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Original Article

End-to-Side Venous Anastomosis with IJV: Improving Outcomes of Microvascular Anastomosis in Head and Neck Reconstruction

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Abstract

Background End-to-side (ES) venous anastomosis is an established approach for head and neck reconstruction and has several benefits over conventional end-to-end (EE) anastomosis. However, this is not preferred by all, which may be due to technical preferences for an EE anastomosis by many surgeons. We present here our experience of routine ES venous anastomosis for head and neck reconstruction over the past 8 years.

Materials and Methods All consecutive head and neck malignancy patients reconstructed with free flap and our routine ES internal jugular vein (IJV) anastomosis approach between 2015 and 2023 have been included in this study. Flap-related variables are reviewed retrospectively.

Results Reconstruction was done with a total of 585 free flaps including 303 radial forearm flaps (RFFs), 143 osteocutaneous fibula flaps (OCFFs), and 139 anterolateral thigh (ALT) flaps. The flap survival rate was 573/585 (97.95%). Re-exploration and salvage rates were 45/585 (7.69%) and 38/45, respectively (84.44%).

Conclusion Routine use of ES anastomosis simplifies microvascular anastomosis by avoiding efforts related to the selection of recipient vessels, providing a single large-caliber venous outlet, the favorable geometric orientation of the pedicle, and ease of re-exploration. The vascular anastomosis for RFF, ALT, and OCFF flap is feasible with 7–0 sutures and under 4.5X loupe magnification with this approach quite conveniently with similar outcomes to the reported flap survival rate in the contemporary practice.

Keywords
- end to side
- IJV
- venous anastomosis
- head and neck reconstruction
- re-exploration

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Introduction

Successful venous anastomosis plays a major role in microvascular reconstruction of the head and neck as flap failure is mostly attributed to venous thrombosis.[1] An end-to-side (ES) anastomosis to internal jugular vein (IJV) serves several benefits such as constant anatomy, large-caliber venous outflow, provision of accommodating multiple anastomoses, suitable match for any size and length of flap vein(s), and availability after neck dissection in redo cases. Improved flap survival and reduced venous thrombosis have been reported with the ES anastomosis to IJV in several studies.[2–4] Despite its many advantages, the ES venous anastomosis is still not routinely used by all, probably due to technical preferences for an end-to-end (EE) anastomosis by many surgeons, particularly whenever a branch of the IJV is available. We present here our experience with ES venous anastomosis for head and neck oncosurgical reconstructions over the past 20 years of microvascular surgical practice.

Materials and Methods

This retrospective cohort study includes all consecutive patients reconstructed with free flaps for head and neck malignancies with our "routine (ES) IJV anastomosis" approach in two separate affiliated institutes between 2015 and 2023. The preferential (ES) venous anastomosis was done to an IVC stump on either side of the neck, whenever feasible. The arterial anastomosis was preferably made with the facial artery stump on either side of the neck, or to an alternate stump (superior thyroid artery, lingual artery, external carotid artery stump, etc.) of the same side whenever facial artery stump was not available. In the cases where due to insufficient pedicle reach an ES with IJV was not feasible, an IJV tributary had to be used for an EE anastomosis and these cases are excluded from the present study. The oncologic clearance and reconstruction were done by two separate teams of oncosurgeons and plastic surgeons. Patient-related variables were collected from the hospital database and analyzed. Informed written consent was obtained for unanonymized data publications, and standard ethical guidelines were followed. Institutional ethical clearance was taken for publication.

The oncosurgical clearance and neck dissection were performed by the oncosurgeons. The facial artery and IJV on one side have been preserved (►Fig. 1).

Three different free flaps, radial forearm flap (RFF), osteocutaneous fibula flap (OCFF), or anterolateral thigh (ALT) flap, were used for reconstruction according to the size of the defect and component of tissue loss. The RFF was elevated with a segment of the cephalic vein and communicating vein as the authors' preferred approach.[5] The artery was dissected up to the origin to obtain maximum length and diameter in all cases. The anastomosis was performed on the opposite side of the neck, where a suitable vascular stump was not available on the same side. All the anastomoses were performed under 4.5X loupe magnification.

