Organ Preservation Surgery for Advanced Unilateral Glottic and Subglottic Cancer

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Objectives: Functional surgery of unilateral T2b to T3 glottic cancer and cricoid chondrosarcoma is possible using the technique of tracheal autotransplantation. The objective of this paper is to report the functional and oncologic outcome of 24 consecutive patients treated with this technique between 2001 and 2007.

Methods: Seventeen patients, of whom nine were previously irradiated, had unilateral glottic cancer with impaired mobility of the vocal fold. Clinical staging was T2b to T3N0. Seven patients had a chondrosarcoma of the cricoid cartilage. In a first operation, an extended hemilaryngectomy was performed, and a radial forearm flap, comprising a distal fascial and a proximal skin component, was transferred to the neck. The fascial paddle was wrapped around the upper 4-cm segment of cervical trachea, and the skin paddle was used for temporary closure of the extended hemilaryngectomy defect. The definitive reconstruction was performed after 2 to 3 months and consisted of removal of the skin paddle from the laryngeal defect and a transplantation of a patch of revascularized cervical trachea to reconstruct the laryngeal defect.

Results: Swallowing and speech were restored after the first operation. The glottic and subglottic airway lumen was restored during the second operation. The tracheostomy could be closed in 20 patients. After a median follow-up period of 33 (range, 1–66) months or almost 3 years, 23 patients remained free of tumor recurrence.

Conclusions: Tracheal autotransplantation can be recommended as a functional treatment for selected T2b to T3 glottic cancers and for unilateral chondrosarcomas of the cricoid cartilage. The technique is oncologically robust while resulting in good postoperative function.

Key Words: Glottic cancer, subglottic cancer, cricoid chondrosarcoma, tracheal autotransplantation, revascularization, organ preservation.

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INTRODUCTION

Surgical treatment of advanced cricoid chondrosarcomas and of unilateral T2b to T3 (T2b, T2 glottic cancer with impaired mobility; T3, glottic cancer with vocal fold fixation) glottic cancer usually requires a total laryngectomy because endoscopic laser resection and chemoradiation will be successful in only a minority of patients. Radiation and chemotherapy have not proven to be beneficial in cases of cricoid chondrosarcomas, and total laryngectomy is usually inevitable when half of the cricoid cartilage needs resection to obtain clear section margins.

A unilateral T2b to T3 glottic cancer can be diagnosed as a recurrence after previous radiation therapy or as a new primary tumor. Although one side of the larynx may be completely healthy, a total laryngectomy is usually advocated for advanced, unilateral glottic cancer that is diagnosed after previous radiation therapy.1 A new primary unilateral T2b to T3 glottic cancer can be treated by organ preservation chemoradiation protocols with salvage total laryngectomy in cases of persistent or recurrent tumor, with a laryngeal preservation rate of approximately 50%.2

We described a laryngeal reconstruction technique that allows for a functional surgical treatment of unilateral chondrosarcomas of the cricoid cartilage and of selected unilateral T2b to T3 glottic cancer both as primary treatment and after previous irradiation.3–7 The resection of unilateral T2b to T3 glottic cancers and of cricoid chondrosarcomas necessitates removal of one complete half of the cricoid cartilage. This extended hemilaryngeal defect can be reconstructed with a revascularized segment of the cervical trachea. The segment of cervical trachea that is used for reconstruction is revascularized by wrapping it with a radial forearm fascia flap. A two-stage reconstruction technique is necessary to bring the cervical trachea with intact vascularity inside the hemilaryngectomy defect. The
The reconstruction technique was designed to fulfill two essential requirements: reconstruction of the sphincteric and respiratory function of the larynx without compromising the oncologic results.

MATERIALS AND METHODS
In a 6-year period (2001–2007), 24 patients were treated. Seventeen patients were treated for a squamous cell carcinoma. These tumors were classified as T2b (3 patients) and T3 (14 patients). Nine (2 T2b, 7 T3) patients were treated after recurrence of a T1 glottic tumor treated with radiation therapy. The neck was staged as N0 in all patients of the series. Seven patients were treated for a chondrosarcoma of the cricoid cartilage.

