Case Report

Composite Hyoid Bone Graft Interposition for the Treatment of Laryngotracheal Stenosis

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Hyoid bone · Subglottic stenosis · Tracheal stenosis · Laryngeal stenosis · Hyoid interposition grafts · Laryngotracheal reconstruction

Abstract
Introduction: Chronic laryngotracheal stenosis (LTS) remains a challenging problem for otolar yngologists. A composite hyoid bone interposition graft has the potential to be an ideal graft because the head and neck surgeon can obtain the graft in the same operative field with good vascular supply from the muscle pedicle. Methods: A composite hyoid interposition graft was used to provide structural support for the reconstructed lumen of the larynx or trachea in 2 cases of LTS. Results: Two patients underwent successful decannulation with acceptable laryngeal function over a long-term observation period. Conclusion: This technique allows vascularized stable graft survival with minimal donor site morbidity. Furthermore, it can be performed for thyroid, cricoid, and tracheal stenosis without fear of damage to the recurrent laryngeal nerves.

Introduction

The management of laryngotracheal stenosis (LTS) has always been a difficult surgical challenge. Mild-to-moderate stenosis with an intact framework can occasionally be treated by repeated balloon dilation or laser endoscopic dissection. Severe stenosis with an injured framework usually requires staged surgery involving widening of the lumen and reconstruction with structural support because a laterally unsupported lumen is at risk of restenosis.
nosis. To expand the constricted lumen and to create a stable reconstructed lumen, a well-vascularized, easily accessible, and rigid graft is needed. A hyoid bone graft may provide structural support for the reconstruction of the anterior laryngotracheal lumen. A composite hyoid bone graft has the potential to be the ideal graft because the head and neck surgeon can obtain the graft in the same operative field with good vascular flow from the muscle pedicle. We present 2 cases of LTS successfully treated with a composite hyoid bone interposition graft.

**Case Report**

**Case 1: Tracheal Stenosis**

A 60-year-old female presented with a history of subarachnoid hemorrhage, which had occurred 7 years ago. She had received tracheostomy with long-term mechanical ventilation and had undergone decannulation after several weeks. One year later, she began experiencing stridor and was short of breath but received treatment for asthma. She experienced severe shortness of breath during minor tasks such as changing clothes, so she was usually unable to leave her bed without oxygen therapy. She was eventually referred to our hospital with several years’ history of stridor and worsening dyspnea. Bronchoscopy and CT images revealed severe tracheal stenosis with a diameter of ≤3 mm and an injured framework of tracheal cartilage at the level of tracheal rings 3–4. This was assumed the site of the previous tracheostomy (fig. 1a, b).

Emergency airway treatment was needed. However, because transoral intubation of the patient was predicted to be difficult, tracheostomy was performed under local anesthesia. As a first step of staged surgery, a tracheal trough was established by splitting the scarred anterior wall of the trachea at the level of rings 2–5 (fig. 2a, b). Two months later, intact mucosa of the lumen with an injured framework was observed. As a second step, a hinge flap method was used for closing the lumen of the upper side of the trough and a composite hyoid bone-thyrohyoid muscle graft was interposed into the anterior wall of the trachea by reflection and suturing in a transverse position as structural support. The thyrohyoid muscles on both sides were maintained as pedicles (fig. 2c–f). A tracheostoma was retained at the bottom of the trough. Although videofluorography at 3 days after surgery showed mild aspiration because of an impaired laryngeal elevation, within 2 weeks, the patient no longer needed a feeding tube and was able to eat normal food asymptomatically. Fourteen months after the second surgery, fiberoptic endoscopic examination and CT images revealed persisting good tracheal expansion (fig. 3), and the tracheostoma was closed. The patient had normal breathing, a normal voice, and normal swallowing >2 years after the tracheostoma had been closed.

**Fig. 1.** Case 1. Bronchoscopy (a) and 3D-CT images (b) revealed tracheal stenosis with an injured framework of tracheal cartilage at the level of tracheal rings 3–4 (arrows), possibly the previous tracheostomy site.
Case 2: Laryngeal Stenosis

