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A New Option With the Pedicle Thoracoacromial Artery Perforator Flap for Hypopharyngeal Reconstructions

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Objectives/Hypothesis: The reconstruction of hypopharyngeal defects should focus on minimizing morbidity in a high-risk population while achieving adequate functional results with regard to the restoration of speech, swallowing, and airway control. We introduce the clinical application of the thoracoacromial artery perforator (TAAP) flap as a new reconstructive option for hypopharyngeal defects.

Methods: This method was used to restore oncologic hypopharyngeal defects in nine patients: three who had previous irradiation and surgery, one who had previous surgery only, and another who had previous radiotherapy only.

Results: All of the TAAP flaps of our series were transferred successfully and survived entirely. The donor sites were closed primarily in all cases. No fistulas, stenosis/strictures, dehiscence, or swelling occurred. Pectoralis major muscle function was completely preserved in all patients.

Conclusions: The use of TAAP flap to reconstruct hypopharyngeal defect is a simple and effective method that does not require microsurgical skills. The flap is thin and pliable, with a reliable blood supply.

Key Words: Thoracoacromial artery, perforator flap, hypopharyngeal reconstruction, pectoralis major, pedicled flap.

Level of Evidence: 4.

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INTRODUCTION

The reconstruction of defects following the ablation for hypopharyngeal cancer often requires challenging strategies because of multiple subsites, all of which work in concert to facilitate the goals of speech, swallowing, and airway control.[1] Due to the constant exposure to saliva and digestive enzymes, hypopharynx requires the use of robust reconstructive options to seal off communication between the oropharynx and deep neck spaces. Previous radiation therapy or surgery and concomitant functional disabilities often increase the complexity of the reconstruction, which is burdened with a high risk of potential life-threatening complications.

Although visceral flaps, including colon, ileocolon, gastro-omental, and jejunal flaps, seem to have a relatively low rate of postoperative pharyngocutaneous fistula, major drawbacks include prolonged hospital stay and donor site morbidity due to additional abdominal surgery, which has a high risk of bowel obstruction or ventral hernia occurrence.[1–3] Further microsurgical options used for hypopharyngeal reconstruction include the free radial forearm (RF)[3] and the anterolateral thigh (ALT),[3,4] flaps, which can be extremely challenging because of the complicated inset, as well as the limited availability of recipient vessels due to previous radiotherapy and neck dissection. In addition, these flaps require microsurgical expertise, and an exteriorized island part usually should be used for clinical monitoring of the buried fasciocutaneous free flap needed to resurface the hypopharyngeal defect.

The ideal head and neck reconstructive method should be a one-stage procedure, with the lowest morbidity and mortality also suitable for patients with significant comorbidities, as well as for the elderly. It should result in a short hospital stay, the ability to tolerate postoperative radiation, and early restoration of speech and swallowing.

The pectoralis major (PM) flap is easy to harvest, with no microsurgical anastomosis required, but is limited to selected partial pharyngoesophageal defects for salvage after failed free-flap reconstruction, or in very high-risk patients because its bulkiness leads to a poor functional outcome.[5,6] In addition, the PM major flap requires an unneeded sacrifice of a major trunk muscle, with high donor site contour deformity and muscle

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functional impairment, and the section of the sternocleidomastoid muscle at the time of its transfer with further morbidity.

Therefore, the application of local fasciocutaneous pedicle flaps has gained growing evidence as an alternative for hypopharyngeal reconstructions.[7–14] These flaps require relatively easier surgical techniques, with no microvascular tissue transfer, and have demonstrated a lower systemic and donor-site morbidity than free flaps. Besides the well established application of the internal mammary artery perforator (IMAP)[13,14] and supraclavicular artery island flaps[7–9] for hypopharyngeal reconstruction, some new alternative options for the same purpose has been sparsely described, including the transverse cervical artery island,[10] superficial temporal artery,[11] and submental artery flaps.[12] Nevertheless, IMAP pedicle lengthening might require the removal of the intervening costal cartilage, with subsequent chest deformity. In some circumstances, the internal mammary artery (IMA) might be absent or unusable (because of a previous resection or previous cardiothoracic interventions), the medial chest skin might be scarred, or the IMA could be needed for cardiac surgery. Supraclavicular artery island flap lacks a reliable axial blood supply and has an unacceptable rate of distal skin necrosis.

