REFINEMENTS IN FLAP DESIGN AND INSET FOR PHARYNGOESOPHAGEAL RECONSTRUCTION WITH FREE THIGH FLAPS

JONATHAN A. ZELKEN, M.D.,[1] CHUNG-JAN KANG, M.D.,[2] SHIANG-FU HUANG, M.D.,[2] CHUN-TA LIAO, M.D.,[2] and CHUNG-KAN TSAO, M.D.[1]*

Background: Complications arising from anastomotic failure may occur after pharyngoesophageal reconstruction. In this report we present results of pharyngoesophageal reconstruction with free thigh flaps using a refined design and inset strategy in a series of patients. *Methods:* From May 2011 to December 2012, pharyngoesophageal oncologic defects were reconstructed in 12 men using thigh flaps. Flaps were designed to exceed defect circumference to allow draping of the excess over injury-prone vessels (so-called delta-inset). Patients were 39- to 68-years-old (mean, 51.8-years-old) at the time of surgery. BMI ranged from 17 to 28 kg/m^2 (average, 21.5 kg/m^2). The sites of defects were the hypopharynx in 11 cases and the pharynx in 1 case. Ten anterolateral thigh (ALT) flaps and 2 anteromedial thigh (AMT) flaps were used. All patients underwent radiation therapy. *Results:* The average flap size was 22 $\times$ 9 cm (range: 16–26 $\times$ 7–11 cm^2). There were no partial or total flap losses, and no donor site complications. Follow-up was 19.3 months (range: 2.4–21.6 months) including 8 patients (75%) who succumbed to disease in the follow-up period. Oral intake was achieved in all patients. Recipient site complications occurred in 50% of cases and included fistula (2 cases), fistula and stricture (2 cases), stricture (1 case), and lymphocele (1 case). Four patients required revision for fistula. *Conclusions:* A refined thigh flap design and inset method in pharyngoesophageal reconstruction may circumvent complications arising from toxic drainage and vascular injury. However, there are insufficient data to make meaningful comparisons to alternative methods. © 2015 Wiley Periodicals, Inc. Microsurgery 00:000–000, 2015.

Successful reconstruction of the aerodigestive tract is a formidable challenge that requires complete flap survival, a watertight seal, and resistance to stenosis and stricture. Marginal necrosis and dehiscence is poorly tolerated in the setting of microbes, radiation, and pharyngoesophageal transit. Comorbidities in head and neck cancer patients and increased operative time of combined extirpation-reconstruction cases adds further risk.[1] One series described 9.6% failure of head and neck free flaps, as compared to 5.6%, 4.9%, and 2.5% in the extremity, breast, and trunk, respectively.[2]

The standard for pharyngoesophageal reconstruction has evolved from local[3] and regional myocutaneous flaps[4,5] to free tissue transfer.[6,7] Viscera-based reconstruction is practiced, but fasciocutaneous flaps are in vogue for decreased donor-site morbidity and improved outcomes.[1] Fasciocutaneous flaps from the forearm, arm, and thigh have been described; more recently Miyamoto reported his experience with a pure-muscle pectoralis flap in secondary reconstruction.[8] At our institution the anterolateral (ALT) and anteromedial thigh flaps (AMT) are favored for ease of harvest and well-tolerated donor site morbidity.

Innovations in pharyngoesophageal reconstruction address flap loss, fistula and stricture,[9–17] but long-term outcomes data are scarce in the literature. Strictures and fistulae, the yardstick outcomes of most studies, are a costly nuisance but may improve with nonoperative management. Since flap loss and death are irreversible and potentially preventable, these are our primary concerns. Toxic drainage and radiation injury may result in friable blood vessels at increased risk for blowout. In this report we present results of free thigh flap pharyngoesophageal reconstruction using a refined design and inset method intended to divert toxic drainage and circumvent related complications in a small series of at-risk cancer patients.

PATIENTS AND METHODS

Twelve thigh flap pharyngoesophageal reconstructions were performed for circumferential segmental defects of the aerodigestive tract in 12 men at a single hospital (Chang Gung Memorial Hospital, Linkou, Taiwan) from May 2011 until December 2012. Patients were 39- to 68-years-old (mean, 51.8 years old) at the time of surgery. Patients who underwent patch coverage for non-circumferential defects with free or pedicled flaps were not included. The BMI of patients ranged from 17 to 28 kg/m^2 (average 21.5 kg/m^2). Reconstruction was performed at the time of tumor extirpation in every case. Defect etiology was malignant neoplasm in all 12 cases; 7 were primary and 5 were recurrent lesions. The defect

Grants/Financial disclosure statement: None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this manuscript.

