Three-dimensional Reconstruction of Supraglottic Structures after Partial Pharyngolaryngectomy for Hypopharyngeal Cancer

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Objective: Larynx-preserving surgery is frequently performed for advanced hypopharyngeal cancer involving the larynx. However, reconstruction after partial pharyngolaryngectomy (PPL) remains a challenging problem because of the high risk of postoperative aspiration. In this report, we describe our new three-dimensional method for reconstructing supraglottic structures with a radial forearm flap. This is a retrospective analysis of 20 patients who underwent PPL for having hypopharyngeal cancer involving the larynx at our institution from 1996 to 2005.

Methods: The resulting pharyngolaryngeal defects were reconstructed with radial forearm flaps in all patients. Three-dimensional structures were reconstructed with a single nylon suture, which was used to hoist the flap and ensures that the arytenoids and the aryepiglottic fold were of appropriate height.

Results: Radial forearm flaps were transferred successfully in all but one case. Swallowing function was satisfactory in all patients, and decannulation could be performed in all but one patient. Postoperative conversational function in all patients was rated as excellent with Hirose’s scoring system.

Conclusions: Free jejunum transfer is the method of first choice for reconstruction of a defect after partial hypopharyngectomy. However, the complex supraglottic structures of the larynx are difficult to reconstruct with a free jejunal graft after PPL. In such cases, we perform three-dimensional reconstruction of the pharyngolaryngeal defect with a radial forearm flap and have achieved satisfactory postoperative function. We believe that our new procedure is a useful method for functional reconstruction after PPL.

Key words: hypopharyngeal cancer — partial pharyngolaryngectomy — hypopharyngeal reconstruction — radial forearm flap — head and neck reconstruction

INTRODUCTION

Total pharyngolaryngectomy has historically been the treatment of first choice for advanced hypopharyngeal cancer. However, preserving the voice is a major concern when cancer of the head and neck is resected. Recently, partial resection of the hypopharynx has become possible, even when the tumor involves the laryngeal structures. In such cases, partial pharyngolaryngectomy (PPL), in which parts of the hypopharynx and the supraglottic structures are resected simultaneously, can be performed. However, reconstruction after PPL is often complicated by postoperative aspiration. The free jejunal patch graft is a good choice for reconstruction after simple partial resection of the hypopharyngeal wall, but when the larynx has also been partially resected, reconstructing the complex supraglottic structures with a free jejunal patch graft is difficult. In the present report, we describe our method of three-dimensional reconstruction.
reconstruction of supraglottic structures using a radial forearm flap after PPL and the results of postoperative functional analysis.

MATERIALS AND METHODS

SURGICAL PROCEDURE

All operations were performed with endotracheal intubation and systemic anesthesia. A J-shaped skin incision was used to expose the hyoid bone and the thyroid cartilage, and the lateral third of the thyroid cartilage was resected. Hypopharyngeal cancer was extirpated through lateral or superior pharyngotomy. In most patients, the hypoid bone, pyriform sinus, arytenoids and aryepiglottic fold were resected only on the affected side. In some patients, part of the epiglottis, the posterior wall of the hypopharynx or the false vocal cord was resected simultaneously. The true vocal cords were not resected in any patient. Unilateral or bilateral cervical lymph node dissection was performed before primary tumor resection.

Microvascular reconstruction with a radial forearm flap was performed immediately after tumor extirpation. A radial forearm free flap, with an average size of 7 × 7 cm², was harvested from the side opposite to the patient’s dominant hand under avascularization with a tourniquet. The donor site was closed with a split-thickness skin graft from the lower extremity. The elevated flap was transferred to the neck mucosal defect and sutured with 4-0 monofilament absorbable stitches. First, the top of the remaining arytenoid was sutured to the flap as a key point. Next, the flap was sutured to the internal wall of the laryngeal box and pulled forward to the postcricoid mucosa and toward the apex of the pyriform sinus. From the bottom of the pyriform sinus, the flap was sutured to the margin of the posterior wall defect toward the cranial side. Flap suturing was temporarily stopped at the superior margin of the mucosal defect.

At this time, the most important part of this procedure was performed. To create an aryepiglottic fold of appropriate height, a 3-0 monofilament nylon suture was fixed to the back of the flap. This nylon suture was not tied until the anterior margin of the mucosal defect was sutured to the flap. Finally, the 3-0 monofilament nylon suture was stitched to the intermediate tendon of the digastric muscle, which had been separated from the hyoid bone. As a result, a part of the flap was hoisted to create the aryepiglottic fold. After the flap had been completely sutured, microvascular anastomosis between the flap pedicle and the cervical vessels was performed (Figs 1 and 2).

