

Use of Internal Mammary Vessels in Head and Neck Microvascular Reconstruction

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Objective: To describe the use of the internal mammary vessels (IMVs) in microvascular head and neck reconstruction in a small case series with select donor sites.

Design: Retrospective medical record review study.

Setting: Oregon Health and Science University and University of Alabama.

Patients: Patients for whom IMVs were used for head and neck reconstruction from January 1, 1998, through December 31, 2010.

Main Outcome Measures: Intraoperative or postoperative complications, flap survival, and morbidity due to the flap.

Results: Of 2721 free tissue transfers, 55 (2%) (in 48 patients) used IMVs. Use of IMVs was associated with

ablative surgery with sternal resection (25 of 55 [45%]), a vessel depleted neck (23 of 55 [42%]), and fistula repair with gross contamination due to prior flap failure or chronic pharyngocutaneous fistula with vessel depleted neck (7 of 55 [13%]). Flaps included radial forearm (33 of 55 [60%]), jejunum (9 of 55 [16%]), ulnar (5 of 55 [9%]), and other (8 of 55 [14%]). No vein grafts were used. Pneumothorax developed in 1 patient (2%). Postoperative fistulas were observed in 14 of 48 patients (29%); the fistulas healed conservatively in 7 patients (50%), rotation of flap tissue was required in 2 patients (14%), and the fistulas persisted in 5 patients (36%). The flap survival rate was 98%.

Conclusion: Internal mammary vessels provide reliable recipient vessels for cervical and sternal microvascular reconstruction.

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ALTHOUGH THE NECK PROVIDES an abundance of recipient vessels for free tissue transfer, patients who undergo multiple neck operations for recurrent tumor or wound complications have limited options for microvascular transfer. Dissection of the carotid system after previous surgery and radiation treatment to the neck may result in injury to the hypoglossal nerve or luminal injury to the carotid system or internal jugular vein that can be difficult to control. If the ipsilateral vessels have been previously dissected, it is common to explore the contralateral aspect of the neck to find appropriate vessels. However, dissection of the vessels with concurrent pharyngeal violation risks exposure of the vessels to salivary contamination. Cervical vessels may not be accessible or exposure of these vessels may not be suitable for microvascular reconstruction.¹

Techniques to obtain recipient vessels for microsurgery include accessing alter-

native vessels, such as the transverse cervical vessels, the thoracoacromial vessels, and the cephalic vein; transposition of the thoracodorsal vessels; and other techniques, including flap selection to provide a long vascular pedicle or the use of vein grafts.^{2,3} Surgical management of head and neck cancer, especially after intensive medical treatment, can result in a paucity of recipient vessels for microvascular anastomosis. The internal mammary vessels (IMVs) have been used in head and neck reconstruction in small case series with select donor sites.^{4,5} We describe successful use of the IMVs for this purpose.

METHODS

The microvascular reconstructive services at Oregon Health and Science University and University of Alabama maintain an institutional review board–approved prospective database on all free tissue transfers. Using these databases, we reviewed the medical rec-

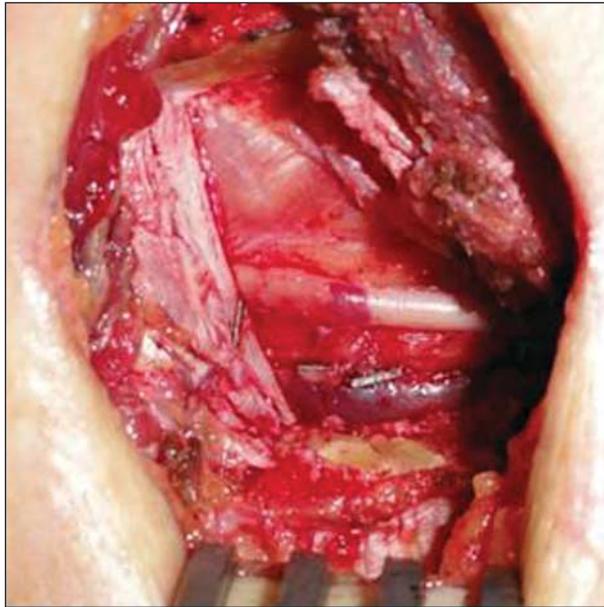


Figure 1. Exposed internal mammary vessels after 3-cm rib resection.