[1]Department of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital, Chang Gung Medical College and Chang Gung University, Taipei, Taiwan

[2]Department of Otolaryngology, Chang Gung Memorial Hospital, Chang Gung Medical College and Chang Gung University, Taipei, Taiwan

*Correspondence to: Chung-Kan Tsao, M.D., Division of Reconstructive Microsurgery, Department of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital, Chang Gung University, 5 Fu-Hsing St. Kuei-Shan, Taoyuan, Taiwan. E-mail: nightman251@hotmail.com

Received 14 January 2015; Revision accepted 13 May 2015; Accepted 15 May 2015

Published online 00 Month 2015 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/micr.22432

Table 1. Patients' Information

Age/Sex	Tumor	Location	Flap size (cm)	Donor site	Radiation therapy		Complications		Flap survival	Revisions	Days til PO	Diet	Follow-up (mo)	Final outcome
					Preop	Postop	Early	Late						
54/M	Primary SCC	Hypopharynx	16 × 8.5	AMT	Yes	Yes	No	Stricture fistula	Yes	DP	44	Soft	41	Tumor-free fistula resolved stricture resolved
39/M	Recurrent SCC	Hypopharynx	20 × 10	AMT	No	Yes	No	No	Yes	No	21	Soft	2	Expired
49/M	Primary SCC	Hypopharynx	22 × 9	ALT	Yes	No	No	No	Yes	No	21	Solid	10	Expired
68/M	Recurrent SCC	Lateral pharynx	22 × 9	ALT	Yes	No	No	Stricture	Yes	No	14	Rice	42	Tumor-free stricture resolved
39/M	Primary SCC	Hypopharynx esophagus	26 × 10.5	ALT	Yes	No	No	No	Yes	No	14	Solid	14	Expired
48/M	Recurrent SCC	Hypopharynx	21 × 10.5	ALT	Yes	No	No	Lymphocele	Yes	Skin paddle obliteration	14	Soft	10	Expired
48/M	Recurrent SCC	Hypopharynx esophagus	24 × 11	ALT	Yes	No	No	Fistula	Yes	DP	240	Soft	18	Expired
47/M	Primary SCC	Hypopharynx	20 × 8.5	ALT	Yes	No	No	Fistula	Yes	DP	30	Solid	8	Expired
52/M	Recurrent SCC	Hypopharynx	20 × 8.5	ALT	Yes	No	No	No	Yes	No	14	Rice	40	Tumor-free
62/M	Primary SCC	Hypopharynx esophagus	26 × 7	ALT	Yes	Yes	No	No	Yes	No	21	Soft	14	Expired
55/M	Primary SCC	Hypopharynx	23 × 8.5	ALT	No	Yes	No	No	Yes	No	21	Soft	7	Expired
61/M	Primary SCC	Hypopharynx	25 × 8	ALT	Yes	Yes	No	Stricture fistula	Yes	DP	60	Soft	27	Tumor-free fistula resolved stricture resolved

SCC, squamous cell carcinoma; ALT, anterolateral thigh flap; AMT, anteromedial thigh flap; RT, radiation therapy; PO, per orem*; DP, deltopectoral flap.*