A 20-year-old female presented to our hospital with laryngeal stenosis. She had been diagnosed with lymphangiomatosis of the larynx after suffering from dyspnea and stridor soon after birth. Laryngeal stenosis was attributed to tracheostomy and repeated laser microsurgery. Her glottis was found to be completely closed due to scarring and adhesions. First, a laryngeal trough was created by splitting the scarred anterior wall of the larynx, and a Montgomery T-tube was inserted into the larynx for 7 months. However, her glottis was completely closed again 1 month after decannulation. Epithelialization and structural support for widening the larynx were thought to be the key requirements in this case. A laryngeal trough was created again by splitting the scarred anterior wall of the larynx, and the palatine mucosa was grafted onto the raw surface of the larynx after the removal of scar tissue. A well-fitting mold was placed in the lumen. Two months after the procedure, regeneration of the normal mucosa was observed. The lumen of the laryngeal trough was closed by the mucosal flap, and the composite hyoid graft was moved down and interposed to the laryngeal fissure to provide structural support (fig. 4). The middle segment of the hyoid immediately lateral to each lesser cornu was used as the graft. Infrahyoideal muscles were maintained as the pedicle. Careful observation with a plugged tracheostoma in place for 4 months revealed no dyspnea and a normal swallowing function. Finally, the tracheostoma was closed. Ten years after the last surgery, she has hoarseness of voice but no symptoms during breathing or swallowing.
Fig. 3. Case 1. Axial (a) and sagittal (b) views on a CT scan revealed a sufficient lumen of the trachea at 8 months after the second surgery. The high-density area indicates the grafted hyoid bone at the previous stenosis site (arrowhead).

Fig. 4. Case 2. The laryngeal trough was created by splitting the scarred anterior wall of the larynx, and the palatine mucosa was grafted onto the raw surface of the larynx after the removal of scar tissue. A well-fitting mold was placed in the lumen. Two months after the procedure, regeneration of the normal mucosa was observed. The lumen of the laryngeal trough was closed by a mucosal flap, and the composite hyoid graft (arrows) was moved down and interposed into the laryngeal fissure as structural support.
Discussion

Using the hyoid bone as a graft in treating LTS is a classic yet uncommon method. The first use of the hyoid bone as a graft to repair laryngeal stenosis was reported by Looper [1] in 1938. For 3 decades, no surgeon paid much attention to this procedure. Finnegan et al. [2] restudied this concept using animal models in 1975. Ward et al. [3] reported successful results in 3 of 4 human cases of not only glottic but also subglottic and tracheal stenosis in 1976. In the 1970s and 1980s, Ward et al. [3] further established this procedure and, together with other colleagues, Ward reported successful clinical results in 20 cases in 1986 [4]. Furthermore, long-term stability of the grafted hyoid bone was reported at follow-up examinations conducted more than 5 years postoperatively [5]. Although other sporadic reports showed successful outcomes [6–9], the composite hyoid interposition graft technique for LTS has not yet been accepted widely.

Primary resection with end-to-end anastomosis can be a curative treatment as a single-stage laryngotracheal reconstruction. However, in this approach, the risk of damage to the recurrent laryngeal nerves cannot be ignored [10]. The hyoid interposition graft has the advantage that it can be used without concerns over recurrent laryngeal nerve paralysis. The costal cartilage, as a nonvascularized free graft, is also used as structural support for laryngotracheal reconstruction but this technique requires a second skin incision and is an unfamiliar surgical technique for the head and neck surgeon. Composite hyoid interposition grafts require a single incision and are easy to learn for head and neck surgeons. The composite hyoid interposition graft technique is still worthwhile because it allows vascularized stable graft survival, minimal risk to recurrent laryngeal nerves, and minimal donor site morbidity.

For a successful outcome, it is important to assess the mucosal condition. If not only structural support but also sufficient epithelialization is needed, as observed in case 2, it is recommended to graft skin or oral mucosa onto the raw surface of the lumen after the excision of scar tissue, as previously reported [9].

The hyoid bone graft was originally interposed in a longitudinal direction with a unilateral sternohyoid muscle as a pedicle [1–5]. However, the resulting graft may sometimes be too short to widen the lumen. A promising strategy for reinforcing the lumen laterally is to interpose the longish hyoid bone graft in a transverse direction with the thyrohyoid muscles on both sides as the pedicles, as we described in case 1. This technique, employing muscle pedicles on both sides, provides an additional guarantee of adequate blood supply to the graft. To our knowledge, this is the first report in which thyrohyoid muscles on both sides were used as pedicles for the grafted hyoid bone.

Conclusion

Two patients with LTS underwent successful decannulation with an acceptable laryngeal function over long-term follow-up observation periods. This technique allows vascularized stable graft survival with minimal donor site morbidity, and it can be used for the treatment of thyroid, cricoid, and tracheal stenosis without fear of recurrent laryngeal nerve paralysis.

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References