During a first operation, the tumor was resected, the laryngeal defect was repaired temporarily using the skin paddle of the radial forearm flap, and the cervical trachea underwent revascularization. On the tumor side, only the epiglottis, the aryepiglottic fold, and the corniculate and cuneiform cartilages were preserved (Figs. 1A, 2A, and 3A). The ipsilateral thyroid lobe and tracheoesophageal lymph nodes were removed as well as the lymph nodes at levels II, III, and IV. A radial forearm free flap with a fascial paddle and a skin paddle was dissected. The skin paddle was sutured into the laryngeal defect, and the fascial paddle was wrapped around the cervical trachea for revascularization. An expanded polytetrafluoroethylene (ePTFE) membrane (Preclude Pericardial Membrane, 0.1 mm, W.L. Gore and Associates, Inc. Flagstaff, AZ) was applied over the fascia flap. The ePTFE prevents adhesions between flap and surrounding tissue and facilitates dissection during the second operation. The radial forearm vessels were sutured to the neck vessels (radial artery end-to-end to the superior thyroid artery; radial vein end-to-side to internal jugular vein). A tracheostomy was placed above the revascularized trachea (Fig. 1B).

Definitive reconstruction of the laryngeal defect was performed during a second operation after 2 to 3 months. The skin paddle of the radial forearm flap was removed from the laryngeal defect, and the section margins were reevaluated to exclude tumor recurrence (Fig. 1C). The fascial-enwrapped segment of revascularized trachea was isolated, moved upward, and sutured into the laryngeal defect. The mediastinal tracheal stump was mobilized and sutured to the reconstructed larynx (Fig. 1D). In this operation, the vascular pedicle of the radial forearm flap remained untouched. A tracheostomy was maintained in the suture line between the reconstructed larynx and the mediastinal trachea.

The tracheostomy was closed after restoration of all laryngeal functions, usually 1 to 2 months after the second operation. The tracheostomy was closed by inverting the skin around the tracheostomy, a small procedure performed under local anesthesia. A coronal reformatted computed tomography (CT) scan was taken after the first and second operation.

RESULTS
The CT scan taken after the first operation showed a full restoration of the sphincter function at the glottic

Fig. 1. Organ preservation surgery: overview of longitudinally incised model. (A) Outline of tumor. Tumor (1 = T3 glottic cancer with subglottic extension; 2 = cricoid chondrosarcoma) is resected with inclusion of cricoid cartilage and with preservation of the aryepiglottic fold (asterisk). Anterior commissure is resected if the tumor (1) reaches the anterior border of the vocal fold. (B) First operation. Radial forearm fascia (1) is wrapped (arrow) around the cervical trachea (cartilaginous part) for revascularization. Radial forearm skin flap (2) is sutured into the laryngeal defect for temporary closure. Radial blood vessels (3) are sutured to neck vessels (radial artery end-to-end to superior thyroid artery; radial vein end-to-side to internal jugular vein). Tracheostomy allows (asterisk) respiration. (C) Second operation. Skin paddle (2) is removed from the defect and de-epithelialized (shaded area). Revascularized trachea is isolated (black lines) and transplanted to the laryngeal defect (arrows). Tracheostomy allows (asterisk) respiration. (D) The tracheal patch is sutured into the laryngeal defect. Part of the membranous trachea (asterisk) is resected to allow for anastomosis of the tracheal stump to the reconstructed larynx (arrows).
level and an incomplete restoration of the subglottic airway lumen (Fig. 3B). Swallowing of solids and liquids was possible 1 week after the first operation. After the first operation, speaking was possible during finger occlusion of the tracheostomy. The voice quality can be evaluated on the videos (available online only). Pathologic examination of the resection specimen revealed all section margins to be tumor free. Thyroid cartilage invasion (pT4) was seen in three patients who were initially staged as T3. A positive lymph node with extracapsular spread (patient 18) was found in only one of the lymph node dissections.

All 24 patients were tumor free on reevaluation during the second operation (Table I). The respiratory function was restored by the tracheal patch both at the glottic and at the subglottic level (Fig. 2B and C). The CT scan taken after the second operation showed a full restoration of the sphincter function at the level of the remaining arytenoid while the airway lumen was restored both in the anterior glottic and subglottic area (Fig. 3C and D). Some aspiration of saliva was seen during the first days after operation, and most patients resumed oral feeding after 1 week. One patient (patient 9) did not succeed in swallowing without aspiration, and a completing total laryngectomy was performed 4 months after tracheal autotransplantation. Tracheostomy closure was delayed in another patient (patient 21) because of swallowing problems caused by postirradiation pharyngeal hypococontractility. After the second operation, the patients could speak after finger occlusion of the tracheostomy. Hands-free speaking was possible after tracheostomy closure. Because of a restricted airway at the level of the anastomosis between the reconstructed larynx and the trachea, the tracheostomy was reopened in two patients. In the first patient (patient 6), the tracheostomy was reopened immediately, whereas in the second patient (patient 15), it was reopened after 4 months. These two patients are now speaking with a corked tracheostomy tube. Laryngeal endoscopy and voice quality after tracheal autotransplantation can be evaluated on the videos (available online only).