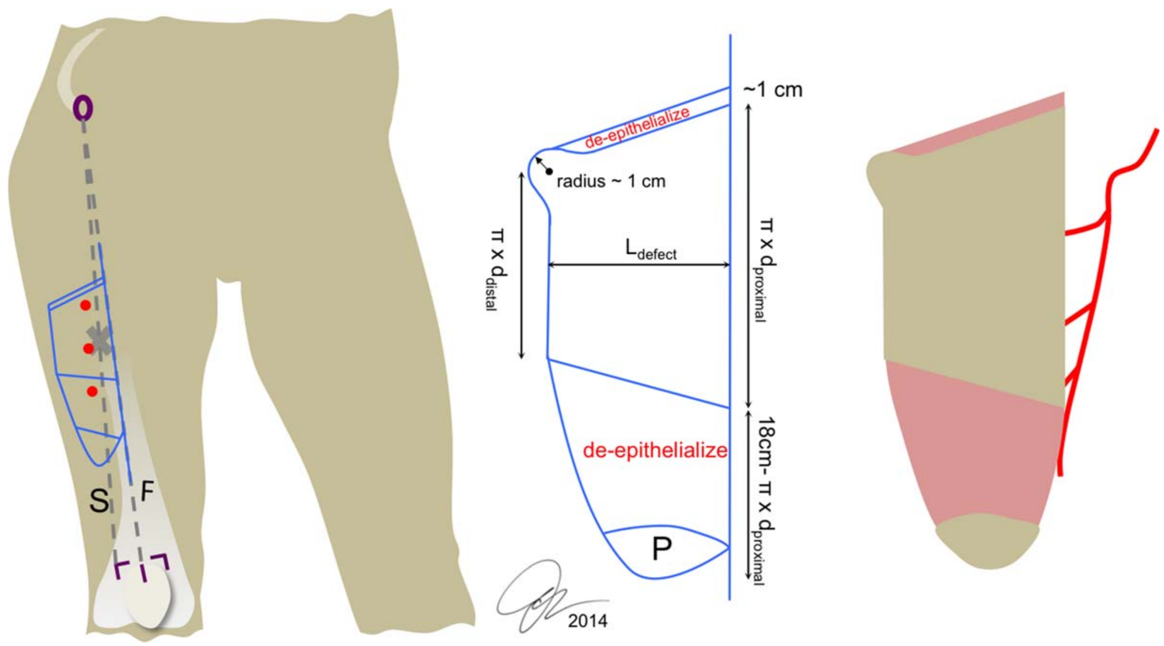

Figure 1. Markings for ALT flap. Left panel*: S and F lines, and the neo-esophageal "trapezoid" centered about 1–2 reliable perforators. In this example, the medial limb was proximal and the lateral limb distal.* Center panel*: measurements used in flap design.* Right panel*: a graphic representation of the raised flap.*

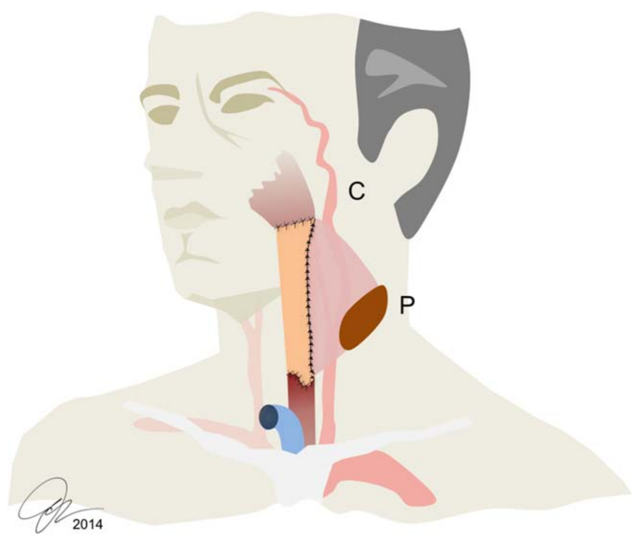

Figure 2. Simplified depiction of hypopharyngeal reconstruction after left-sided neck dissection. In this example the flap was designed to shield the diseased neck from toxic leakage and radiation, protecting vulnerable tissues like the carotid artery (C). The suture line was oriented away from the contralateral neck. The skin paddle (P) was at the most distal end of the flap, theoretically enhancing sensitivity to perfusion changes.

site was the hypopharynx in 11 cases and the pharynx in 1 case. There was tumor involvement of the carotid sheath in 5 cases with resultant exposure of the carotid media layer. There were 3 cases of synchronous esophageal cancer. Ten patients (83%) were irradiated preoperatively. There were no associated skin defects at the time of the original procedure (Table 1). Procedures followed were in accord with the Helsinki Declaration of 1975.

Surgical Technique

A single surgeon (C.K.T.) performed all operations. Either an ALT or an AMT flap was marked in the supine position with the hip internally rotated and knee extended. Two lines were drawn: one from the ASIS to the midpoint of the superior patella ("F line") and one to the superolateral patella ("S line"). Reassuring Doppler signals confirmed perforator position. The F line was the medial boundary for ALT flaps and the lateral boundary for AMT flaps. The S line represented the axis of the descending branch of the lateral femoral circumflex artery. Flap width was dictated by defect length. Flaps were designed as long as possible to facilitate coverage. ALT flaps up to 26 cm and AMT flaps up to 20 cm were reliably harvested. A 3 × 5 cm cutaneous paddle was designed distally. The laterality of the irradiated neck dictated orientation of the trapezoidal design. The long and short limbs reflected the diameter of the pharyngeal and esophageal diameter (limb length = π × diameter). We overcorrected limb length by 1–1.5 cm. A rounded knob-like expansion of the shorter (esophageal) side was designed proximally (Fig. 1).