ords of all patients undergoing free tissue transfer with the use of the IMVs (the internal mammary artery and vein) for microvascular anastomosis at Oregon Health and Science University (M.K.W.) and University of Alabama (E.L.R.) from January 1, 1998, through December 31, 2010. Fifty-five flaps in 48 patients (2%) involved use of the IMVs for reconstruction of defects in the head and neck region. Medical records were reviewed to determine patient age, indications for surgery, prior therapies, flap types used, indication for use of the IMVs, and surgical complications. Medical records were reviewed to determine any intraoperative or postoperative complications. Flap survival and morbidity due to the flap were assessed and analyzed.

To harvest the IMVs, we make a 3-cm horizontal incision over the third rib, identify and reflect the pectoralis major muscle laterally, expose the rib, perform subperichondrial dissection, and remove a 2- to 3-cm segment of rib. We then remove the posterior perichondrium and expose the underlying vascular bundle as demonstrated in **Figure 1**. The vascular bundle is carefully dissected and mobilized from the underlying parietal pleura to avoid entry into the pleural space and to provide sufficient length to avoid arterial and venous kinking. We generally dissect the IMVs just distal to the third costal interspace, which reliably yields an artery averaging 2.4 mm and a vein averaging 3 mm in 70% of cases as previously reported.³ The vessels are then ligated and transposed superiorly for microvascular anastomosis as demonstrated in **Figure 2**. We found no preference between the right and left sides as long as we did not dissect the vessels distal to the third intercostal space. The artery is anastomosed with a 9-0 nylon suture in an end-to-end fashion, whereas the vein is anastomosed with the coupling device. During the dissection we have displaced the medial insertion of the pectoralis muscle. If the sternum is intact, we then place the divided pectoralis muscle into the defect created by the rib removal. A Penrose drain is placed in the wound, and the wound is closed in 2 layers. We do not use suction drains at this recipient site. However, when the wound is part of a sternal resection, the neck and sternal wound are drained with suction drains. With careful dissection and planning, IMV isolation with the technique described will reliably provide a recipient artery and vein in patients with no prior invasive upper chest surgery.

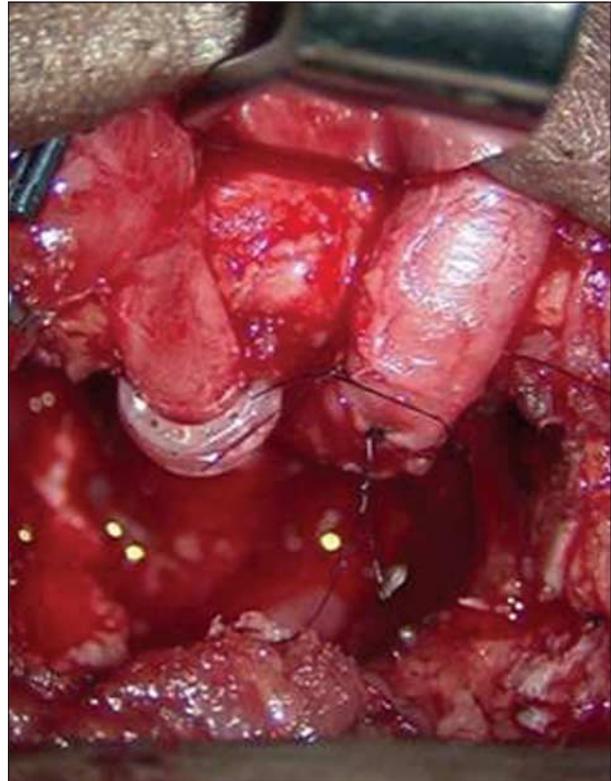


Figure 2. Internal mammary vessel anastomoses after superior transposition.

