

# Feasibility and Reliability of Microvascular Reconstruction in the Vessel-depleted Previously Operated Neck

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## Abstract

**Background:** Microvascular reconstruction of defects in the head and neck has always been a challenge in patients who have undergone previous neck dissection, owing to the prior resection of potential recipient blood vessels used for free flap perfusion. **Objective:** The objective of the study is to evaluate the reliability and safety of free flap reconstruction in patients who have had previous neck dissection. **Materials and Methods:** Twenty-four free flaps were performed in 22 patients with a previous history of neck dissection for head-and-neck squamous cell carcinoma. These included patients who underwent salvage surgery for recurrent cancer as well as patients undergoing secondary reconstruction following previous oncological resections. Flap includes 12 radial forearm free flaps, 5 fibula flaps, 1 rectus abdominis flap, and 6 anterolateral thigh flaps. **Results:** In cases with the previous history of selective neck dissection, recipient vessels on the ipsilateral/same side of the previously operated neck were used, while contralateral vessels were used in patients with a history of modified radical or radical neck dissection. Vein grafts were not necessary, except for one case. In our series, we did not have any flap loss or considerable increase in operative time. **Conclusions:** Free flap reconstruction of head-and-neck defects is highly successful in patients with a history of previous neck dissection, despite a relative scarcity of recipient blood vessels. Careful planning and relying on flaps with a long vascular pedicle obviates the need to perform a suitable vein graft. In our present series, careful planning and the right choice of a free flap with a long vascular pedicle contributes to the absence of free flap failure. In our experience, previous neck dissection should not be considered as a contraindication to microvascular reconstruction of previously operated oncologic defects.

**Keywords:** Free flaps, microvascular surgery, neck dissection, recurrence, vessel compromised neck

## INTRODUCTION

Microvascular free flaps have been proven to be both reliable and functionally effective for reconstruction of major head-and-neck defects. Many clinical series of head-and-neck free flap reconstructions following ablative cancer surgery have reported flap survival rates in the range of 98%–99%.<sup>[1-3]</sup>

Free flap reconstruction is extremely challenging in patients who have undergone previous neck dissection, ipsilateral to the site of defect reconstruction. Previous neck dissection reduces the availability of potential recipient blood vessels for free flap anastomosis and perfusion.<sup>[4]</sup> The lack of potentially suitable cervical recipient blood vessels can increase the complexity of achieving successful free flap reconstruction and thereby may increase the risk of free flap failure.<sup>[5]</sup> Vessel-depleted

neck is a term commonly used by reconstructive surgeons with free tissue transfers in difficult situations after tumor ablation. Many surgeons consider vessel-depleted neck as a condition where no suitable recipient vessels are found in the neck for anastomosis, which necessitates identifying vessels outside the neck for successful reconstruction.<sup>[6]</sup> However,

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there are situations where vessels can still be found in the neck for free tissue transfer before looking for vessels outside the neck.<sup>[7]</sup> These compromised necks are a challenge for the microvascular surgeon planning for a free tissue transfer. We consider “vessel-compromised neck” as a situation where a patient has undergone previous neck dissection and has been planned for free tissue transfer on the same side for the second primary/recurrence.<sup>[7]</sup> There have been very few studies that have focused on the impact of previous neck dissection on the microvascular head-and-neck reconstruction. This study describes our experience of successful free tissue transfer in the vessel-compromised neck and the techniques adopted for the same. In our series of 22 cases, we describe the reliability and safety of free flap transfer following previous neck dissection and also suggest recommendations for optimizing free flap survival.

## MATERIALS AND METHODS

Twenty-two patients with a previous history of neck dissection for the treatment of head-and-neck cancer underwent a total of 24 microvascular free flaps, with two patients receiving double free flaps for secondary reconstruction of defects in the head-and-neck region. Data reviewed were (1) patients age, (2) sex, (3) histopathology of lesion, (4) classification of previous neck dissection, (5) indication and timing of free flap reconstruction, (6) classification of defects, and (7) cervical recipient vessel selection. In patients with large recurrent cancers that crossed the midline, defect laterality was classified according to the initial site of origin of the tumor or the location of the epicenter of the defect. Neck dissections were classified as radical neck dissections, modified radical neck dissections (preserving spinal accessory nerve), or selective neck dissections including supraomohyoid, lateral, posterolateral, or anterior type (preserving internal jugular vein [IJV]).