The inset method was named after its cross-sectional resemblance to the lower case Greek letter delta (δ). The flap was inset with the interval between the neo-esophagus and skin paddle buried under native skin (Fig. 2). The buried portion and 1 cm of the proximal rim of the neo-esophagus were de-epithelialized (Fig. 3). The vertical suture line was oriented 45°–60° away from recipient vessels (Fig. 4). Surplus distal flap tissue was draped over vessels of the neck that were compromised or vulnerable to scarring and irradiation. After establishing flap configuration and lie, running absorbable suture was used to invaginate the de-epithelialized vertical suture line of the neo-esophagus. Proximal and distal anastomoses were performed using intervening 3–0 and 4–0 absorbable sutures. The distal knob was inset into a linear esophageal rent to maximize anastomotic circumference. The flap was stented with a nasogastric tube and feeding tube inserted beyond the distal anastomosis. Anastomotic integrity was evaluated with clean dry gauze while methylene blue was injected through the feeding tube with moderate force. The skin paddle was incorporated into the wound closure in a tension-free manner. Closed-suction and Penrose drains were placed in dependent areas.

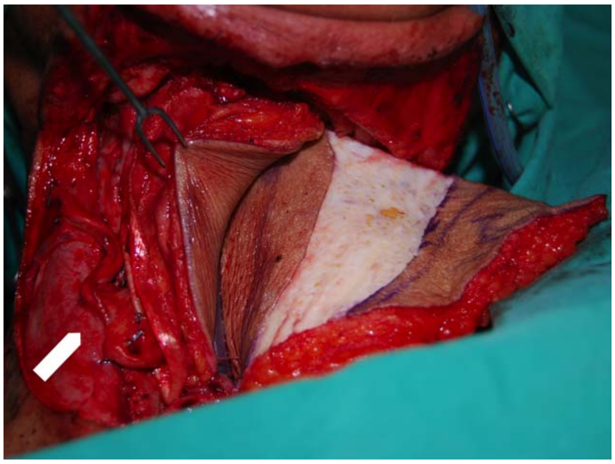

*Figure 3. In this illustration the flap was inset with the skin paddle directed away from the anastomotic site (*white arrow*), and oriented obliquely. The cutaneous paddle lined and protected compromised tissues below.*

The donor site was closed in layers over closed suction drains soon after the flap was raised to minimize edema and facilitate primary closure. In some cases, hemi-circumferential scoring of the crural fascia, perpendicular to the fascial defect, helped to reduce localized muscle bulge and distribute compartmental contents. If part of the wound could not be approximated with a small penetrating towel clamp, it was covered with a split-thickness skin graft from either thigh and secured with a bolster dressing for five days.

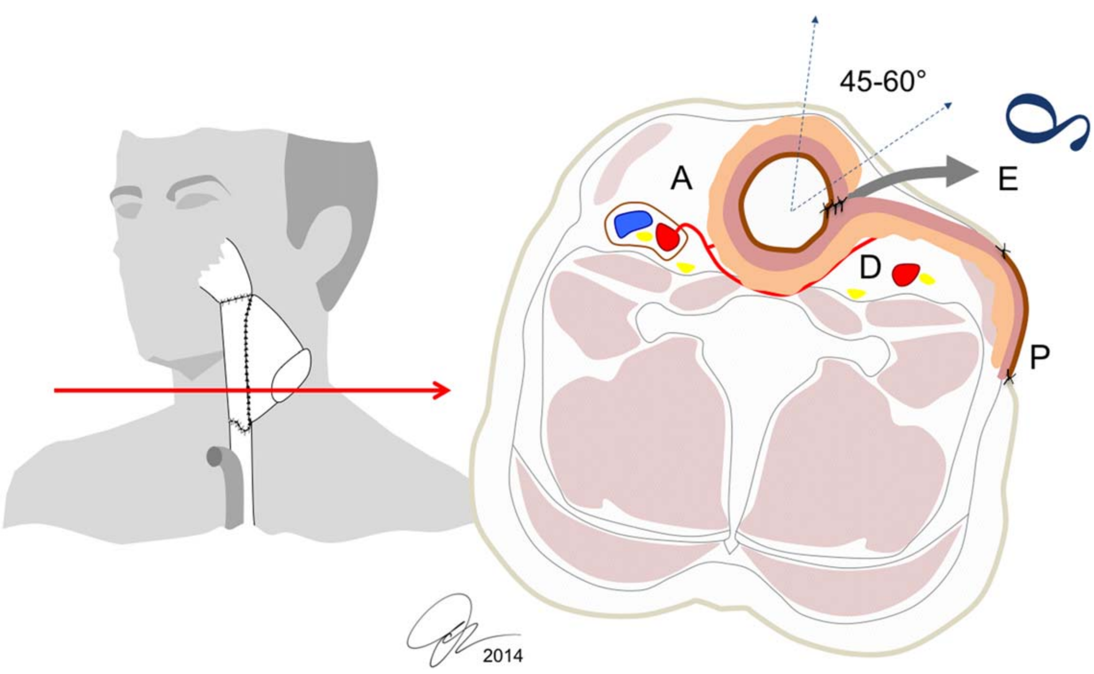

Figure 4. Cross-sectional anatomy at the level of the red arrow *in the left panel and loose resemblance to the Greek letter δ (*blue, above right*). The axially oblique orientation of vertical suture was intended to direct fluid egress (E) away from the anastomotic site (A). The islandized skin paddle (P) was designed for monitoring and as a tissue bank for secondary surgery. The buried portion was designed for insulation and fistulous drainage diversion from the dependent neck (D).*

