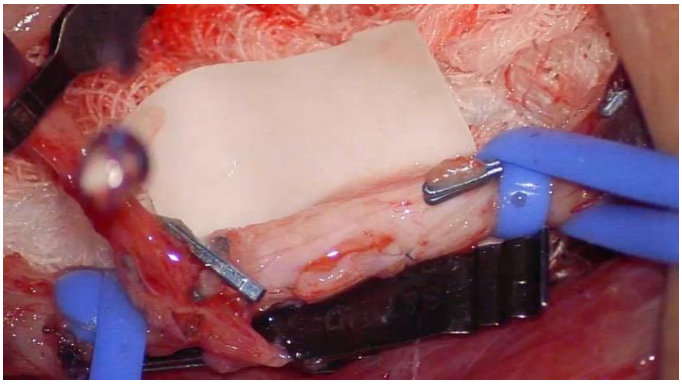

Figure 4. Maintaining an adequate position with the vascular clamp for posterior wall anastomosis, which omits any additional aid from the surgical assistant.

A second single microvascular clamp was applied close to the junction of anastomosis to retract the pedicle vein at 180 degrees angle laterally along the long axis of IJV to expose the posterior wall. The microvascular clamp was then secured in position with gauze or surrounding tissues (Figure 4). Left to right continuous looping technique was used for posterior wall anastomosis (Figure 5).

Once the anastomosis was completed, most proximal vessel loop was released. Retrograde blood flow from IJV was used for checking anastomosis leak. The proximal and distal single microvascular clamps were released sequentially to establish first venous drainage of the flap (Figure 6). Same steps were repeated for distal IJV end-to-side anastomosis achieving sequential end-to-side venous anastomoses.

Clinical experience and potential drawbacks

The senior author Dr. Tommy Nai-Jen Chang had performed more than 30 ETS micro-venous anastomoses using this technique, with 100% success rate to date. This technique shares the same potential drawback of all forms of ETS anastomoses, as such, if ETS anastomosis revision is needed, it is more difficult than ETE anastomosis revision.

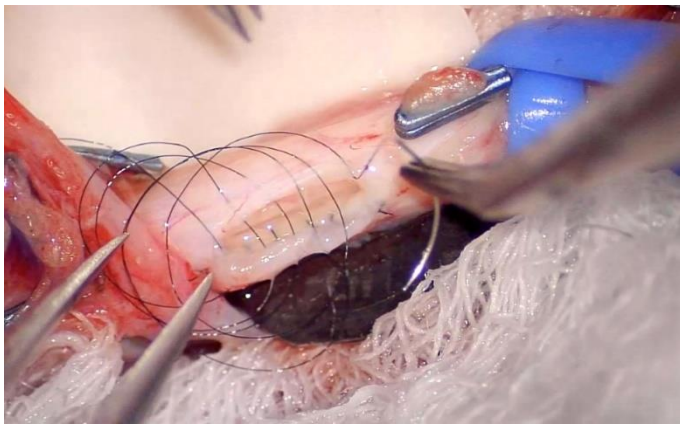

Figure 5. Demonstrating left to right continuous looping technique used for posterior wall anastomosis.

Discussion

Both experimental [2-4] and clinical studies [1,5] indicate that the patency rates of venous ETE and ETS microvascular anastomoses are the same. Bas et al. [2] conducted an animal study using rat models to compare ETE and ETS microvascular anastomoses in the setting of significant vessel calibre discrepancies. The result showed a superior endothelial healing with ETS over ETE anastomosis, which was demonstrated histologically and electro-microscopically. The better the endothelium heals post anastomosis, the decreased platelet aggregation, and therefore the reduced thrombus formation and anastomosis failure.

ETS anastomosis may disrupt haemodynamics of the free flap at the site of the anastomosis theoretically. The concern was derived from potential interruption of laminated blood flow through intima propria as ETS invariably anastomosed with a sharp angle [2]. This phenomenon is presumed to be worsened in the low pressured venous system. Such intravascular haemodynamic disturbances, however, do not translate into a

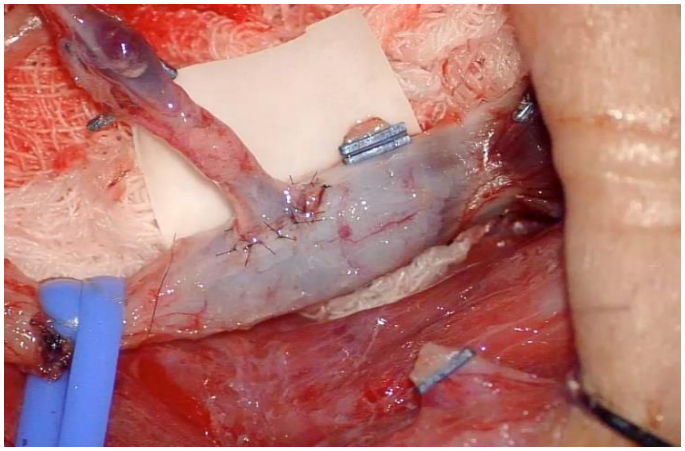

Figure 6. Sequential release of proximal and distal single vascular clamp to establish venous drainage of the flap.