## RESULTS

There were 18 men and 4 women with a history of neck dissection for head-and-neck cancer who underwent secondary microvascular free flap reconstruction. The average age at the time of surgery ranged from 42 to 68 years. All defects were related to previous treatment of head-and-neck squamous cell carcinoma. Twenty-four free flap reconstructions were carried out in conjunction with the resection of recurrent cancers or secondary primary cancers, with all defects reconstructed previously with local/distant pedicled flaps. Two reconstructions post radiotherapy were done in conjunction with segmental mandibulectomy for the treatment of advanced osteoradionecrosis of the mandible. The defects undergoing reconstruction were classified as oropharyngeal soft-tissue defects (20 cases) and oropharyngeal composite defects (2 cases).

All patients had a previous history of neck dissection. In all the 22 cases, a previous neck dissection had been performed

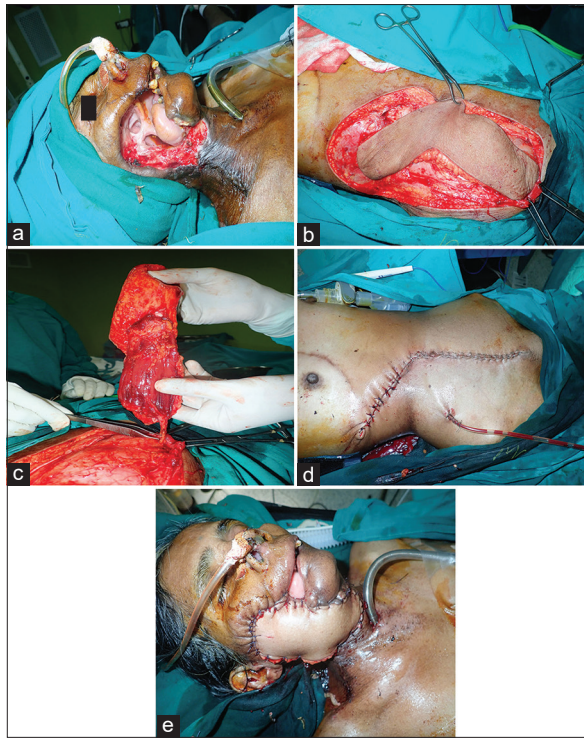
ipsilateral/contralateral to the site of the defect. Overall, there were 5 cases of previous radical or modified radical neck dissection and 17 cases of previous selective neck dissection. In addition, three patients of the 22 previously operated cases had a history of ipsilateral radical neck dissection combined with contralateral selective neck dissection. Two cases had received postoperative radiation therapy following ipsilateral selective neck dissection.

Flap selection included 12 radial forearm flaps, 5 fibula flaps, 1 rectus abdominis flap, and 6 anterolateral thigh free flaps. Recipient vessel selection is summarized in Tables 1 and 2. The number of recipient arteries and veins used for free flap perfusion exceeds the number of reconstructions performed because dual venous drainage was used in select cases of radial forearm flap and fibula flap reconstruction, and there were two cases of simultaneous transfer of two free flaps [Figures 1-3]. Overall, cervical recipient vessels located on the side of the neck that was contralateral to the defect site were used in almost all 22 cases of microvascular reconstruction. The contralateral facial artery was the most common recipient artery, while the most common recipient vein was divided relatively evenly between the contralateral internal and external jugular veins (EJVs) [Table 1]. Cervical recipient vessels for free flap perfusion were located in the field of previous selective neck dissection much more frequently than in the field of previous radical or modified radical neck dissection. It was not necessary to use any additional vein grafts to lengthen the vascular pedicles that supplied the free flaps in any of our cases.

Two cases required an emergency re-exploration within 24 h. Of reconstruction, in both the cases, patients had previously undergone a left radical neck dissection that was ipsilateral to the defect site; the mandibular and skin defect was reconstructed using simultaneous transfer of a fibula free flap and a radial forearm free flap. Both the flaps were perfused using recipient vessels in the contralateral right neck. The microarterial anastomosis created between the peroneal artery of the fibula flap and the right facial artery thrombosed 24 h postoperatively. This anastomosis was urgently revised and the fibula flap was successfully salvaged. There were no cases of free flap failure, resulting in a success rate of 100%.