RESULTS

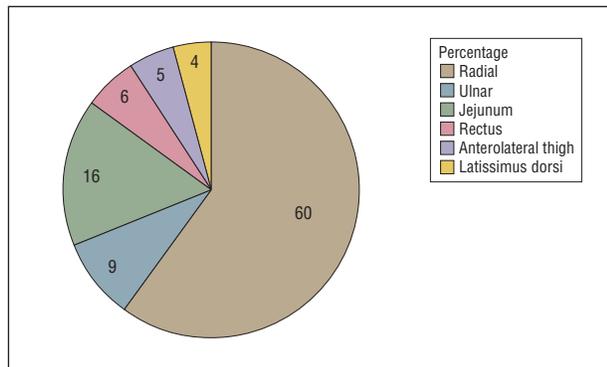
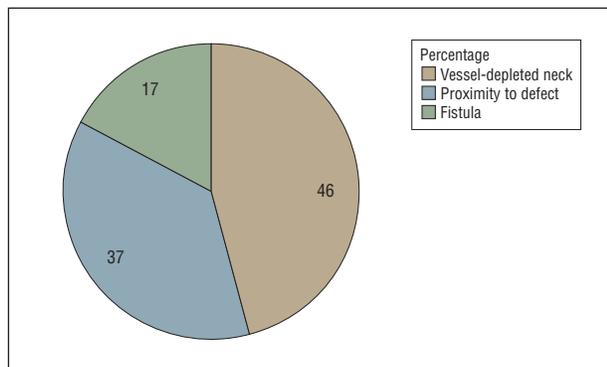
During a 12-year period, the IMV was used for microvascular anastomosis in 55 of 2721 flaps (2%). The mean age of the patients was 65 years (range, 40-87 years). Indications for surgery were recurrent small cell carcinoma (60%) followed by recurrent thyroid carcinoma (20%) and salivary fistula (15%). Review of prior therapies indicates a heavily pretreated population, with 80% having undergone prior ablative surgery, 64% having unilateral or bilateral neck dissection, 70% receiving prior radiation, and 22% receiving preoperative concurrent chemoradiation. There were 13 patients (27%) who underwent prior free flap reconstruction (**Table 1**). The radial forearm flap was the most commonly used, with the distribution of free flaps shown in **Figure 3**. Eight patients (17%) had 2 simultaneous free flaps. Indications for use of the IMVs included proximity to defect after sternal resection (38%), vessel depleted neck (47%), and secondary reconstructions of pharyngocutaneous fistulas (15%) (**Figure 4**).

Two mortalities occurred in this cohort: the first from sepsis related to anastomotic leak from gastric pull-up and concurrent ulnar flap and the second due to myocardial infarction 1 day after discharge (**Table 2**). Pneumothorax was recognized in 5 patients at the time of the surgical ablation and treated with chest tubes by the ablative team. This finding was unrelated to IMV preparation by the microvascular team because chest tubes were inserted after tumor ablation before reconstruction. Other surgical complications included one flap failure that was

Table 1. Patient Characteristics

Characteristic	Value ^a
Age, median (range), y	65 (40-87)
Indications	
Squamous cell carcinoma	36 (78)
Recurrent	29 (60)
Recurrent thyroid carcinoma	9 (20)
Salivary fistula	7 (15)
Esophageal stenosis	1 (2)
Osteoradionecrosis	1 (2)
Chondronecrosis	1 (2)
Sternal resection	18 (38)
Recurrent small cell carcinoma	10 (21)
Recurrent thyroid carcinoma	8 (17)
Prior therapy	
Prior surgery	41 (87)
Unilateral neck dissection	7 (16)
Bilateral neck dissection	22 (48)
Prior free flap reconstruction	12 (26)
Radiation	32 (70)
Concurrent chemoradiation	11 (23)

^aData are presented as number (percentage) of 48 patients unless otherwise indicated.