*Figure 5. Postoperative evaluation at 4 weeks revealed hyperemic irradiated neck tissue and a comparatively robust skin paddle (*red arrow*).*

Postoperatively, the skin paddle was monitored for changes in color, turgor, and temperature without specialized instruments. When there was concern, bleeding was evaluated with superficial scoring of the skin using an 18-gauge needle and irrigated with heparinized saline solution. No effort was made to identify or monitor a perforator using Doppler. The donor extremity was monitored for signs of neurovascular injury and compartment syndrome.

RESULTS

All flaps were based on the lateral femoral circumflex system. Ten ALT and 2 AMT flaps were raised. The average flap was 22 cm long × 9 cm wide (range, 16–26 cm × 7–11 cm). Combined reconstruction with gastric pull-up was performed in 2 of 3 patients with esophageal cancer. There were no perioperative complications requiring re-exploration or flap salvage maneuvers.

Average follow-up time was 19.3 months (range: 2.4–21.6 months). No donor site complications were reported and all flaps survived. All patients achieved oral intake. The average time to intake was 5.8 weeks (range: 2–32 weeks) for all patients. One patient that required 32 weeks to achieve oral intake had recurrent fistulae that ultimately resolved with deltopectoral flap coverage. Excluding that patient, average time to oral intake was 3.5 weeks. A soft diet (7 patients), rice diet (2 patients), and solid diet (3 patients) were achieved. Five patients (42%) received postoperative irradiation (Fig. 5).

Eight patients succumbed to their disease 10 months into the follow-up period (range: 2–18 months). Cause of death was unknown in many cases, but there was no evidence of flap-related causes like sepsis or carotid blowout. No deep space infection, abscess, or other life-threatening complications were documented. Late complications occurred in 6 cases (50%) and included fistula alone (2 patients), fistula and stricture (2 patients), stricture alone (1 patient), and lymphocele (1 patient). Fistulae occurred during the course of postoperative irradiation in three cases. Four patients required one or more revisions for fistula repair.

DISCUSSION

Compared to locoregional options, we prefer free tissue transfer for pharyngoesophageal reconstruction to maximize quantity and quality of donor tissue. Locoregional options should be reserved for revision procedures that warrant less tissue, including the deltopectoral flap for fistula repair. The thigh is an important warehouse that provides a versatile surplus of tissue and is favored at our institution.[18] Unlike visceral donor tissue, the abdomen is not violated and there is a tendency toward less "wet" speech.[1,19,20] Versatile thigh flaps are preferable in all types of reconstruction, so the harvest and anatomy are familiar.

Refinements in hypopharyngeal reconstruction techniques target early flap loss, fistula, and stricture.[9–17] Murray et al. reviewed recent innovations,[21] but did not identify any modification that independently reduced complications. That review cited fistula and stricture rates of 13% and 16.1%, respectively, among 20 series. A <1% perioperative mortality rate was cited, but long-term mortality was not elaborated. More recently, Selber et al. observed fistula and stricture rates of 11% and 9.3% in their own database of 193 circumferential reconstructions. They cited a 5-year survival rate of 0–35% depending on esophageal pathology but did not discuss cause of mortality.[22]

Despite the dismal survival rates of persons with head and neck cancer who require pharyngoesophageal reconstruction[16,22] most outcomes studies target treatable complications like hematoma, fistula, stricture, and infection. Some series do not mention follow-up time at all.[9,13,15] Most series do not address mortality[9,13–15]; when mortality is discussed the cause of death is seldom elaborated. In our series, 75% of patients expired after 3.5 years, and in most cases the cause of death was unknown.

Life-threatening flap-related complications like meningitis, sepsis, and carotid blowout may be vastly underreported. Carotid blowout afflicts 2.9–4.3% of all head and neck cancer patients[23–27] with mortality rates reported as high as 50%,[24,28] yet no recent series address its incidence or strategies to prevent blowout.[9,10,13–15,22] Accordingly, in six series with 315 pharyngoesophageal reconstructions, more than 10 occurrences of carotid blowout would be expected, yet none are reported.[23] In one series of 2,590 patients, independent risk factors for blowout were BMI < 22.5 kg/m^2, primary lesion in the hypopharynx, open neck wounds, radical neck dissection, and radiation dose $\geq$70 Gy. With an average BMI of 21.5 kg/m^2 and the fact that every patient in our series was irradiated, lifetime risk of blowout is significant. Considering this risk, the tail of the delta-inset thigh flap (dITF) was designed to shield irradiated, skeletonized, and unsheathed great vessels in the ipsilateral neck from additional irradiation and exposure-related vascular injury.