Anastomosis

The flap was transferred to the defect. The neck vessels were prepared on the selected side for anastomosis. The preserved facial artery stump was delivered under the digastric muscles and trimmed until a spurt of blood flow was seen. The arterial anastomosis was completed with 7–0 Prolene interrupted sutures. The arterial anastomotic clamp was left in place and the venous pedicle was oriented for anastomosis. The venous anastomosis site was selected along the length of the IJV according to the available length of the venous pedicle while avoiding any kinking or tension on the flap vein. A Satinsky clamp was applied along the chosen IJV site (►Fig. 2A, B). A transverse venotomy was made on the IJV to match the diameter of the flap vein and stretched along the length of the

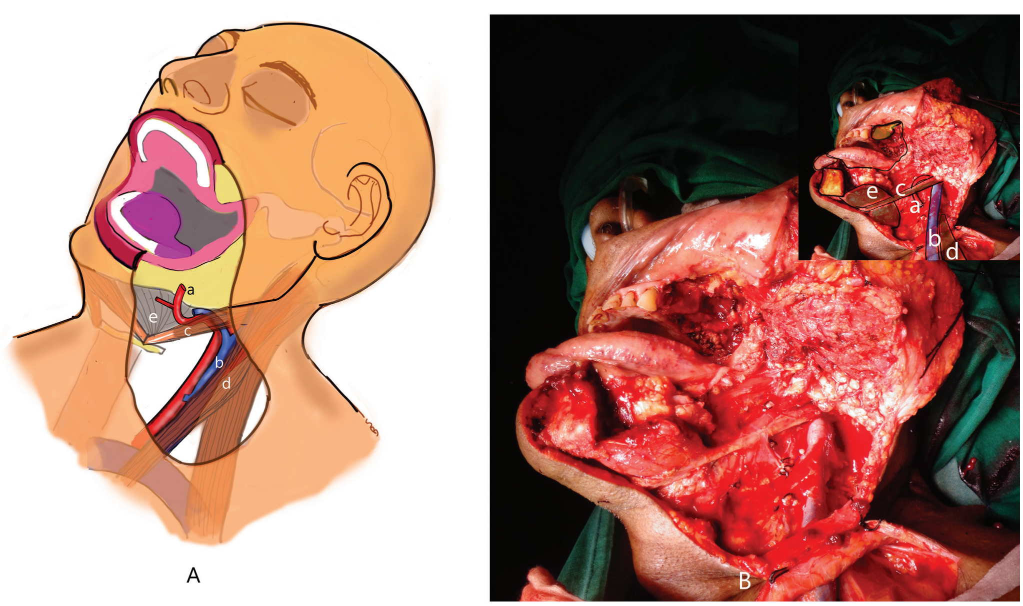

Fig. 1 Surgical anatomy of head and neck microvascular reconstruction. (**A**,**B**) Anatomical location and orientation of the recipient vessels. The anatomical structures are marked in the inset of the clinical photograph. a, facial artery stump; b, internal jugular vein; c, posterior belly of digastric; d, sternomastoid; e, mylohyoid.