**Figure 3.** Flap selection.**Figure 4.** Indications for use of the internal mammary vessels in 48 patients.

remedied with an additional free flap. This same patient also developed a pneumothorax identified by chest radiography on postoperative day 2 that presented with progressive dyspnea and subcutaneous emphysema 2 days after his second free flap reconstruction. This single pneumothorax was related to IMV preparation and was not noted intraoperatively. Two patients developed wound

Table 2. Intraoperative and Postoperative Surgical Complications

Complications	No. (%) of 48 Patients
Death	2 (4)
Flap failure	1 (2)
Partial failure	1 (2)
Salvage attempts	0
Pneumothorax	1 (2)
Pneumothorax with sternal resection	5 (10)
Chest wound infection	2 (4)
Seroma	1 (2)
Fistula	14 (29)
Conservative management	7 (15)
Local flap	2 (4)
Persistent	5 (10)

infection at the chest IMV recipient site, one of which required incision and drainage. Fistula formation occurred in 14 of 48 patients (29%), with 4 of those 14 patients developing a recurrent fistula after undergoing a secondary reconstruction for fistula repair. In most patients these fistulas healed secondarily. Two patients required use of local flaps for closure and the fistulas persisted in 5 patients.

COMMENT

Secondary head and neck microsurgery typically relies on recipient cervical vessels with use of the transverse cervical vessels or IMVs when the external carotid and internal jugular vein are unavailable or exposure of the vessels is unwarranted. A subset of patients who have undergone multimodality therapy, typically multiple operations with radiation or chemoradiation, will have poor recipient vessel availability. The transverse cervical and IMVs remain the best options because they are outside the field of a selective neck dissection, provide both a vein and artery for use, and do not put the great vessels at risk for salivary exposure. Our preference in these patients is to use the contralateral aspect of the neck if possible. Most of the time these vessels will be available and acceptable. Use of the contralateral aspect of the neck may require vein grafts. In our experience, vein grafts do not increase the failure rate, although they do increase the overall operative time.

Others have described the use of reverse thoracodorsal vessels or thoracoacromial vessels. The IMVs have proven useful as a recipient vessel resource. Use of the IMVs as “rescue” recipient vessels in less than 2% of flaps performed during the last 12 years at our institutions has provided the microvascular surgeon with a straightforward recipient vessel option. These vessels assist and eliminate reconstructive uncertainty in these complex patients who have often undergone previous neck dissections followed by recurrence with additional neck dissections and further loss of recipient vessels after aggressive ablative surgery. It is important to recognize recipient vessel challenges preoperatively to inform the patient of the risks associated with additional incisions.

In the current study, we identified 3 groups that benefited from the use of IMVs. The first group required pharyngeal reconstruction with associated sternal resec-

tion. The second group included recurrent tumor ablation patients requiring free flap reconstruction in a vessel-depleted neck. The third group included patients requiring reconstruction of acute or chronic salivary fistulas.

Given the proximity of the IMVs after sternal resection, the IMVs were used in 18 of the 48 patients (38%) (26 of 55 free flaps [47%]) because they were accessible within the surgical field after resection of the medial clavicle and first, second, and occasionally third ribs by the ablative team. Eight of these 18 patients required 2 simultaneous free flaps, typically with jejunum for total laryngopharyngectomy reconstruction and an additional soft tissue flap for reconstruction of the tracheostoma. **Figure 5** demonstrates the easily accessible IMVs in patients after sternal resection. The proximity of the IMVs to the ablative defect makes vascular anastomosis straightforward.

The patients with vessel-depleted necks in our series (22 of 48 [46%]) had undergone extensive prior ablations, neck dissections, and free flap reconstructions. These patients either had severely scarred tissue or the external carotid or internal jugular system had been ligated. Use of the IMVs in these patients requires flaps with long vascular pedicles to obviate the need for vein grafts (16 radial forearm free flaps, 2 ulnar flaps, 1 anterolateral thigh, and 1 latissimus dorsi in the current series).^{6,7} In the current series, it was not necessary to routinely perform computed tomographic angiograms or other imaging studies to evaluate patients preoperatively for recipient vessels as has been reported by others requiring second free flaps.⁵ The readily accessible IMVs serve a useful option in this patient population with minimal recipient site morbidity⁸ (Figure 2).