In addition, surgical site infections (SSI) resulting from salivary leak may induce inflammation, vessel thrombosis and flap failure. In a series of 12 patients, Genden et al. attributed one flap loss to a deep neck infection secondary to fistula.[9] Overall SSI after head and neck surgery ranges from 24 to 87% in the literature.[29–31] Yang et al. observed 15 infections in 40 ALT-based head and neck reconstructions (37.5%), and 5 of 23 hypopharyngeal reconstructions (21.7%).[31] We recognize data[17,32–34] that suggest fistulae occur at the T-junctions of the tubed flap where the vertical suture line and anastomoses intersect. We therefore oriented those junctions obliquely to divert toxic runoff from the contralateral neck, away from the microvascular anastomosis, and shielded from dependent regions of the ipsilateral neck. If neck dissection was performed on both sides, vascular anastomosis was performed on the healthier side with the tail draped over the comparatively more compromised side.

The dITF was designed to protect the patient from secondary effects of toxic leakage and radiation injury. Four patients developed fistulas in this series (33%). Other recent series' rates vary widely (range: 7–50%),[9,10,13–15,22] and small sample sizes make it difficult to generate meaningful comparisons. We did not identify why our rate was higher than other series. Deconditioning, malnutrition, and variations in diagnosis, reporting, and patient care across centers and nations are probable culprits. Furthermore, 10 of 12 patients had preoperative radiation.[35,36] Chemotherapy and radiation (CCRT) are the first line of therapy for hypopharyngeal cancer at this institution, except in extensive cases (2 of 12 in this series) when extremely poor prognoses warrant palliative treatment versus cure. Surgery was reserved for those who failed to respond to CCRT or recurred after CCRT. The advanced nature of disease in our patients, and exclusion of noncircumferential lesions probably contributed to the fistula and stricture rates we report.

Radiation therapy prolongs survival but it also promotes stricture formation. Stricture risk reduction was addressed by integrating a knob (U-shaped advancement flap) into the flap. Inspired by Randolph's Y-U advancement pyloroplasty, this modification was designed to maximize antral diameter, pedicle base width, and blood flow to the tip.[37] The knob should be designed proximally where tissue is easiest to close. Longitudinal orientation of the flap facilitated closure. In this series, defect length (and thus, flap width) was 11 cm or less; primary donor site closure was achieved in every case.

Monitored skin paddles are not a new concept[15,38] and may prove advantageous over the implantable Doppler.[11,14–17,22,39–43] The dITF skin paddle was positioned distally and perfused by the subfascial plexus. This may enhance sensitivity to changes in perfusion (100% in one study[15]). Furthermore, the skin paddle can be internalized to obliterate anastomotic leaks after it is no longer needed for monitoring, as was the case for one patient in this series.

Although the data are unpublished, the senior author observed two nonfatal carotid blowouts after 12 reconstructions when traditional reconstructive methods were used. The dITF method was designed to divert drainage at the T-junctions and vertical suture line where breakdown is most likely.[17,32–34] It may not outperform other methods should a leak occur elsewhere; this is the greatest limitation in flap design. There are not enough data to determine whether the dITF method reduces carotid blowout risk and mortality; this is the greatest limitation of this series. Ongoing data collection at this center, perhaps with multicenter collaboration, might reveal trends toward reduced mortality, flap loss, and infection.

Despite our best efforts, fistulae and strictures should be anticipated using state-of-the-art methods in pharyngoesophageal reconstruction. Large defects, high functional demands, malnutrition, and radiation injury favor reconstructive failure. The dITF was designed to minimize fistula and stricture risk, *as well as* secondary effects of these somewhat inevitable complications. The dITF may be a feasible strategy to prevent mortality and infection-related flap loss via fistulous leak diversion and soft tissue augmentation after free flap pharyngoesophageal reconstruction.

CONCLUSIONS

The dITF may be a feasible approach to pharyngoesophageal reconstruction. Refinements in thigh flap design and inset may circumvent complications secondary to toxic drainage, radiation, and vascular injury. We encourage dITF implementation on the basis of our experience, but further data are needed to conclusively evaluate infection, flap loss, carotid blowout, and mortality risk reduction. With the present data, meaningful comparisons cannot be made to alternative reconstructive strategies.

REFERENCES

1. Reece GP, Bengtson BP, Schusterman MA. Reconstruction of the pharynx and cervical esophagus using free jejunal transfer. Clin Plast Surg 1994;21:125–136.