**Table 1: Recipient artery and vein selection**

	Contralateral neck	Ipsilateral neck
Recipient artery		
Facial artery	12	Nil
Lingual artery	8	
Superior thyroid artery	1	
External carotid artery	3	
Transverse cervical artery	0	
Recipient vein		
Internal jugular vein	18	Nil
Anterior jugular vein	1	
External jugular vein	5	
Transverse cervical vein	0	



**Figure 1:** (a) Post radiation defect, (b) vertical rectus abdominis flap, (c) vertical rectus abdominis myocutaneous flap pedicle, (d) donor site closer, and (e) flap *in situ*



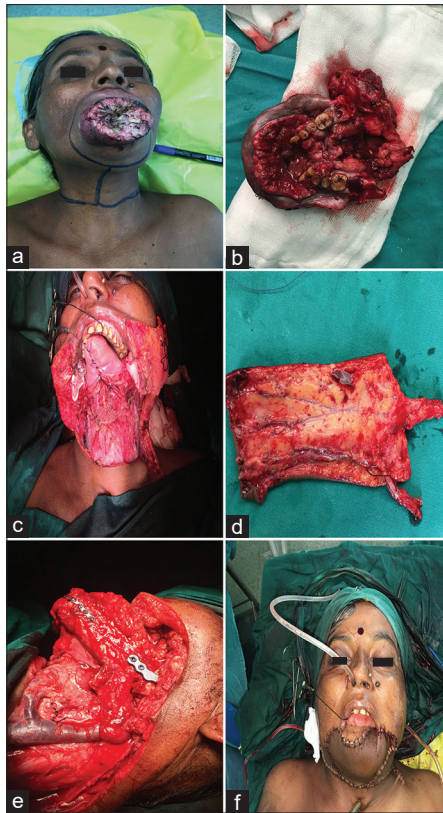
**Figure 2:** (a) Recurrent squamous cell carcinoma, (b) resection markings, (c) Specimen, (d) radial forearm free flap, (e) flap *in situ*

**Table 2: Patient characteristics**

Age	Sex	Primary diagnosis	First surgery	Duration of 2 <sup>nd</sup> surgery	Free flap	Artery	Vein	Ipsilateral neck	Contralateral neck
42	Male	SCC	WLE	6	RFFF	Facial	IJV	Nil	Yes
44	Male	SCC	WLE + LF	6	RFFF	Facial	IJV	Nil	Yes
42	Male	SCC	WLE + LF	6	RFFF	Facial	IJV	Nil	Yes
56	Male	SCC	WLE + PMMC	9	Fibula	Superior thyroid	IJV	Nil	Yes
48	Male	SCC	WLE + PMMC	7	ALT	Lingual	IJV	Nil	Yes
42	Male	SCC	WLE + STG	6	RFFF	ECA	IJV	Nil	Yes
51	Male	SCC	WLE + LF	6	ALT	Facial	IJV	Nil	Yes
55	Male	SCC	WLE + STG	6	RFFF	Facial	AJV	Nil	Yes
59	Male	SCC	WLE + PMMC	8	Fibula	ECA	IJV	Nil	Yes
65	Male	SCC	WLE + PMMC	9	Fibula	Lingual	IJV	Nil	Yes
68	Male	SCC	WLE + PMMC	10	Fibula + RFFF	Lingual + facial	IJV	Nil	Yes
68	Male	SCC	WLE + LF	6	ALT	ECA	EJV	Nil	Yes
49	Male	SCC	WLE + PMMC	6	VRAMF	Lingual	IJV	Nil	Yes
57	Male	SCC	WLE + LF	6	RFFF	Lingual	EJV	Nil	Yes
64	Male	SCC	WLE + PMMC	10	Fibula + RFFF	Facial + lingual	IJV	Nil	Yes
63	Male	SCC	WLE + PMMC	6	ALT	Lingual	EJV	Nil	Yes
61	Male	SCC	WLE + STG	5	RFFF	Facial	EJV	Nil	Yes
47	Male	SCC	WLE + LF	6	ALT	Facial	IJV	Nil	Yes
65	Female	SCC	WLE + STG	6	RFFF	Facial	EJV	Nil	Yes
68	Female	SCC	WLE + PMMC	6	ALT	Lingual	IJV	Nil	Yes
66	Female	SCC	WLE + RFFF	5	RFFF	Facial	IJV	Nil	Yes
68	Female	SCC	WLE + PMMC	6	RFFF	Facial	IJV	Nil	Yes