The thoracoacromial artery perforator (TAAP) flap has not been yet reported in the literature for hypopharyngeal reconstructions. In this article, which represents an extension of our previous investigations[15–17] on the vascularity and indications of TAAP flap in head and neck reconstruction, we introduce the clinical application of the TAAP flap as a new reconstructive option for hypopharyngeal defects.

PATIENTS AND METHODS

Patients

From 2007 to 2013, this method was used in nine patients to restore eight partial and one circumferential hypopharyngeal postoncologic defects. All of the patients were male, and their ages ranged from 26 to 58 years (mean, 33.2 years). The defect size varied from 3 cm by 3 cm to 6 cm by 12 cm, with a mean size of 4.2 cm by 6.4 cm. Of these patients, three of them had previous irradiation and surgery, one had previous surgery only, and another had previous radiotherapy only.

Anatomical Basis

The thoracoacromial artery (TAA) arises from the axillary artery below the junction of the middle and lateral thirds of the clavicle.[15–17] It divides into four branches below the clavicle and enters the deep surface of the upper border of the pectoralis major muscle approximately at its midpoint.[15–17] The clavicular branch (medially) and the deltoid and acromial branches[15–17] (laterally) nourish the clavicular head of the PM muscle, both providing musculocutaneous perforators that supply the anterior chest wall tegument. The pectoral branch supplies the intermediate region of the sternocostal head of PM muscle and anastomoses with the terminal branches of lateral thoracic artery, the anterior intercostal branches, and the IMAPs itself.

The vascular basis of the new TAAP flap has been highlighted in a previous investigation on 12 cadavers in which a constant perforator of the pectoral branch was present in the "septum" between the clavicular and the sternocostal heads of the PM muscle in 21 out of 24 hemichests.[15–17] The perforators were consistently observed in an area of 4 cm^2 around the intersection of a line joining the acromion to the xiphoid process with a perpendicular line drawn from the midclavicular point[15–17] (Fig. 1). The flap's pedicle, which was lengthened by inclusion of the TAA up to its origin from the axillary artery, had a mean length of 7 cm, and the caliber had a mean size of 0.7 mm.[15–17] The TAAP flap perforasome extended from the clavicle superiorly to the fourth intercostal space inferiorly and from the sternum medially to the anterior axillary fold laterally.

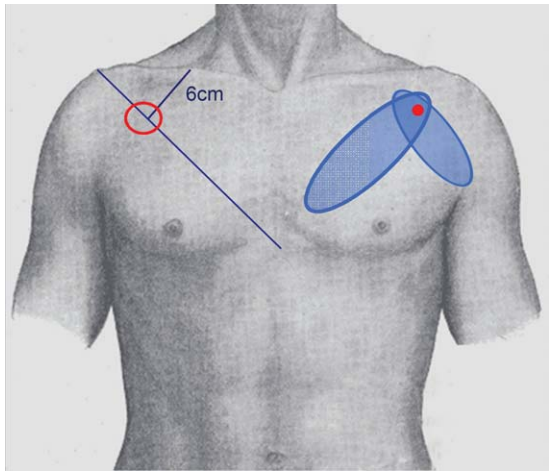

Fig. 1. The TAAP perforators are consistently found in an area of 4 cm^2 around the intersection of a line joining the acromion to the xiphoid process, with a perpendicular line drawn from the midclavicular point. Including the dominant ipsilateral TAAP, a pedicle island flap can be designed with its long axis orientated vertically, vertically-obliquely, and obliquely according to the pedicle length and planned size. TAAP = thoracoacromial artery perforator. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

Method

In all patients, the hypopharyngeal tumor was resected under direct vision, with a 2 cm to 3 cm tumor-free margin (until sections of the surgical margins were negative) to cater for submucosal spread and hence ensure adequate oncological clearance. In four cases, a partial laryngectomy was performed.