PATIENTS

From 1996 to 2005, 20 patients with hypopharyngeal cancer underwent PPL and immediate reconstruction with a radial forearm flap. Patients ranged in age from 43 to 76 years (mean age, 57.9 years) and included 18 men and two women. Most of the patients had T2 or T3 hypopharyngeal cancer of the pyriform sinus and 60% of the patients had metastasis to cervical lymph nodes preoperatively (Table 1). Cervical dissection was unilateral in 17 cases and bilateral in three cases. Up to two-thirds of the epiglottis was resected in four patients. Four patients had received radiotherapy to the neck, because of cancer of the esophagus, mesopharynx, hypopharynx or larynx. One patient underwent postoperative radiotherapy because of a positive surgical margin.
RESULTS

The flap was transferred successfully in 19 of 20 patients, and the immediate postoperative course was uneventful in 11 of 20 patients. Total necrosis of the flap developed in one patient because of arterial thrombosis, but the defect was closed conservatively. Venous thrombosis developed in one patient on the first postoperative day, but the flap was salvaged after the venous anastomosis was re-explored. Partial necrosis of the flap developed in three patients but healed with conservative treatment. Pharyngocutaneous fistula developed in seven patients, of whom two required surgical debridement and one required transfer of a pedicled pectoralis major myocutaneous flap because of wound infection.

A temporary tracheal stoma was placed in all patients but could be closed 8–89 days after surgery (median, 22 days) in 19 patients. However, closure was not possible in one patient because of airway stenosis caused by the excessive volume of the transferred flap. Oral feeding was resumed 7–33 days after surgery (median, 13 days). The mean follow-up period was 35.1 months, and 13 patients are alive without recurrent disease.

Functional results were evaluated 6 months or even longer after surgery. Postoperative functions were analyzed on the basis of the type of diet tolerated, the presence of aspiration and conversational ability. Ten patients could eat a normal diet, and seven could eat a soft diet. The usual degree of aspiration was observed in only two patients, but decannulation could be performed at 26 and 89 days postoperatively in these patients, who could tolerate a soft diet. Conversational ability was analyzed with Hirose’s Japanese scoring system in 19 patients (1): conversation ability was rated as excellent in 18 patients and as poor in one patient, in whom decannulation was not possible (Table 2).

REPRESENTATIVE CASE

A 65-year-old man presented to our hospital with throat pain of 1 month duration. Endoscopic examination revealed an ulcerative tumor at the right pyriform sinus, and a pathological diagnosis of well-differentiated squamous cell carcinoma was made. Computed tomography revealed tumor invasion only to the submucosal layer but showed metastasis to a single lymph node of the superior internal deep lymphatic nodes. Finally, the tumor was diagnosed as T2N1 hypopharyngeal cancer. In August 2000, surgery was performed under general anesthesia and included PPL, left cervical lymph node dissection, partial resection of the thyroid cartilage and hyoid bone, and tracheostomy and was followed by immediate reconstruction with the method previously described. Postoperative leakage was not detected with video fluoroscopy, and oral feeding was resumed 7 days postoperatively. The temporary tracheostoma was closed 13 days postoperatively, and the patient was discharged to home 21 days after surgery.

Eighteen months after the operation, the functional outcome was considered satisfactory: the patient could eat a normal diet without aspiration, and conversational ability was rated as excellent. The created aryepiglottic fold retained the shape it had immediately after the operation (Figs 3, 4 and 5). Four years after the operation, the reconstructed supraglottic structures have maintained their anatomical shapes (Fig. 6).

DISCUSSION

In the past, PPL was performed only for selected patients. Ogura et al. (2) have suggested the following criteria for candidates for PPL: (i) the true cords and arytenoids are freely mobile and free of gross tumor involvement; (ii) the apex of the pyriform sinus is not involved by tumor; and (iii) there is no thyroid cartilage invasion. However, several reports concerning larynx-preserving surgery have been published because of a greater desire for voice preservation (3–5). When resection does not include the lateral wall of the pyriform sinus, the pharyngeal defect can be closed easily with a hinge flap or a local mucosal flap (6). However, if the resection is more extensive, a free flap, such as a jejunal patch

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graft or a radial forearm flap, is needed to close the pharyngeal defect.