SCC=Squamous cell carcinoma; WLE=Wide local excision; LF=Local flap; STG=Split-thickness skin graft; PMMC=Pectoralis major myocutaneous flap; RFFF=Radial forearm free flap; ALT=Anterolateral thigh flap; VRAMF=Vertical rectus abdominis myocutaneous flap; IJV=Internal jugular vein; EJV=External jugular vein; ECA=External carotid artery; PMMC=Pectoralis major myocutaneous flap





**Figure 3:** (a) Recurrent squamous cell carcinoma, (b) Specimen, (c) neck clearance, (d) radial forearm free flap, (e) fibula reconstruction, and (f) final closure with double flap

Preoperative radiotherapy had no impact on free flap viability. Low molecular-weight heparin (5000 IU) was used as a stat bolus immediately after the completion of anastomosis in all 22 cases.

## DISCUSSION

Over the past century, the use of microvascular free flaps has greatly enhanced the wide range of options available to achieve the surgical reconstruction of defects in the head and neck. Microvascular free flaps allow single-stage reconstruction at the time of surgical resection. Although the first microscope-assisted transfer of a free flap was reported in 1973,<sup>[4]</sup> earlier to the 1990s, there was limited enthusiasm in the use of free flaps for the reconstruction of head-and-neck defects.<sup>[8]</sup> This reluctance arose from several perceived shortcomings of microvascular tissue transfer. Such concerns included questions regarding the reliability of a technique that was dependent on small-vessel vascular anastomoses for a successful outcome and the potential for an adverse impact on the costs and complications of therapy.<sup>[5,9]</sup>

As surgeons became more experienced with microvascular free flap techniques, the reliability of free flaps has improved steadily. An early survey revealed that the rate of successful free flap transfer was 89% during the first decade of clinical experience with microvascular surgery;<sup>[5]</sup> by the mid-1990s,

several large series reported successful head-and-neck reconstruction using free flaps in 91%–95% of cases.<sup>[10–13]</sup> In 1999, Blackwell described a success rate of 99% in 119 cases of microvascular head-and-neck reconstruction,<sup>[11]</sup> while Singh *et al.* reported success in 98% of 200 cases.<sup>[2]</sup> Improved free flap reliability has been due to improved microvascular techniques, increased reliance on free flaps with long vascular pedicles that contain large-caliber blood vessels, and greater experience by individual surgeons.

The most common cause of free flap failure is thrombosis of the vascular pedicle in the region of the microvascular anastomosis.<sup>[14]</sup> Microvascular reconstruction in the head and neck is more challenging in patients who have undergone previous neck dissection due to prior resection of potential recipient blood vessels.<sup>[15,16]</sup> It is understood that a relative unavailability of potential recipient blood vessels in the neck might result in an increased risk of free flap failure in patients with a history of previous neck dissection.<sup>[6,17]</sup>

The present series details 22 patients who underwent free flap reconstruction following previous neck dissection, achieving a success rate of 100%. About 10% of the neck dissections were contralateral to the defect site. Prior radiation therapy does not appear to have a negative impact on flap survival since most of our patients had both pre- and postoperative radiation therapy. Our study, therefore, does not identify previous neck dissection as a risk factor associated with an increased rate of free flap failure. Our series indicate that free flaps need not be avoided when there is a history of previous neck dissection. Although free flaps proved reliable, almost all of our patients required the use of cervical recipient blood vessels in the contralateral neck, reflecting an increased complexity of reconstruction. The use of contralateral recipient blood vessels is rarely necessary in the absence of previous neck surgery.