Perforator detection, planning, and dissection of the TAAP flap were made, as previously described.[15–17] Preoperatively, a handheld Doppler probe was used to identify and mark the dominant perforator from the pectoral branch of TAA within the 4 cm^2 area in which a line joining the acromion to the xiphoid process intersected a perpendicular line drawn from the midclavicular point, as previously investigated. Including the dominant ipsilateral TAAP, a pedicle island flap was designed with its long axis orientated vertically, vertically–obliquely, and obliquely according to the pedicle length and the planned size, and it was applied to resurface the hypopharyngeal defect (Fig. 1). Usually, the perforator showing the strongest signal during the Doppler evaluation between the bilateral sides was chosen. After the head and neck surgeon extirpated the tumor, all of the patients underwent an immediate one-stage reconstruction with a pedicled TAAP flap. The size of the defect and the required pedicle length were estimated, and the skin paddle was consequently marked on the chest of the patient, with the TAAP entering proximally in the cutaneous paddle to extend the distal reach of the flap.

The flap was elevated beginning from the medial margin in a medial-to-lateral direction until the selected TAAP emerging from the septum between the clavicular and the sternocostal heads of PM muscle was visualized. Dissection proceeded, following the perforator course toward the source vessels until the flap was completely islanded. The superior retraction of the PM muscle allowed for further proximal dissection of the TAA that was skeletonized, except for a small cuff of muscle around it toward its origin to enhance the length of the pedicle. Dissection ended when the origin of the TAA from the subclavicular artery was encountered, providing a sufficient pedicle length so the flap could be freely tunneled under the clavicle. During dissection, the pectoral branch of TAA nourishing the PM muscle was preserved, so the PM flap still remained available as backup flap. As the length of the pedicle was sufficient to freely rotate the flap, it was passed under the clavicular head of the PM muscle and through either a subcutaneous tunnel or under the clavicle bone and inset into the hypopharyngeal defect. In both cases, the authors made sure that the tunnel was large enough to avoid any pedicle compression or kinking. The skin paddle was secured with interrupted sutures to ensure a watertight seal to avoid any leakage and maintain the ability to swallow. The donor site was always closed directly.

Cases Report

Case 1. A 44-year-old man complained of pharyngeal pain for 8 months (Fig. 2). Laryngoscopy examination showed a 2.5 cm by 3 cm mass in the oropharynx, in front of the anterior commissure, posterior to midline of posterior wall of pharyngeal and lower to the esophageus. Two lymphoid nodes were palpated in his right cervical area. After the tumor resection and right neck dissection, the residual defect required reconstruction. With the help of a Doppler device, a right pedicle TAAP flap measuring 4 cm by 6 cm was marked on the right hemichest of the patient, based on a dominant myocutaneous perforator found in the septum between the clavicular and the sternocostal heads of the PM muscle. The TAAP flap was rotated and tunneled beneath the clavicle bone to the neck area and then deep through the right sternocleidomastoid muscle inset into the hypopharyngeal defect and secured with interrupted sutures to ensure a watertight seal, and the donor site was sutured directly. Postoperative wound healed smoothly. The tracheal tube was unplugged 48 hours days after surgery. At the 12th day postoperatively, the patient resumed oral intake without accidental aspiration, and the feeding tube was removed after 22 days. Postoperative laryngopharyngoscopic image showed no fistulas, stenosis/strictures, dehiscence, or swelling at 12-months follow-up. The PM muscle function was completely preserved at 12 months.