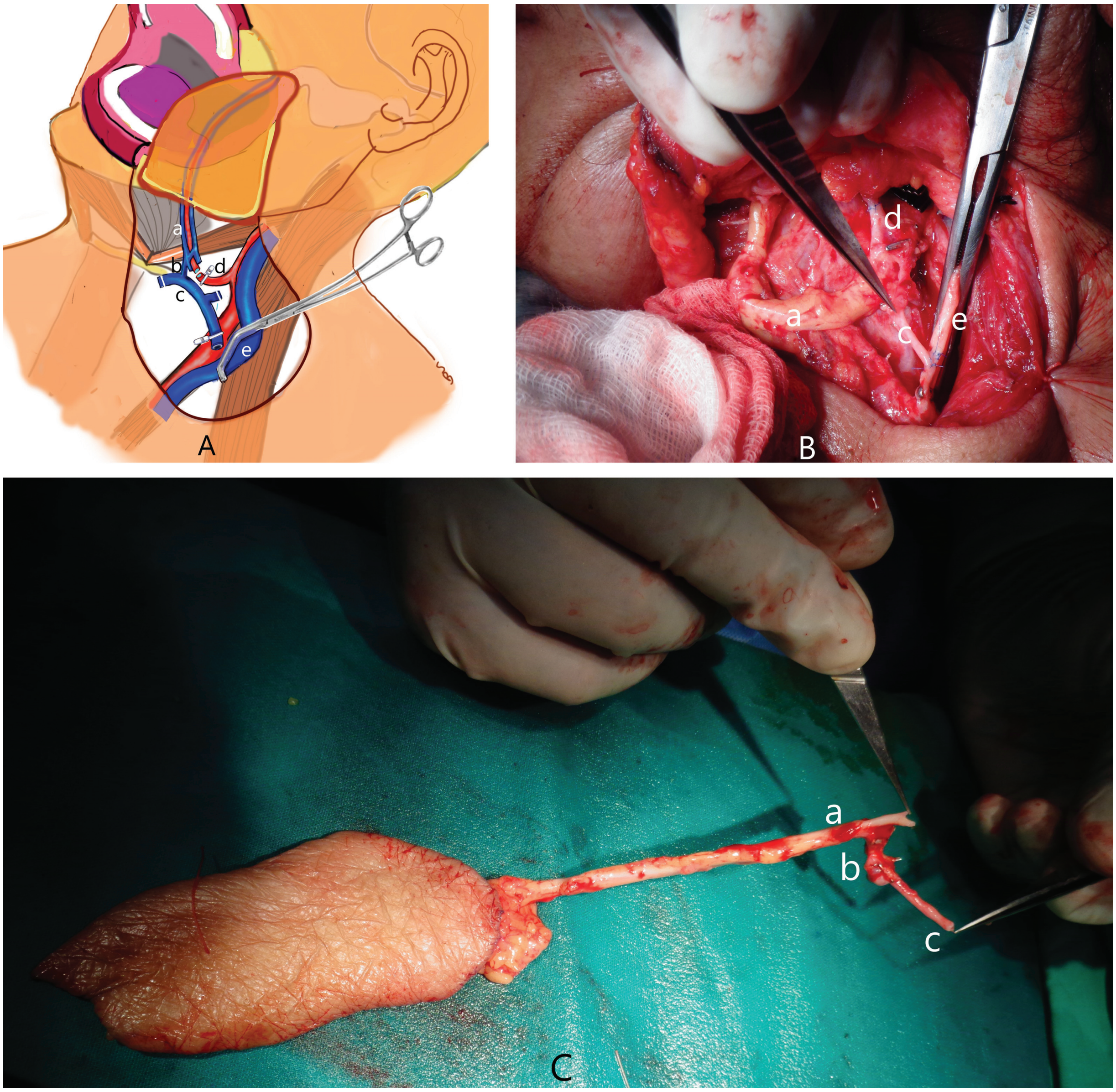

Fig. 2 End-to-side (ES) anastomosis with a radial forearm flap (RFF). (**A, B**) Orientation of the vascular pedicles, and method of venous elevation-occlusion with Satinsky's clamp. (**C**) RFF harvested with the communicating vein and cephalic vein. a, flap pedicle with radial artery and VC; b, communicating vein; c, cephalic vein; d, facial artery; e, internal jugular vein.

vein to produce a "fish mouth." An ES anastomosis was then performed from the posterior wall to the anterior wall with the prior placement of corner sutures and interrupted sutures in between, resulting in a rhomboid-shaped anastomosis (►**Fig. 3**). After completion of both anastomoses, the arterial anastomosis, venous anastomosis on the IJV, and confluence of venous and arterial pedicle remain in a triangular orientation without any acute angulation (►**Fig. 4**). When additional flap veins were available or if the operating surgeon felt the need for a second ES venous anastomosis, it was carried out along the same lines. The flap inset was completed and the neck wound was closed over a suction drain.

When re-exploration and redo of the venous anastomosis was required, the ES anastomosis was divided and sealed off. A second ES anastomosis using the same flap vein (or another if available) was carried out at a separate site on the IJV depending upon the health of the venous pedicle. The patients were followed up for flap monitoring and survival for 5 days in the hospital.

Results

Operative Data

A total of 585 free flaps including 303 RFFs, 143 OCFFs, and 139 ALT flaps were used for reconstruction within the study period. In 10 cases, anastomosis was performed on the contralateral side with 6 of them being done for prior irradiated neck and 4 for previously failed free flaps. The harvested venous pedicle length varied between10 and 18 cm. Single venous anastomosis was performed in 576 cases and dual anastomosis was done in 9 cases, of which 6 were OCFFs and 3 were ALT flaps.