The extent of the previous neck dissection has an impact on the need to rely on contralateral vessels. In most of the cases of previous selective neck dissection, cervical recipient blood vessels were successfully located in the field of the previous neck dissection.<sup>[18]</sup> By contrast, all patients with a history of modified radical or radical neck dissection required the use of cervical recipient blood vessels in the opposite side of the neck. This is likely due to the unavailability of suitable cervical recipient veins in the field of previous modified radical or radical neck dissection.<sup>[19]</sup> The facial and superior thyroid arteries are commonly ligated during cases of selective, modified radical, and radical neck dissection. However, the external carotid artery and medial branches of the external carotid artery such as the lingual artery are commonly preserved during neck dissection and may be available to use as cervical recipient blood vessels during subsequent cases of microvascular flap reconstruction.<sup>[16]</sup> This explains why the external carotid artery and lingual artery are used frequently within the ipsilateral neck as compared with the contralateral neck.<sup>[7,13]</sup> However, the external and IJVs are routinely sacrificed during a modified

radical or radical neck dissection. This makes availability of a recipient vein within the field of previous modified radical or radical neck dissection more difficult compared with after previous selective neck dissection where the external or IJVs are more commonly preserved.<sup>[12,15,17]</sup>

Another approach indicated in the literature when there is not a suitable recipient vein relies on cephalic vein transposition.<sup>[20]</sup> In cases of previous modified radical or radical neck dissection, the cephalic vein can be transposed from the ipsilateral arm to the neck to serve as a recipient vein for free flap perfusion.<sup>[14,16,20]</sup> Advantages of this technique include the fact that only one microvascular anastomosis is required, and the high-flow, low-pressure cephalic-subclavian system may be resistant to stasis and thrombosis.<sup>[20]</sup> The primary disadvantage of this technique arises from the increased potential of kinking or extrinsic compression of the venous pedicle within its long subcutaneous course, particularly where the cephalic vein crosses over the clavicle.<sup>[20,21]</sup>

In cases where the same side or ipsilateral cervical recipient blood vessels are unavailable, vein grafts can be used to lengthen vascular pedicle to reach remote recipient vessels.<sup>[17]</sup> In our present series, the need to use vein grafts was eliminated by careful preoperative planning and reliance on free flaps that contain long vascular pedicles. Two previous large series of microvascular head-and-neck reconstruction have correlated the use of vein grafts with an increased risk of free flap failure, so they are best avoided whenever feasible.<sup>[9,13]</sup> Daniel *et al.* had operated on 33 patients with previous neck dissections for the secondary free flap reconstruction. Among these 33 patients, 19 had recurrence/second primary, while 14 had flap failures.<sup>[4]</sup> They approached the contralateral side for anastomosis in 22 patients and did not have any flap failure. None of the cases in their study required vein graft, which may be similar to our study. We used contralateral vessels similar to that of Daniel *et al.* They did not have any flap loss but had hematoma evacuation done in one case. The results of their study were similar to ours. Jacobson *et al.* had done 14 free tissue transfers in the vessel-depleted neck. All the patients in their group had IJV ligated in the first surgery, making “out of ipsilateral neck vessels” the only choice for anastomosis.<sup>[16]</sup> They used the cephalic vein in 9 of the 14 patients for venous anastomosis and used vein grafts on four occasions for arterial.<sup>[16,20]</sup> The systematic review by Frohwitter *et al.* involved case reports and case series.<sup>[19]</sup> The most commonly used arteries were internal mammary artery (28%), thermal coronary angiography (15.9%), and (STA) superior thyroid artery (14.9%); and the veins were cephalic vein (25.9%), internal mammary vein (24.4%), and (STV) superior thyroid vein (15.4%). In our study, the most commonly used arteries are contralateral superior thyroid and contralateral facial; and the veins are contralateral IJV and EJV [Figures 1-3]. According to them, the ideal vessel for these conditions should comply the following: (1) vessel with reliable anastomotic appearance, length, and caliber; (2) surgical exposure of vessel should not bring further damage to the pretreated neck; and (3) the

vessel should lie in the nonradiated part of the body.<sup>[19]</sup> We have observed that the vessels in the radiated neck can also be used for anastomosis with good results, which provided that it is of good caliber and has healthy intima and adequate flow in it. In this systematic review, there is no description of the use of vessels of contralateral neck (commonly used by us) which are in the virgin field and still lie closer to the defect as compared to other outside the neck. In our series, radial forearm free flap, fibula flap, rectus abdominis flaps, and anterolateral thigh flaps accounted for 100% of the donor sites selected. All of these flaps contain long vascular pedicles that usually can reach cervical recipient blood vessels in the contralateral neck without requiring the use of vein grafts.