Case 2. A 56-year-old gentleman had previous reconstruction, with a local myocutaneous cervicoplatysma flap after a tumor resection involving the hypopharyngeal and upper esophageal tract and radiation therapy. A 2 cm by 2 cm fistula developed, exposing the nasogastric tube. After 6 months of conservative dressing, a radical debridement was performed, leaving a pharyngoesophageal and anterior neck skin composite defect. A left 10 cm by 5 cm TAAP flap was harvested based on the perforator identified preoperatively with the Doppler device (Fig. 3). The flap was tunneled under the intervening bridge of skin and through a tunnel created under the clavicle bone and the sternocleidomastoid muscle. The midpart of the paddle was deepithelialized, allowing the single flap to resurface both the inner esophageal defect and the anterior neck skin. The patient recovered uneventfully, and the barium test and laryngoscopy presented the good functional recovery 13 months postoperatively.

RESULTS

All of the TAAP flaps of our series were transferred successfully and survived entirely with excellent functional results after 15 months of mean follow-up. The pedicle length varied between 6 cm and 10 cm (mean 8.2 cm), and the flap size ranged from 4 cm by 5 cm to 6 cm by 12 cm, with a mean thickness of 0.5 cm. In three cases, the flap was passed under the clavicle bone, whereas in the remaining six cases it was inset in the neck defect through a subcutaneous tunnel. The donor sites were closed primarily in all cases. Postoperative laryngopharyngoscopic image showed no fistulas, stenosis/strictures, dehiscence, or swelling. PM muscle function was completely preserved in all patients. The postoperative barium test and laryngoscopy presented the good functional recovery of hypopharynx.

The tracheal tube plugging training was used for 24 to 48 hours and then removed. After 10 to 14 days postoperatively, the patients resumed oral intake (liquid then solid food) without accidental aspiration. Then, after 14 to 40 days (mean 25 days), the stomach tube was removed.

DISCUSSION

The main goal of single-stage hypopharyngeal reconstruction should be the fast recovery of the patient's ability to speak, breath, and swallow through the restoration of the airway and digestive way integrity and the preservation of pharyngeal space. Several flaps and techniques have been used for this purpose, and all of them have advantages and disadvantages.[18–24]

In this investigation, we have introduced the pedicle TAAP flap as a new valid option, with several advantages over the previously reported methods.[15–17] The location of the TAAP flap skin paddle in close proximity to the hypopharyngeal region made the flap suitable for pedicled transfer. The adjacent neck flaps, including the submental flap, do not have a constant blood supply that could also be both injured by neck dissection and have a limited size of the skin paddle (less than 3–4 cm) that could be stiff after radiation. Furthermore, the cosmetic result could be unpleasant with the loss of the cervicomental angle. The length of the TAAP flap pedicle is 6 cm to 8 cm, but it can be elongated up to 10 cm, as shown in our series, or more through skin paddle deepithelialization, whereas the IMAP pedicle lengthening may require the removal of the intervening costal cartilages. After the harvesting of the TAAP flap, the pedicle of the flap is passed under the clavicular head of the PM muscle and through either a subcutaneous tunnel or under the clavicle bone, depending on the length of pedicle required and inset into the hypopharyngeal defect. The tunnelization can be useful to elongate the pedicle and have less tension on the vessels. The TAAP pedicle is thinner as compared to the PM pedicle, so it is easy to tunnel in the neck area. The authors made sure that either the subcutaneous or subclavicular tunnels were large enough to avoid any pedicle compression or kinking. The strong vascularity of TAAP flap gives this flap an adequate blood supply, and preservation of the