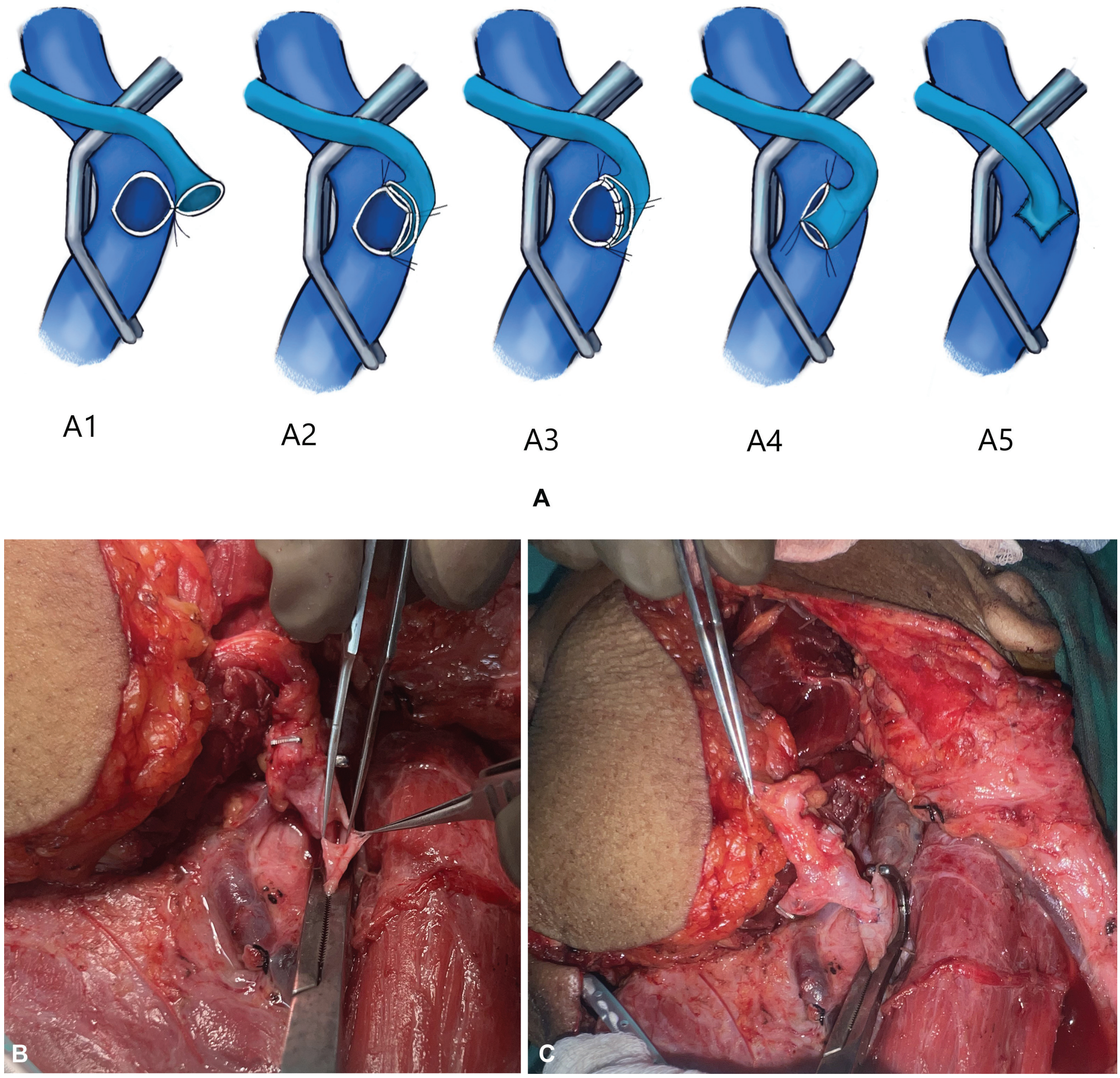

Fig. 3 End-to-side (ES) anastomosis technique with internal jugular vein (IJV). (**A**) ES anastomosis technique. A1, posterior wall fixed with the apex of the fish mouth; A2, upper and lower borders of the vein fixed with the center of the upper and lower margins of venotomy; A3, posterior wall suture completed with interrupted sutures in between the fixed points; A4, anterior margin of the vein fixed with the anterior apical point of venotomy and anastomosis completed with interrupted sutures in between; A5, diamond-shaped anastomosis. (**B,C**) Venotomy and venous anastomosis.

