The Laryngoscope
Lippincott Williams & Wilkins, Inc., Philadelphia

Radial Forearm Free Flap Pharyngoesophageal Reconstruction

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Objectives: **This study evaluates the outcome of pharyngoesophageal reconstruction using radial forearm free flaps with regard to primary wound healing, speech, and swallowing in patients requiring laryngopharyngectomy.** ***Study Design:*** **Retrospective review in the setting of a tertiary, referral, and academic center.** ***Patients and Methods:*** **Twenty patients underwent reconstruction of the pharyngoesophageal segment using fasciocutaneous radial forearm free flaps.** ***Results:*** **All free flap transfers were successful. An oral diet was resumed in 85% of the patients after surgery. Postoperative pharyngocutaneous fistulas occurred in 4 patients (20%) with 3 resolving spontaneously. Distal strictures also occurred in 20% of the patients. Five patients who underwent tracheoesophageal puncture achieved useful speech.** ***Conclusions:*** **Advantages of radial forearm free flaps for microvascular pharyngoesophageal function include high flap reliability, limited donor site morbidity, larger vascular pedicle caliber, and the ability to achieve good quality tracheoesophageal speech. The swallowing outcome is similar to that achieved after jejunal flap pharyngoesophageal reconstruction. The main disadvantage of this technique relates to a moderately high incidence of pharyngocutaneous fistulas, which contributes to delayed oral intake in affected patients.** ***Key Words:*** **Radial forearm free flap, jejunal free flap, pharyngoesophageal reconstruction, total laryngopharyngectomy.**

Laryngoscope, **111:807–810, 2001**

INTRODUCTION

Combined surgery and radiotherapy traditionally has been the treatment of choice for advanced carcinomas of the hypopharynx. The earliest methods of reconstruction of the hypopharyngeal segment relied on the use of local cervical tissue.[1–6] In 1942, Wookey[6] popularized a two-stage repair of pharyngoesophageal defects using local skin flaps. In 1965 Bakamjian[7] described a two-stage reconstruction with the deltopectoral flap. Subsequent development of island myocutaneous flaps for head and neck reconstruction in 1979 made it feasible to carry out single-stage pharyngoesophageal reconstruction using well-vascularized segments of skin. Such flaps included the pectoralis major myocutaneous flap described simultaneously by Ariyan[8] and Baek,[9] the trapezius flap described by Demergasso and Piazza,[10] and the latissimus dorsi myocutaneous flap reported by Quillen.[11]

Seidenberg[12] introduced revascularized free visceral flaps for pharyngoesophageal reconstruction in the form of the free jejunal flap in 1959. Free flaps did not, however, become widely used for hypopharyngeal reconstruction until after the refinement of microvascular techniques during the 1970s. Harii[13] described the use of a tubed fasciocutaneous free flap for pharyngoesophageal reconstruction in 1985. The radial forearm fasciocutaneous free flap (RFFF) has been used both as a patched graft in cases in which there is insufficient mucosa to achieve primary closure, as well as a tubed flap for reconstruction of circumferential defects of the hypopharynx and cervical esophagus.

The RFFF is used less commonly than jejunal free flaps for microvascular reconstruction of the pharyngoesophageal segment with only approximately 200 cases reported in the literature. At our institution, however, it is the most commonly used method for hypopharyngeal and cervical esophageal reconstruction following total laryngopharyngectomy (with or without cervical esophagectomy) or total laryngectomy with partial pharyngectomy when there is insufficient remaining mucosa to achieve primary closure. The outcome of RFFF pharyngoesophageal reconstruction is examined to highlight the relative advantages and disadvantages of this method.

Technique

Allen's test is performed to ascertain that the radial artery can be sacrificed without resulting in ischemia of the hand. A shield-shaped skin paddle is positioned over the radial artery and cephalic vein on the distal volar aspect of the nondominant forearm (Fig. 1). The distal width of the flap at the cervical esophageal anastomoses is usually 6 to 8 cm, while the proximal width of the flap at

Presented at The Western Section of the American Laryngological, Rhinological and Otological Society, Inc., La Costa, California, January 6, 2001. Winner of the Resident Travel Award.

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Editor's Note: This Manuscript was accepted for publication February 21, 2001.