The free jejunal patch graft is an ideal material for reconstructing mucosal defects after partial pharyngectomy because of its self-lubrication by secreted mucous and good adaptation between the jejunal mucosa and pharyngeal mucosa. However, intestinal secretion might be a problem if the internal mucosal wall of the laryngeal box is reconstructed with a jejunal graft after PPL. The possibility of frequent aspiration caused by mucus secretion has been reported (7,8). Reconstructing the complex supraglottic shape of the larynx is difficult with a free jejunal graft because of the loose connection between the mucosal layer and the submucosal structure. For these reasons, our first choice of material for reconstructing defects resulting from PPL is the radial forearm flap, which is thin and pliable.

The indications for PPL and reconstruction with our new method are as follows. The most important factor is the extent of the primary tumor. A patient with hypopharyngeal cancer limited to one side of the pyriform sinus is an ideal
candidate for surgery with our new method. Therefore, the best surgical indication is T2 or T3 tumor which does not require total laryngectomy. If the tumor is T1, mucosal defect can be closed primarily, and a T4 tumor usually requires total laryngectomy. On the other hand, part of the epiglottis, posterior wall, postcricoid mucosa and the arytenoids of one side can be included in the resected area, because these subsites can be reconstructed simultaneously with the transferred forearm flap. Older patients (>75 years) are not good candidates, because of their higher likelihood of having aspiration pneumonia. Furthermore, patients who have received radiotherapy to the neck are not good candidates, because of the high risk of postoperative complications. In our series, leakage or flap necrosis developed in two of the four patients who had received radiotherapy.

Reconstructing the complex three-dimensional structures around the larynx and hypopharynx can be difficult. Furthermore, postoperative aspiration is considered inevitable when supraglottic tissues, such as the arytenoids and the aryepiglottic fold, have been resected (3). Previously suggested reconstructive materials include the osteomuscular local flap (3), the forearm flap with costal cartilage (5) and the forearm flap with palmaris longus tendon (9). Artificial materials, such as hydroxy apatite, can also be used to create the height of the arytenoids. Reconstruction with these materials is relatively complex and, in particular, the use of artificial materials can cause postoperative infection.

Because of the limitations of previously described methods of reconstruction, we have established a simpler reconstructive procedure for preventing aspiration after PPL. We believe that restoring the normal anatomy of the supraglottic structures as completely as possible is important. The height of the aryepiglottic fold is anatomically supported by the aryepiglottic muscle, which is located in the upper part of the aryepiglottic fold. The aryepiglottic fold and muscle protect the larynx from mis-swallowing: it functions as a purse string to close the opening of the larynx during swallowing. When the aryepiglottic fold has been reconstructed, a swallowed food bolus cannot directly enter the larynx. As a result, satisfactory postoperative swallowing function can be obtained. The most notable point of our reconstructive procedure is that an aryepiglottic fold of an appropriate height is created with a single nylon suture that hoists the transferred flap cranially.

Advantages of our new procedure for creating an aryepiglottic fold of appropriate height include its reliability and simplicity. The radial forearm flap is a reliable flap for head and neck reconstruction and has been widely accepted. The use of a single nylon suture to reconstruct the aryepiglottic fold is also a simple and easy method. Furthermore, our method does not require the harvest of additional materials, such as cartilages and tendons, or their complex arrangement or fixation.

On the other hand, a considerable limitation of our method is the delayed sensory recovery of the transferred flap. Urken et al. (5) have reported favorable functional results after transfer of sensate radial forearm flaps and free costal cartilage in six patients. However, in our series, 18 of 20 patients could resume oral feeding without severe aspiration within 1 month after surgery. So soon after surgery, however, full sensory nerve regeneration cannot be expected, despite nerve anastomosis having been performed. We believe that reconstructing the aryepiglottic fold to as near its normal shape as possible is more important than nerve anastomosis. Another possible limitation of our technique is the gradual loosening of the nylon suture after surgery. The height of the reconstructed aryepiglottic fold could decrease as the suture loosens. However, in our patients, we observed no such change in the shape of the aryepiglottic fold for at least 2 years postoperatively. Although the mechanism of resisting tension power is unclear, the postoperative scar might help maintain the aryepiglottic fold structure. Furthermore, should such a change in shape occur, it would occur slowly, enabling the patients to tolerate it and adapt.

CONCLUSION
We believe that our new method of three-dimensional reconstruction is effective for patients with pharyngolaryngeal defects after PPL. The key to satisfactory postoperative function is to restore the complex three-dimensional structure of the aryepiglottic fold.

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Conflict of interest statement
None declared.

References