2. Wong AK, Joanna Nguyen T, Peric M, Shahabi A, Vidar EN, Hwang BH, Niknam Leilabadi S, Chan LS, Urata MM. Analysis of risk factors associated with microvascular free flap failure using a multi-institutional database. Microsurgery 2015;35:6–12.
3. Silver CE. Reconstruction after pharyngolaryngectomy-esophagectomy. Am J Surg 1976;132:428–434.
4. Bakamjian VY. A Two-stage method for pharyngoesophageal reconstruction with a primary pectoral skin flap. Plast Reconstr Surg 1965;36:173–184.
5. Ariyan S. Further experiences with the pectoralis major myocutaneous flap for the immediate repair of defects from excisions of head and neck cancers. Plast Reconstr Surg 1979;64:605–612.
6. Harii K, Ebihara S, Ono I, Saito H, Terui S, Takato T. Pharyngoesophageal reconstruction using a fabricated forearm free flap. Plast Reconstr Surg 1985;75:463–476.
7. Wu CC, Lin PY, Chew KY, Kuo YR. Free tissue transfers in head and neck reconstruction: Complications, outcomes and strategies for management of flap failure: Analysis of 2019 flaps in single institute. Microsurgery 2014;34:339–344.
8. Miyamoto S, Kayano S, Fujiki M, Sakuraba M. Combined use of the cephalic vein and pectoralis major muscle flap for secondary esophageal reconstruction. Microsurgery 2014;34:319–323.
9. Genden EM, Jacobson AS. The role of the anterolateral thigh flap for pharyngoesophageal reconstruction. Arch Otolaryngol Head Neck Surg 2005;131:796–799.
10. Ho MW, Houghton L, Gillmartin E, Jackson SR, Lancaster J, Jones TM, Blackburn TK, Homer JJ, Loughran S, Ascott FM, Shaw RJ. Outcomes following pharyngolaryngectomy reconstruction with the anterolateral thigh (ALT) free flap. Br J Oral Maxillofac Surg 2012; 50:19–24.
11. Komorowska-Timek E, Lee GK. Tube-in-a-tube anterolateral thigh flap for reconstruction of a complex esophageal and anterior neck defect. Ann Plast Surg 2014;72:64–66.
12. Murray DJ, Gilbert RW, Vesely MJ, Novak CB, Zaitlin-Gencher S, Clark JR, Gullane PJ, Neligan PC. Functional outcomes and donor site morbidity following circumferential pharyngoesophageal reconstruction using an anterolateral thigh flap and salivary bypass tube. Head Neck 2007;29:147–154.
13. Parmar S, Al Asaadi Z, Martin T, Jennings C, Pracy P. The anterolateral fasciocutaneous thigh flap for circumferential pharyngeal defects–can it really replace the jejunum?. Br J Oral Maxillofac Surg 2014;52:247–250.
14. Spyropoulou GA, Lin PY, Chien CY, Kuo YR, Jeng SF. Reconstruction of the hypopharynx with the anterolateral thigh flap: Defect classification, method, tips, and outcomes. Plast Reconstr Surg 2011; 127:161–172.
15. Tan NC, Shih HS, Chen CC, Chen YC, Lin PY, Kuo YR. Distal skin paddle as a monitor for buried anterolateral thigh flap in pharyngoesophageal reconstruction. Oral Oncol 2012;48:249–252.
16. Yu P, Hanasono MM, Skoracki RJ, Baumann DP, Lewin JS, Weber RS, Robb GL. Pharyngoesophageal reconstruction with the anterolateral thigh flap after total laryngopharyngectomy. Cancer 2010;116: 1718–1724.
17. Yu P, Robb GL. Pharyngoesophageal reconstruction with the anterolateral thigh flap: A clinical and functional outcomes study. Plast Reconstr Surg 2005;116:1845–1855.
18. Lin CH, Wei FC, Lin YT, Yeh JT, Rodriguez Ede J, Chen CT. Lateral circumflex femoral artery system: Warehouse for functional composite free-tissue reconstruction of the lower leg. J Trauma 2006;60:1032–1036.
19. Carlson GW, Schusterman MA, Guillamondegui OM. Total reconstruction of the hypopharynx and cervical esophagus: A 20-year experience. Ann Plast Surg 1992;29:408–412.
20. Tan NC, Lin PY, Kuo PJ, Tsai YT, Chen YC, Nguyen KT, Kuo YR. An objective comparison regarding rate of fistula and stricture among anterolateral thigh, radial forearm, and jejunal free tissue transfers in circumferential pharyngo-esophageal reconstruction. Microsurgery 2014 Nov 28. [Epub ahead of print]