Outcome

Re-exploration was done in 45 cases (7.69%). Re-exploration was done within the first 12 hours in 31 cases and after that period in 14 cases. In 30 cases of re explorations, the cause of flap compromise was found to be other than anastomosis patency. The anastomosis was maintained at the same site of the IJV with management of responsible causes such as position change, evacuation of clots, reorientation of drains, improvement of circulatory status, etc. In the remaining 15 cases, a redo anastomosis was done to a separate site of the IJV. Redo anastomosis with the same venous pedicle to a separate site was done in nine cases. Anastomosis with the second pedicle to a separate site was done in six cases. The flap revision survival rate was 38/45.

Complete flap failure was observed in 12 cases (6 RFFs, 3 OCFFs, and 3 ALT flaps), resulting in a flap survival rate of 573/585 (97.94%). Partial flap loss was seen in one case due to skin paddle necrosis in the OCFF case. The skin defect was reconstructed with a free RFF with anastomosis to the opposite side in this case successfully. Among the 12 failed flaps, 3 were due to arterial thrombosis in a previously irradiated neck. The other nine were due to venous thrombosis, out of which five were noted in the previously irradiated neck.

Discussion

Flap failure after routine microvascular oncosurgical head and neck reconstructions is mainly attributed to venous failure. A range of choices for venous anastomosis including

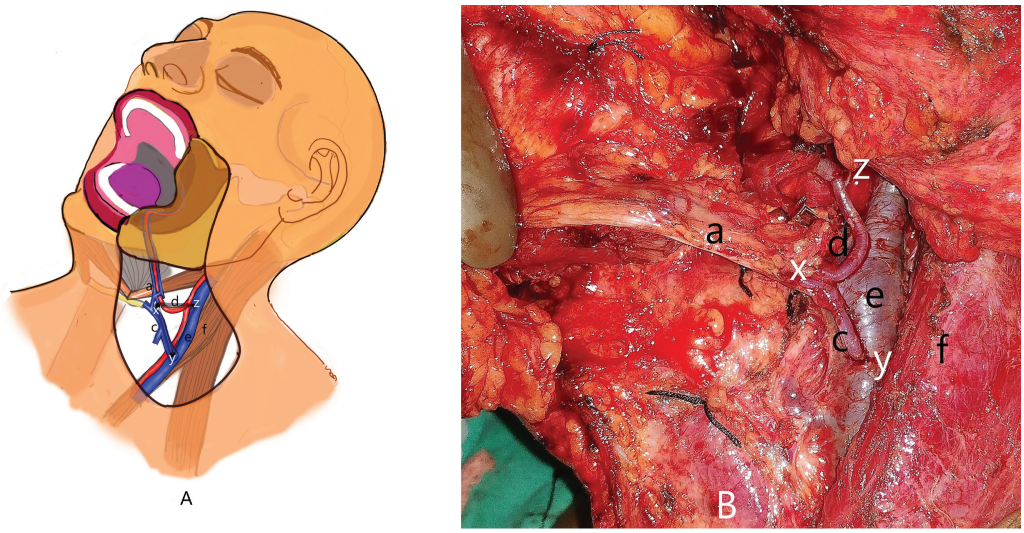

Fig. 4 (A, B) Postanastomotic "triangular orientation" of pedicles. a, vascular pedicle of flap; c, venous pedicle; d, arterial pedicle; e, internal jugular vein; f, sternomastoid muscle; x, confluence of venous and arterial pedicles; y, venous anastomosis; z, arterial anastomosis.

external jugular vein (EJV), anterior jugular vein, transverse cervical vein, and branches of the IJV such as the anterior and common facial vein, lingual vein, and superior thyroid vein remain available for an EE anastomosis.[4] According to availability, superficial location, familiarity with the anatomy, and surgeons' preferences, an EE anastomosis has been practiced widely for head and neck reconstruction. However, unavailability, traction, torsion to the pedicle, and compression during neck movement remain major concerns for such anastomosis. An ES anastomosis with the main IJV or remnant IJV stump is reserved for such cases.[6,7] Moreover, an ES anastomosis is preferred when there is a significant size discrepancy between the anastomotic vessels.[8]

The IJV is the preferred venous draining avenue over the EJV in many centers due to its anatomical configurations and availability. The unavailability of the IJV within the operative field is very rare in routine oncosurgical head and neck cases. Large caliber, constant location, availability after neck dissection, provision of multiple anastomoses, and accommodation of vascular discrepancies are major factors influencing the choice of the IJV for venous anastomosis.[2–4] Besides being subjected to negative pressure during respiration, large-caliber anastomosis and protection from traction and torsion are believed to diminish venous thrombosis and improve flap survival with the IJV compared to the EJV.[9–11]

However, a technical difficulty in creating anastomosis deep in the jugular groove, and unfamiliarity with the anatomy and ES anastomosis, particularly in small-caliber pedicles, may restrain the use of ES IJV anastomosis routinely as the first choice.