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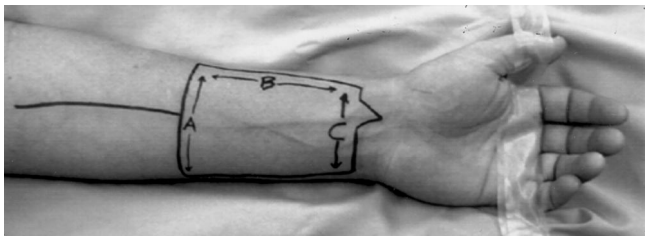

Fig. 1. A shield-shaped flap is designed overlying the radial artery and cephalic vein for reconstruction of circumferential pharyngoesophageal defects. The width of the proximal portion of the skin paddle (A) is determined by the circumference of the oropharyngeal resection margin and is usually 12 to 14 cm. The length of the pharyngoesophageal defect as measured from the oropharyngeal resection margin to the esophageal resection margin determines the length of the skin paddle (B). The width of the distal skin paddle (C) is determined by the circumference of the esophageal resection margin and is usually 6 to 7 cm. A triangular extension is incorporated into the distal aspect of the skin paddle. This is inset into a longitudinal incision made in the esophagus to enlarge the circumference and break up the annular nature of the distal enteric anastomosis to reduce the risk of stricture.

the oropharyngeal anastomoses is usually 12 to 14 cm. A 2-cm long triangular-shaped skin extension is incorporated at the end of the flap to be integrated into a linear incision in the cervical esophageal remnant in a lock and key fashion to enlarge these enteric anastomoses. The total length of the pharyngoesophageal defect as measured from the oropharyngeal mucosal remnant to the cervical esophageal remnant determines the length of the flap. If necessary, bilobed fasciocutaneous flaps are created by demucosalizing an interval skin in the midforearm to reconstruct both external neck skin and the pharyngoesophageal defect.

For circumferential defects, we prefer to create the proximal and distal enteric anastomoses prior to tubing the flap on itself. Harii[13] described tubing the flap on itself prior to flap harvest and insetting, to lessen the ischemia time. However, it has been our experience that the exposure for the more difficult proximal and distal enteric anastomoses is improved if the longitudinal suture line to tube the flap is done last. If remnant hypopharyngeal tissue is present, the free flap is "patched" onto the mucosa. At the distal enteric anastomoses, a 2-cm longitudinal incision is made in the cervical esophageal remnant, and the triangular-shaped skin extension of the forearm flap is incorporated into this incision. This technique enlarges the circumference and breaks up the annular nature of the distal enteric anastomoses to reduce the risk of stricture formation. After the insetting is completed, the flap is revascularized using appropriate cervical recipient vessels.

Preoperative assessment by a speech pathologist determines candidates for tracheoesophageal puncture (TEP). In our practice, relative contraindications for TEP include poor manual dexterity, dementia, active alcoholism, and patients over the age of 70 years. TEP is performed through the common parting wall of the esophagus and trachea approximately 15 mm inferior to the mucocutaneous junction at the 12 o'clock position of the tracheostoma. This is done through the native esophagus or through the RFFF, depending on whether cervical esophagectomy is performed. To lessen the risk of pharyngocutaneous fistula, primary TEP is only carried out in patients who do not require cervical esophagectomy and only when the common parting wall has not been dissected during the laryngopharyngectomy. In patients who require cervical esophagectomy or dissection of the common parting wall, a secondary TEP is usually done after an interval of approximately 6 weeks.

PATIENTS AND METHODS

Twenty patients underwent RFFF reconstruction for pharyngoesophageal defects by the senior author (K.E.B.) between June 15, 1996, and November 7, 2000, at the University of California Los Angeles Medical Center. There were 13 men and 7 women in the group with a mean and median age of 63.9 and 64 years, respectively (Table I). Fourteen patients (70%) underwent pharyngoesophageal reconstruction following total laryngopharyngectomy for advanced laryngopharyngeal squamous cell carcinoma (SCCA). Six patients (30%) had reconstruction for strictures or fistulas secondary to prior radiation and/or surgical treatment of laryngopharyngeal SCCA. Four patients had cervical esophagectomy in conjunction with total laryngopharyngectomy.

Bilobed RFFF incorporating two skin paddles into the reconstruction was used in 5 patients. Patched RFFF was completed in 9 patients where remnant hypopharyngeal tissue was present. Tubed RFFF was used in 11 patients who had complete circumferential defects. The majority of the patients had previous radiation treatment (17 of 20, 85%). Four patients underwent secondary TEP and one patient had primary TEP at the time of surgery. Speech and swallowing assessments were made by a speech pathologist. Maximum speech intensity was measured at a distance of 12 inches from the lips using a handheld sound level meter in the patients with TEP. Morbidity and perioperative mortality was recorded prospectively using a personal computer spreadsheet database.