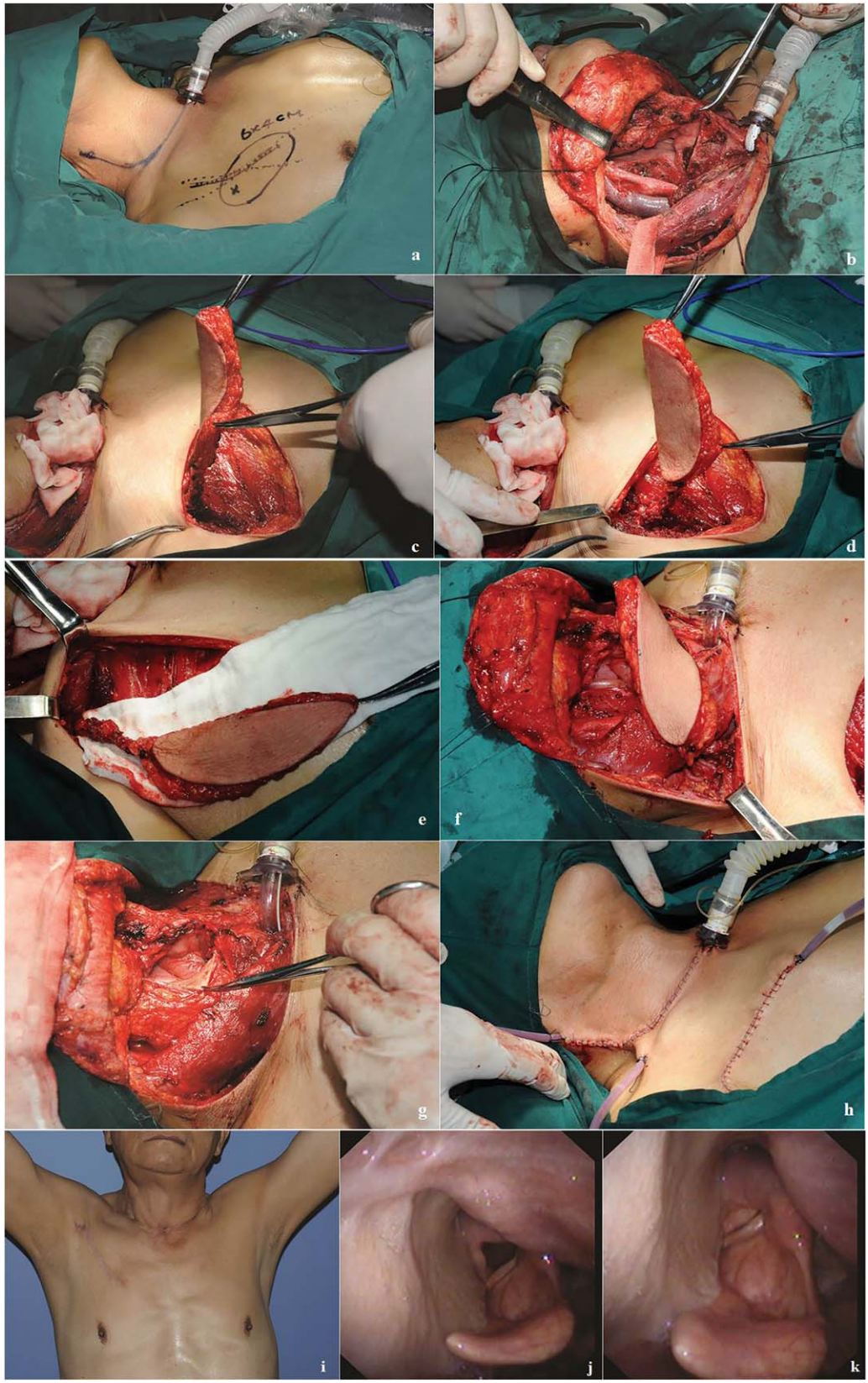

Fig. 2. (a) A 44-year-old man complained of pharyngeal pain for 8 months. A right pedicle thoracoacromial artery perforator flap measuring 6 × 4 cm was marked on the right hemichest of the patient. (b) The residual defect after the tumor resection. (c, d, e) The TAAP flap that was harvested and the TAA that was skeletonized, except for a small cuff of muscle around it toward its origin to enhance the length of the pedicle. Dissection ended when the origin of the TAA from the subclavicular artery was encountered, providing a sufficient pedicle length (f) so that the flap could be freely rotated and tunneled beneath the clavicle bone to the neck area and then deep through the right sternocleidomastoid muscle, inset into the hypopharingeal defect, and (g) secured with interrupted sutures to ensure a watertight seal. (h) The donor site was sutured directly. (i) The pectoralis major muscle function was completely preserved at 12 months. (j, k) Postoperative laryngopharyngoscopic image showed no fistulas, stenosis/strictures, dehiscence, or swelling at 12-months follow-up.
TAA = thoracoacromial artery perforator [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