Finally, patients with acute or chronic pharyngocutaneous fistulas are difficult to manage secondary to host factors, including hypothyroidism, wound infection, malnutrition, comorbidity, prior treatments, and recipient vessel depletion.^{9,10} Harvesting and using the IMVs in these clinical situations at the outset of the operation avoid further great vessel exposure in patients with compromised wounds and neck tissue from prior therapies. Of the 7 patients in our series who required IMVs for recipient vessels for fistula reconstruction, 4 patients had subsequent fistula recurrence. The overall rate of fistulas observed in this patient population (14 of 48 [29%]) is consistent with other reports of salvage laryngectomy reconstruction.¹¹ This patient population represents a select group of patients in whom higher complication rates should be anticipated and methods to lower complications, such as buttressing wounds with regional flaps, should be strongly considered.¹²

The morbidity of the procedure is related to possible pneumothorax and the defect in the chest wall. Pneumothorax occurred in 6 patients, 5 with pneumothorax that occurred at the time of sternal resection. The process of rib resection is no different than that used for cartilage harvest for a variety of other head and neck reconstructive procedures. Careful stripping of the cartilage will prevent the formation of a pneumothorax. In larger resections involving the sternum, we now place chest tubes when there is a large pleural

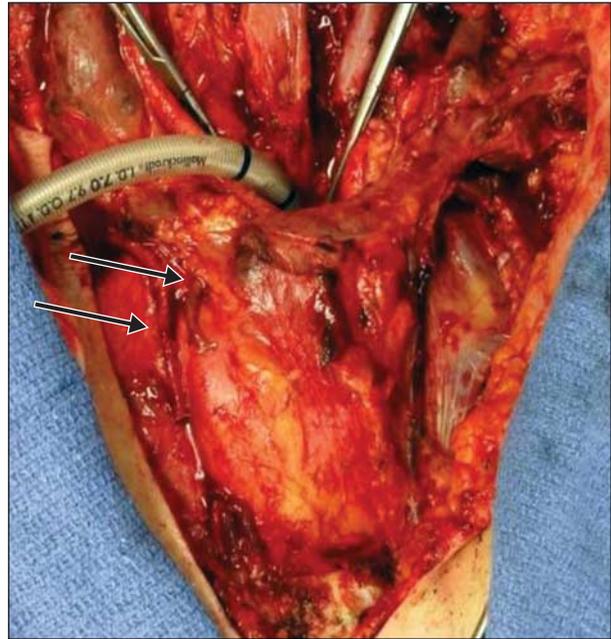


Figure 5. Sternal resection with exposed internal mammary vessels (arrows) (internal mammary artery and vein).

tear. We have found it difficult to repair the pleura in these circumstances.

Use of recipient IMVs for microvascular head and neck reconstruction provides the microsurgeon with an important vessel alternative in patients after sternal resection, in those with a vessel-depleted neck where vessels are unavailable or unsuitable for anastomosis, and in cases of acute or chronic fistula where concurrent wound infections and/or vessel depletion occurs. In such cases, the IMVs should be considered. Outcomes and complications with the IMVs are similar to other vessel alternatives. Our low rate of pneumothorax confirms the ease of harvesting these recipient vessels and should not dissuade others from attempting to use these vessels for microvascular reconstruction. Selecting flaps with long vascular pedicles will prevent the need for interposition vein grafts.

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Author Contributions: Drs Rosenthal and Wax had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Schneider, Rosenthal, and Wax. *Acquisition of data:* Schneider, McClain, Robb, and Wax. *Analysis and interpretation of data:* Schneider, McClain, Rosenthal, and Wax. *Drafting of the manuscript:* Schneider, Robb, Rosenthal, and Wax. *Critical revision of the manuscript for important intellectual content:* Schneider, McClain, Rosenthal, and Wax. *Statistical analysis:* Schneider. *Administrative, technical, and material support:* Robb. *Study supervision:* Rosenthal and Wax.

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