TABLE I.
Summary of Patient Data.

No. of Patients	20
Sex	
Male	13 (65%)
Female	7 (35%)
Mean Age (y)	63.9
Indications for RFFF	
Total laryngopharyngectomy	14 (70%)
Cervical esophagectomy	4 (20%)
Strictures or fistulas	6 (30%)
Type of RFFF	
Patched	9 (45%)
Tubed	11 (55%)
Bilobed	5 (25%)
Previous XRT	17 (85%)
TEP	5 (25%)
Primary	1
Secondary	4

RFFF = radial forearm fasciocutaneous free flap; XRT = radiation therapy; TEP = tracheo esophageal puncture.

RESULTS

Follow-up ranged between 2 and 50 months. All free flaps were successful and there was no perioperative mortality (Table II). Sixteen of 20 patients (80%) were able to resume oral diets without the need for a gastrostomy tube with an average time of onset of 16 days (range, 9–40 d). One patient with a jejunostomy tube obtained the majority of his calories by mouth. Three patients (15%) required long-term gastrostomy tube placement.

Four patients (20%) developed pharyngocutaneous fistulas. Three fistulas resolved spontaneously. Only one of these patients, who had a significant resection of the base of the tongue requiring bilateral hypoglossal nerve sacrifice, became gastrostomy tube-dependent. The fourth fistula developed in the setting of a patient with postradiation skin necrosis and carotid exposure requiring a pectoralis myocutaneous flap and a superior trapezius flap for coverage. Three of the four patients who developed fistulas had tubed RFFF for circumferential defects. In total, 3 of 11 tubed flaps (27.3%) and 1 of 9 patched flaps (11.1%) developed fistulas. This difference was not statistically significant ($\chi^2 = 0.81$).

Four patients (20%) developed distal enteric anastomotic strictures. These patients were all able to tolerate food by mouth after 1 to 3 esophageal dilations. All four patients with strictures had tubed RFFF. Of the patients who had patched RFFF grafts, none developed strictures. Other surgical complications included radial forearm donor site flexor carpi radialis tendon exposure (4 of 20, 20%) and symptomatic hair growth in the tubed reconstructed region (1 of 20, 5%).

No patients achieved neoesophageal speech. All patients who underwent TEP (n = 5) developed intelligible tracheoesophageal speech, although most had low intensity. The average maximum speech intensity was 70.6 dB (range, 66–74 dB). All patients who underwent TEP used this as their primary means of communication and were subjectively satisfied. There were no complications associated with the placement of TEP.

DISCUSSION

Microvascular pharyngoesophageal reconstruction can be accomplished effectively using enteric free flaps or fasciocutaneous free flaps. The rate of oral alimentation in our series was 85% after RFFF reconstruction of the pharyngoesophagus compared with 90%[13–16] reported in the literature. Among 402 cases of jejunal flap pharyngoesophageal reconstruction reported in the literature that report a swallowing outcome, 82% of patients were able to maintain their weight on oral feeding alone, which is similar to the 80% incidence achieved in the current series. The average postoperative interval to swallowing was on the order of 8 to 16 days after jejunal flap reconstruction, but most patients experienced considerable dysphagia during the first postoperative month, probably as a result of the peristaltic contractions of the jejunum, which are uncoordinated with the swallowing reflex.[17]

Improved speech rehabilitation is one of the key advantages of RFFF reconstruction for pharyngoesophageal defects. The quality of tracheoesophageal speech was good in all patients in this series, similar to that reported by Deschler.[18] Although most of the patients' voices were of low intensity; all of the patients had intelligible speech, used tracheoesophageal speech as the primary means of communication, and were quite satisfied. It is our impression that speech outcome with RFFF is inferior to that achieved in standard laryngectomy but superior to that of jejunal free flaps. Patients who undergo jejunal free flaps rarely achieve useful neoesophageal speech, while mucous production and flap flaccidity often results in a soft, wet-sounding voice in patients who do achieve tracheoesophageal speech.[19,20] In RFFF reconstruction, the skin flap allows for a stiffer speech chamber without significant mucus production or peristalsis as seen in jejunal interposition.[21] One of the limitations of this report is that there is no comparison of speech outcome and acoustic analysis between patients who were reconstructed with RFFF versus jejunal interposition grafts.