As per the senior author's (AG) 20 years' experience of microvascular anastomosis, after a few technical adaptations such as use of a Satinsky clamp for venous occlusion and elevation of the IJV during anastomosis, orientation of the anastomotic pedicles, a posterior to anterior diamond-shaped anastomosis, use of 4.5X loupe magnification and 7–0 sutures, etc., a technical familiarity was obtained and a reduced re-exploration rate was noted with ES anastomosis. This led to the preference for the IJV and ES anastomosis, and this has been used routinely subsequently.

Frequent use of microvascular reconstruction for oncosurgical defects by the oncoplastic team has improved recipient vessel preservation after radical neck dissection. Routine use of facial artery and ES anastomosis with the IJV saves the effort of preserving and searching for suitable vessels for anastomosis. The available pedicle length is adjusted quite well with the provision of venous anastomosis at any location along the vertical length of the IJV. With the triangular geometric orientation, traction and torsion to the pedicle are avoided. After completion of both anastomoses, the pedicle recoils back deep to the sternomastoid groove, so it remains well protected.

Our routine ES venous anastomosis approach suits quite well with free ALT flap and OCFF where the venous diameter is usually 2 to 4 mm. For the RFF cases, the diameter of the venae comitantes is usually less than 1.5 mm. However, the incorporation of a segment of the cephalic vein with the communicating vein in the venous pedicle facilitates venous drainage by a reliable deep venous system through the avenue of a large-caliber cephalic vein, and increases the venous pedicle length[5,12,13] (►**Fig. 2A, C**). (►**Fig. 5**) Routine use of the cephalic vein and communicating vein facilitates the ES approach in RFFs. A vein graft has not been not required in any of our cases. In 10 postradiotherapy neck and redo cases, reconstruction is done with the RFF, where the ipsilateral facial artery stump is not available and anastomosis is made on the contralateral neck. With routine use of these three flaps, vessel diameter, discrepancies, use of vein graft, and operating microscope remain a lesser concern with our approach.

For a vertically oriented anastomosis, it is easy to construct as well as re-explore. It is convenient to re-explore and redo venous anastomosis without using a vein graft. The revision could be done with a higher-up anastomosis and sealing off the previous anastomotic rent on the IJV.