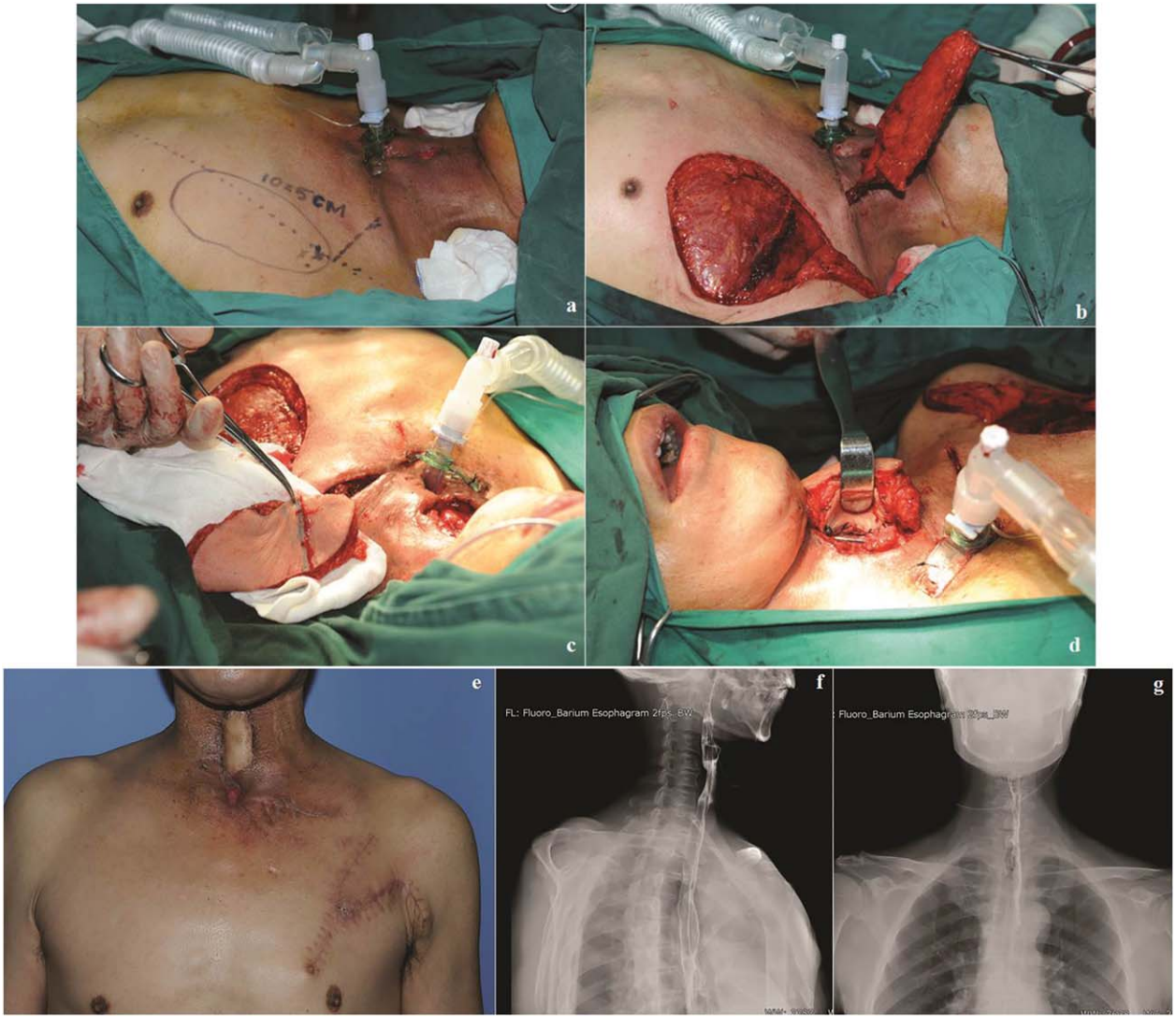

Fig. 3. (a) A 56-year-old gentleman developed a 2 × 2 cm fistula exposing the nasogastric tube. A left 10 × 5 cm TAAP flap was marked and (b) harvested based on the perforator identified preoperatively with the Doppler device. (c) The flap was tunneled under the intervening bridge of skin and through a tunnel created under the clavicle bone and the sternocleidomastoid muscle. (d) The midpart of the paddle was deepithelialized, allowing the single flap to resurface both the inner esophageal defect and the anterior neck skin. (e) The donor site was closed primarily. The patient recovered uneventfully. (f, g) The barium test presented a good functional recovery at 13 months postoperatively. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

pectoral branch of TAA nourishing the PM muscle during the dissection warrants that the PM flap still remains available as backup flap. The TAAP flap is very thin and pliable compared to the PM musculocutaneous flap, which is often too bulky and may narrow the reconstructed pathway. Furthermore, the upper anterior chest skin is thinner than the middle part (IMAP flap) and lower part of chest (PM myocutaneous flap), and it is softer and more elastic than the radial forearm skin (not elastic) and ALT skin (much thicker), making the skin texture of TAAP the best for pharyngeal reconstruction, especially for the posterior wall of hypopharynx in which the thinness is straightforward. The hairless nature of the lateral chest wall area makes use of the TAAP flap more suitable for the lining of intraoral defects, as compared to the usually more hair-bearing medial chest wall skin that is included in the IMAP flap and to the RF and ALT skin paddles. The harvesting of the TAAP flap extends the indication of the pedicle TAAP also in patients with significant comorbidities and in the elderly, especially those whose internal mammary artery should be preserved for possible cardiac surgery. Its pedicle nature makes the TAAP useful in patients with vessel-depleted neck and in previously irradiated patients. The donor site