Another important disadvantage in jejunal free flap reconstruction is the necessity for laparotomy at the donor site. Furthermore, patients who have a history of cirrhosis or previous abdominal exploration may not be candidates for laparotomy.[21] The incidence of abdominal donor-site complications in jejunal harvest has been reported to be as high as 5.8%, with abdominal wound dehiscence, bowel obstruction, and gastrointestinal hemorrhage being the most common problems.[17] We think this is perhaps the most critical drawback to using a jejunal interposition, especially in elderly patients with other comorbid conditions. In contrast, the donor site morbidity is mainly cosmetic in patients with RFFF pharyngoesophageal reconstruction.

RFFF are highly versatile for pharyngoesophageal reconstruction. Flap design can be altered for use both as a

TABLE II.
Summary of Results.

Successful free flaps	20 (100%)
Perioperative mortality	0 (0%)
Long-term oral alimentation	17 (85%)
Without G or J tube	16 (80%)
With G or J tube	1 (5%)
Pharyngocutaneous fistula	4 (20%)
Tubed RFFF	3
Patched RFFF	1
Resolution with conservative management	3
Resolution with surgical management	1
Distal enteric stricture	4 (20%)
Tubed RFFF	4
Patched RFFF	0
Ability to tolerate POs after dilation	4
Other minor complication	
Donor site tendon exposure	4 (20%)
Symptomatic hair growth	1 (5%)
TEP-maximum speech intensity (n = 5)	
Average (dB)	70.6
Range (dB)	66 –74

G = gastrostomy; J = jejunostomy; RFFF = radial forearm fasciocutaneous free flap; PO = food by mouth; TEP = tracheo esophageal puncture.

patch graft when there is a remnant of hypopharyngeal mucosa and as a tubed graft for circumferential defects. In this series, we found that the incidence of strictures is reduced even when a narrow strip of hypopharynx can be preserved during laryngopharyngectomy. During secondary reconstruction of patients with strictures or fistulas after total laryngectomy, the soft tissue envelope of the neck is frequently contracted. In this situation, a bilobed fasciocutaneous flap can be created to expand the soft tissue envelope of the neck and simultaneously reconstruct the external neck skin and the pharyngoesophageal defect.

The main limitation of RFFF reconstruction is the substantial risk of salivary fistula formation, which probably arises from the necessity to perform three suture lines to inset and tube the flap. Our series showed a 20% risk of fistula formation, whereas the incidence of fistula formation after RFFF pharyngoesophageal reconstruction was 25% in 68 cases described in the literature.[13–15,22] Our series indicates that there is an increase in the rate of fistula formation with tubed versus patched RFFF graft (27.3% vs. 11.1%), although not statistically significant. While the high incidence of salivary fistula formation in RFFF reconstruction contributed to an increased incidence of delayed oral intake, no patients reported in the literature or in our series suffered loss of their free flap secondary to local infection leading to thrombophlebitis of the vascular pedicle. Three of four patients in our series resolved the fistula spontaneously with conservative management, while only one patient required further surgical management.

The rate of enteric anastomotic stricture formation in our series was higher than that reported in the literature for both jejunal interposition grafts and tubed fasciocutaneous free flaps.[13,17] Harii has argued in favor of jejunal free flaps because of this issue.[23] In our series, however, all of the stricture patients responded to dilation and eventually achieved an oral diet. Therefore, the strictures had no long-term impact on deglutition in this series.

Microvascular free flaps and pedicled enteric transposition flaps are both effective for single-stage reconstruction of pharyngoesophageal defects. We reserve gastric pull-up in cases in which there is significant tumor extension into the esophagus requiring thoracic esophagectomy. This approach is based on the increased morbidity associated with gastric transposition. There is an approximate 50% incidence of major perioperative morbidity in patients who undergo gastric pull-up, probably arising from the need to perform simultaneous intraabdominal, intrathoracic, and cervical surgery.[24]

CONCLUSION

Advantages of RFFF for microvascular pharyngoesophageal function include high flap reliability, limited donor site morbidity, larger vascular pedicle caliber, and the ability to achieve good quality tracheoesophageal speech. The swallowing outcome is similar to that achieved after jejunal flap pharyngoesophageal reconstruction. The main disadvantage of this technique relates to a moderately high incidence of pharyngocutaneous fistulas and strictures, which contributes to delayed oral intake in affected patients.

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