Based on our experience with the patients in this series, we propose the following algorithm for microvascular flap reconstruction in patients with a history of neck dissection as related to factors that affect recipient vessel selection.<sup>[22]</sup> The status of potential recipient veins within the field of previous neck dissection is usually the most critical factor in determining the selection of cervical recipient vessels for flap perfusion. Our choices for veins were as follows:

1. Corresponding vein accompanying the selected artery
2. Second choice: large branches of IJV in the vicinity of the selected artery
3. Third option: EJV
4. End-to-side anastomoses to IJV
5. Use of appropriate vein grafts to either ipsilateral or contralateral neck
6. Transposition of the cephalic vein.

Some length of the external carotid artery is usually preserved during most of the neck dissections, and an end-to-side arterial anastomosis to the external carotid artery can usually be performed even when all external carotid branches have been previously ligated.<sup>[13,14]</sup>

In patients with a history of radical neck dissection or modified radical neck dissection, plan should be made for the use of recipient vessels in the nonoperated-neck, as it has been our experience that recipient veins are rarely available due to prior resection of the internal and external jugular venous systems in patients with previous radical neck dissection or modified radical neck dissection. In cases where the un-operated neck is contralateral to the defect site, selection of a free flap that offers a long vascular pedicle usually eliminates the need to perform vein grafts, although all patients with previous neck dissection are routinely informed of and consented for the possibility to perform vein grafting if necessary. Average operative time in our series is 6 h for a single flap and 10 h for a double flap.

In patients with a history of a selective neck dissection that is ipsilateral to the defect site, careful review needs to be done to determine the status of the IJV before planning the reconstructive options. In cases where the IJV is preserved during previous neck dissection, we have found that recipient vessels are usually available within the field of the prior neck dissection. In some of the cases, it is necessary to use

recipient vessels within the contralateral neck, because of the difficulty in isolating and preparing suitable recipient veins within the field of previous selective neck dissection, due to periadventitial scarring or perioperative thrombosis of an IJV that had been preserved during a selective neck dissection. Even in these cases, the selection of flaps that offer long vascular pedicles and planning for possible vein grafting is desirable, as the use of contralateral recipient vessels will be necessary in approximately 80% of cases.

In general, healthy vessels of good caliber and distant from irradiated tissues are preferred. Vessels need to be dissected atraumatically under magnification with sufficient mobilization for easy positioning during anastomosis, they must have a good flow on division, and a good pulsatile flow in arteries is a prerequisite and final confirmation.<sup>[22]</sup> Several options described in the literature can be used in truly vessel depleted neck. The cephalic vein, either as an arteriovenous loop or as a recipient vein, can be used, the thoracodorsal pedicle can also be transposed into the neck, and internal mammary vessels could be used. In double free flaps, the first free flap can be used as a recipient vessel for the second free flap. A favorable pedicle geometry and the presence of pulsatile flow from the distal ends are crucial for successful anastomosis.<sup>[23]</sup>

## CONCLUSIONS

Free flap reconstruction of the head and neck is highly successful in patients with a history of neck dissection despite a relative scarcity of potential cervical recipient blood vessels. Recipient vessels can be identified in the field of previous selective neck dissection in approximately more than half of such cases, while recipient vessels are rarely available in the field of a previous radical neck dissection. In the majority of cases of microvascular reconstruction after previous neck dissection, it is necessary to use recipient vessels in the neck that is contralateral to the side of the defect. Reliance on free flaps with long vascular pedicles eliminates the need to perform vein grafts. In our present series of 24 free flap reconstructions, relying on flaps with long vascular pedicle has probably contributed to the absence of free flap failure. In our opinion, previous neck dissection should not be considered as a contraindication to microvascular reconstruction of the head-and-neck defects.

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## Conflicts of interest

There are no conflicts of interest.

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