higher risk of anastomosis failure clinically [1,5]. Similar to Godina's advocacy of using ETS for arterial microvascular anastomosis [6], Acland [4,7], Ueda [1], and Samaha [5] advocated the use of ETS venous micro-anastomosis in the setting of vesselless recipient sites, more importantly, in the presence of significant vessel size discrepancies. In our experience, ETE anastomosis should be avoided if the recipient vein is injured (from trauma/ ablation surgery/ radiation), or consists of thin walls (anterior jugular vein), or has tortuous course (superior thyroid vein). ETS should be considered in the absence of proximal veins and the veins that are poorly located for ETE, where performing anastomosis would result in vessel redundancy.

Several surgical techniques were described in the literatures aiming to simplified ETS anastomosis procedure and flattened the learning curve. Nakagawa et al. [8] modified ETS technique to maximize the exposure of posterior wall by rotating the pedicle vessel by 90 degrees clockwise after placing one anchoring suture from pedicle vessel to IJV. Yazici [9] utilized traditional triangulation method for ETS micro anastomosis. On the other hand, surgical instruments and materials had been developed since late 1970s to assist ETS anastomosis. Weinrib [10] and Karamursel [11] used external metal ring to facilitate their ETS anastomosis. Sacak [12] used two-suture fish-mouth end-to-side microvascular anastomosis with fibrin glue. Baek [13] practiced ETS anastomosis with specially designed "triple vascular clamp", where the third clamp was used to anchor the pedicle vessel in the desirable position and angle. Recently developed anastomosis coupling devices were also trialled in ETS anastomosis clinical practice, as reported by Chernichenko and DeLacure et al. [14,15].

In Chang's Technique of ETS micro-venous anastomosis, the utilization of three vessel loops for IJV occlusion, instead of a double vascular clamp, has got several advantages. It creates equisegmental occlusions of IJV (proximal and distal) that are independent to each other. This set-up allows sequential micro-venous anastomosis without repositioning the recipient vessel (IJV) and instruments, thus saving significant surgical time. If proximal anastomosis is performed first, independent release of proximal segment of IJV is possible while distal segment remains occluded. This provides early venous drainage and restoration of normal intra-flap haemodynamics while having an undisrupted sequential ETS anastomosis for the second vein. Applying vessel loop on IJV is comparatively more vessel-protective than any forms of vascular clamp [16]. Similar to vascular clamps, complete venous occlusions of selected segments of IJV were also achieved. Vessel loops occluded IJV circumferentially and minimised IJV to its least form. This increases the surgical accessibility significantly and optimizes surgical visibility. It provides a safer and more spacious operating field, allows greater surgical manoeuvrability, and may prevent unnecessary injury to IJV.

Similar to Chang's Technique, ETS anastomosis technique presented by Hall et al. [17] utilizes a single clamp on the pedicel vein, and uses it to retract and reveal the posterior wall by turning the clamp over and hooking behind the pedicle vessel that is held in place between the double clamps. In Chang's Technique, a second single microvascular clamp is applied close to the anastomosis junction to retract the pedicle vein at 180 degrees angle laterally along the long axis of IJV to expose the posterior wall. Microvascular clamp is then secured in position with gauze or surrounding tissues. This maneuver self-retracts the anastomosis junction of the posterior wall, which allows the surgeon to perform ETS micro-venous anastomosis independently, and serves as the greatest advantage of this technique over others. Although this technique is created and practiced based on head and neck cases, it is also applicable in reconstruction regions where medium to large recipient vessel is present for ETS anastomosis, particularly if sequential venous anastomosis is specified. This technique, however, is difficult to apply to anastomosis regions with narrow surgical field as the maneuver generally requires sufficient space. Anastomosis to venous comitant of posterior tibial and peroneal artery, for example, will present itself as a great challenge if this technique is used.

Conclusion

This novel technique of sequential ETS micro-venous anastomosis is a modified technique from its classical form. The unique use of vessel loops provides protection to the vessel, while it achieves equisegmental IJV occlusion for sequential (proximal to distal) venous anastomosis. This method not only saves precious operating time from repetitive positioning of instruments and recipient vessel (IJV), but also creates a safer operating field for the microsurgeons. Utilizing a second single vascular clamp over the anastomosis junction provides an anchoring point for self-retraction by revealing and maintaining an accessible position to the posterior wall, once it is turned at 180 degrees laterally. This maneuver allows the surgeon to have full control of the surgical field and perform ETS micro-venous anastomosis confidently and independently.

Article Information

Conflict of Interest Disclosures: None
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Keywords

End-to-side anastomosis; technique; microvascular anastomosis; venous anastomosis; venous anastomosis posterior wall exposure; vessel loops.

Abbreviations

ETS, End-to-Side; ETE, End-to-End; IJV, internal jugular vein

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