21. Murray DJ, Novak CB, Neligan PC. Fasciocutaneous free flaps in pharyngolaryngo-oesophageal reconstruction: a critical review of the literature. J Plast Reconstr Aesthet Surg 2008;61:1148–1156.
22. Selber JC, Xue A, Liu J, Hanasono MM, Skoracki RJ, Chang EI, Yu P. Pharyngoesophageal reconstruction outcomes following 349 cases. J Reconstr Microsurg 2014;30:641–654.
23. Chen YJ, Wang CP, Wang CC, Jiang RS, Lin JC, Liu SA. Carotid blowout in patients with head and neck cancer: Associated factors and treatment outcomes. Head Neck 2015;37:265–272.
24. Heller KS, Strong EW. Carotid arterial hemorrhage after radical head and neck surgery. Am J Surg 1979;138:607–610.
25. Maran AG, Amin M, Wilson JA. Radical neck dissection: a 19-year experience. J Laryngol Otol 1989;103:760–764.
26. Righini CA, Nadour K, Faure C, Rtail R, Morel N, Beneyton V, Reyt E. Salvage surgery after radiotherapy for oropharyngeal cancer. Treatment complications and oncological results. Eur Ann Otorhinolaryngol Head Neck Dis 2012;129:11–16.
27. Shumrick DA. Carotid artery rupture. Laryngoscope 1973;83:1051–1061.
28. Upile T, Triaridis S, Kirkland P, Archer D, Searle A, Irving C, Rhys Evans P. The management of carotid artery rupture. Eur Arch Otorhinolaryngol 2005;262:555–560.
29. Johnson JT, Myers EN, Thearle PB, Sigler BA, Schramm VL Jr. Antimicrobial prophylaxis for contaminated head and neck surgery. Laryngoscope 1984;94:46–51.
30. Seagle MB, Duberstein LE, Gross CW, Fletcher JL, Mustafa AQ. Efficacy of cefazolin as a prophylactic antibiotic in head and neck surgery. Otolaryngology 1978;86(4 Pt 1):ORL-568–572.
31. Yang CH, Chew KY, Solomkin JS, Lin PY, Chiang YC, Kuo YR. Surgical site infections among high-risk patients in clean-contaminated head and neck reconstructive surgery: Concordance with preoperative oral flora. Ann Plast Surg 2013;71(Suppl 1):S55–S60.
32. Akin I, Torkut A, Ustunsoy E, Taskoparan G, Gurzumar A. Results of reconstruction with free forearm flap following laryngopharyngo-oesophageal resection. J Laryngol Otol 1997;111:48–53.
33. Anthony JP, Singer MI, Mathes SJ. Pharyngoesophageal reconstruction using the tubed free radial forearm flap. Clin Plast Surg 1994; 21:137–147.
34. Cho BC, Kim M, Lee JH, Byun JS, Park JS, Baik BS. Pharyngoesophageal reconstruction with a tubed free radial forearm flap. J Reconstr Microsurg 1998;14:535–540.
35. Kao HK, Abdelrahman M, Chang KP, Wu CM, Hung SY, Shyu VB. Choice of flap affects fistula rate after salvage laryngopharyngectomy. Sci Rep 2015;5:9180.
36. Tsou YA, Hua CH, Lin MH, Tseng HC, Tsai MH, Shaha A. Comparison of pharyngocutaneous fistula between patients followed by primary laryngopharyngectomy and salvage laryngopharyngectomy for advanced hypopharyngeal cancer. Head Neck 2010;32:1494–1500.
37. Randolph JG. YU advancement pyloroplasty. Ann Surg 1975;181: 586–590.
38. Urken ML, Weinberg H, Vickery C, Buchbinder D, Biller HF. Free flap design in head and neck reconstruction to achieve an external segment for monitoring. Arch Otolaryngol Head Neck Surg 1989; 115:1447–1453.
39. Fernando B, Young VL, Logan SE. Miniature implantable laser doppler probe monitoring of free tissue transfer. Ann Plast Surg 1988;20:434–442.
40. Hidalgo DA, Jones CS. The role of emergent exploration in free-tissue transfer: A review of 150 consecutive cases. Plast Reconstr Surg 1990;86:492–498. Discussion: 499–501.
41. Paydar KZ, Hansen SL, Chang DS, Hoffman WY, Leon P. Implantable venous doppler monitoring in head and neck free flap reconstruction increases the salvage rate. Plast Reconstr Surg 2010;125:1129–1134.
42. Swartz WM, Izquierdo R, Miller MJ. Implantable venous doppler microvascular monitoring: Laboratory investigation and clinical results. Plast Reconstr Surg 1994;93:152–163.
43. Yu P. One-stage reconstruction of complex pharyngoesophageal, tracheal, and anterior neck defects. Plast Reconstr Surg 2005;116:949–956.