morbidity is limited. The cosmetic result is enhanced because the PM muscle is always conserved, preserving movement and breathing, and the donor site can be sutured directly in all cases, as shown in the present series. Direct closure may be achieved when the width of the flap is less than 6 cm. If a skin paddle wider than 6 cm is required, the authors plan a local perforator flap to resurface the donor site or

shift the indication for the hypopharyngeal reconstruction toward another flap. In addition, the TAAP could be transferred under the sternocleidomastoid muscle that could be preserved. The TAAP flap paddle size also is still suitable in cases in which partial laryngectomy is required, whereas free (free visceral, ALT, RF) flaps are preferred when a pharyngolaryngectomy is performed. The long-term follow-up results of our series indicated that our treatment with the pedicle TAAP flap is a viable option. Further investigations will assess the feasibility of the TAAP flap for esophageal reconstruction.

Some major drawbacks of the TAAP flap exist, which can limit its indications. Due to its small caliber, dissection of the pectoral branch at times may be tedious and time-consuming. Preexpansion is precluded because the TAAP caliber is too small and may be jeopardized, and because its location between the lateral and middle third of the anterior chest wall should allow the expansion of a very limited area. Female patients are not suitable candidates for this flap because of unsightly residual appearance of the scarred anterior chest wall and possible nipple asymmetry.

CONCLUSION

The use of TAAP flap to reconstruct hypopharyngeal defect is an effective method. The flap is thin and reliable, with a strong vasculature, consistent pedicle length and caliber size, and limited donor site morbidity. The advantages include a local transfer with no microsurgical anastomosis required, a reliable blood supply, hairless nature, and pliability, which make it a new successful option for hypopharyngeal reconstruction.

Acknowledgments

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