After a median follow-up period of 33 (range, 1–66) months, 22 patients remained free of tumor. One patient (patient 12) died 32 months after reconstruction because of a gastric tumor without evidence of locoregional tumor recurrence. In one patient (patient 18), a local recurrence was detected 2 years after partial laryngectomy. A laryngeal preservation rate of 95% was obtained, and 22 patients are alive without evidence of locoregional disease.

DISCUSSION

Tracheal autotransplantation allows for a functional treatment of T2b to T3 glottic cancer and cricoid chondrosarcomas. A unilateral glottic cancer with impaired
mobility of the vocal fold may occur before or after irradiation. Such a tumor cannot be removed using laser, vertical hemilaryngectomy, or supracricoid laryngectomy because a safe caudal tumor margin necessitates resection of the cricoid cartilage. Treatment of previously untreated T3 glottic cancer by primary irradiation has yielded local control rates in the 40% to 50% range.1 Of the patients in whom radical irradiation fails, total laryngectomy is reported to salvage approximately half of this group, yielding an overall cure rate of 70%, with a laryngeal preservation rate of the original 50%.2 The same tumor extension in a previously irradiated larynx can only be treated by total laryngectomy. Extended hemilaryngectomy with tracheal autotransplantation for suitable T3 glottic cancers is as radical as the resection obtained during near-total laryngectomy,8 yielding good laryngeal preservation and excellent local tumor control rates. The two-stage approach is advantageous for the oncologic safety of the procedure. The tumor and the neck nodes are removed during the first operation, and the second stage allows for a reevaluation of the section margins before the definitive reconstruction is performed. In our study, only one patient showed a local recurrence 2 years after reconstruction. Extreme care is necessary in previously irradiated patients, especially when the pathology report shows a positive neck node with extracapsular spread.

A revascularized patch of trachea and the preserved aryepiglottic fold are the cornerstones for obtaining good functional results. The extended hemilaryngectomy defect with inclusion of the cricoid cartilage is a difficult defect because the optimal position of the reconstructive tissue is different for the subglottic and glottic area. In the subglottic area, the graft has to maintain an adequate airway by providing an adequate concavity between the anterior and the posterior section line. In the glottic area, the two opposing functions of respiration and sphincter function need to be addressed. For optimal reconstruction at the glottic level, a balance has to be found between optimal respiratory and sphincter function. Complete posterior closure is important for obtaining a good voice and swallowing function, and, therefore, the reconstruction has to be placed in the posterior midline. Complete glottic closure is less critical anteriorly, and therefore a paramedian position of
the graft will allow good respiratory function. Reconstruction of the anterior glottis is easily achieved using the tracheal autotransplant. Experience in this patient series has shown that the aryepiglottic fold is superior for reconstruction of the posterior glottic and supraglottic area. It can be placed in the midline without interfering with the mobility of the contralateral arytenoid.

Four patients did not recover all laryngeal functions. One patient is waiting for tracheostomy closure until recovery of swallowing, and another patient underwent a total laryngectomy because of persistent aspiration. Two patients could not be decannulated because of a restricted airway at the level of the anastomosis between the reconstructed larynx and mediastinal trachea. This anastomosis may show a tendency toward substenosis. This tendency can be anticipated by short-term stenting of the anastomosis.

From the experience obtained in this series, we advise the placement of a silicone stent during tracheal autotransplantation, as shown in Figure 3D.

CONCLUSION
From both a functional and oncologic point of view, tracheal autotransplantation can be recommended as a functional treatment for unilateral glottic cancer with impaired mobility and for cricoid chondrosarcomas. Higher morbidity linked with swallowing difficulties is seen when the reconstruction is performed in irradiated patients. However, for irradiated patients, organ preservation surgery remains a valuable option in patients with unilateral glottic cancer.

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