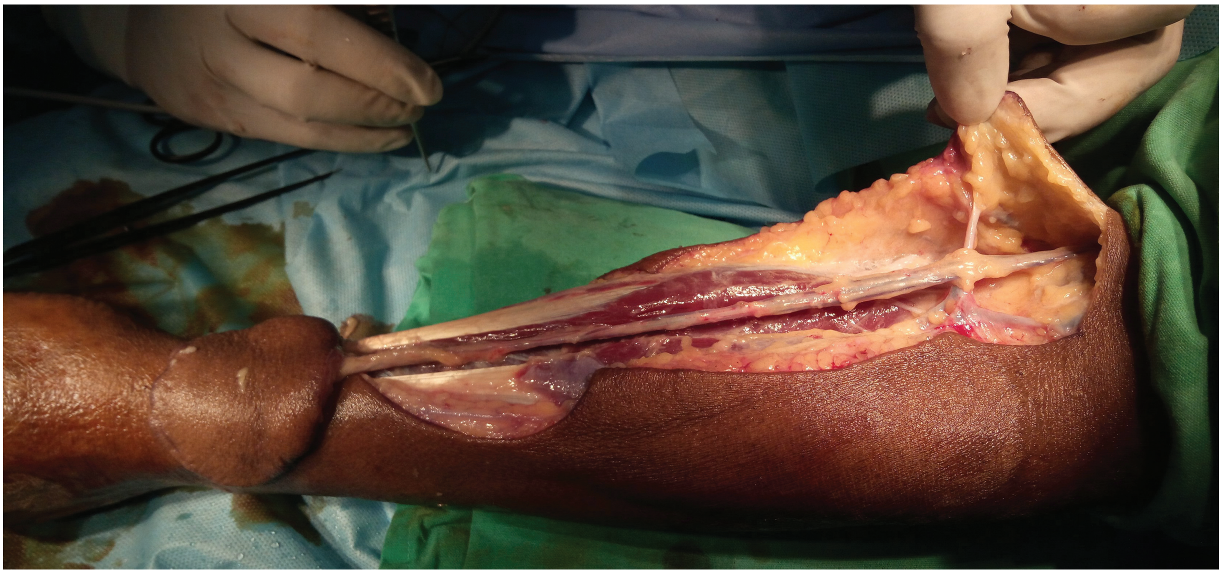

Fig. 5 The possible long pedicle length of a free radial forearm flap (RFF) harvested with communicating vein and cephalic vein.

The most obvious difficulty in constructing an ES anastomosis with the IJV is the deeper location of the IJV. The use of a Satinsky vascular clamp facilitates the elevation of the selected segment of the vein and provides venous occlusion (►**Fig. 2B**). This enables us to construct anastomosis at a superficial plane without any added maneuver.

We have used a horizontal elliptical "fish mouth" venotomy and a rhomboid- or "diamond"-shaped venous anastomosis with the ES approach (►**Fig. 3**). A similar technique has been described earlier by Sen et al for arterial ES anastomosis.[14] According to them, a "diamond"-shaped anastomosis is responsible for improved patency due to increased anastomotic surface area. We believe this may be responsible for better anastomotic patency for venous anastomosis as well. Although we do not have any objective data for this apart from improved re-exploration rate from our earlier cases, we believe the technique is helpful to avoid posterior wall bite, collapse of fish mouth venotomy, and wider anastomosis, which may be responsible for the reduced re-exploration rate in our cases.

An 8–0 or 9–0 suture is commonly used for head and neck reconstruction and done best under the operating microscope. Although this norm is practiced at the beginning of the learning curve, not much data are available on the use of 7–0 sutures or loupe magnification for microvascular anastomosis. Although an operating microscope was available, the cases were performed under "loupe only" and the microscope was not required in any cases in this series. We have observed that in the most commonly performed flaps, RFF, OCFF, or ALT flap, the vessel diameter remains greater than 2.5 mm, which could be comfortably handled with a 4.5X magnifying loupe with placement of a 7–0 Prolene suture. The use of loupe improves operative time by reducing the time to set up and move the operative platform, better visualization of the operative field, easy movement and coordination between surgeon and assistants, comfortable operative position, freedom for access to difficult locations and positions, and reducing surgeons' fatigue. Moreover, the use of a loupe has a quicker learning curve.[15,16] The use of a 7–0 suture further improves the operative time by placement of lesser number of approximating anastomotic sutures. Only in a few cases with relatively small-caliber anastomosis were 8–0 sutures used under loupe magnification. Thus, we believe that at the centers where an operating microscope and 8–0 and smaller sutures are not available or not routinely used, an ES approach still have good feasibility of microvascular head and neck reconstruction.

Finally, we have experienced a decrease in the re-exploration rate than in our earlier practice. A decreased re-exploration rate has been reported after overall improved microvascular suturing and flap survival.[17] The described re-exploration rate and salvage rate in the literature vary from 6 to 14% and 36 to 72%, respectively.[1,18] Re-exploration and salvage rates of the present study were 45/585 (7.69%) and 38/45 (84.44%). Out of 45 re-explorations, 31 were early within 12 hours of primary surgery and all of them were successfully salvaged, improving the overall success of re-exploration as well. Poor salvage rate after re-exploration (8/12) was noted mainly in patients with previously irradiated necks.

The study is limited by the lack of comparative outcome data. As the present study involves a single operating surgeon and a routine ES approach has been practiced exclusively within the study period, a comparative analysis is beyond the scope of this study. However, the study may be considered as a feasibility study of the routine ES approach and results may be used for future comparative analysis of various technical aspects.

Conclusion

Routine use of ES anastomosis simplifies microvascular anastomosis by avoiding efforts related to the selection of recipient vessels, providing the benefit of performing a single large-caliber venous outlet, the favorable geometric orientation of the pedicle, and ease of re-exploration. Vascular anastomosis for RFF, OCFF, and ALT flap can be performed quite conveniently with this approach using 7–0 sutures and under 4.5X loupe magnification, with similar outcomes to the reported flap survival rate in the contemporary practice.

Funding
None.

Conflict of Interest
None declared.

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