Staged Laryngotracheoplasty for the Reconstruction of Laryngotracheal Stenosis: a 12-year experience

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Abstract

Objectives: Laryngotracheal stenosis is a complicated problem without a straightforward solution. In recent years many centers have performed staged laryngotracheoplasty (LTP) with the ultimate goal of attaining long-term airway patency without restenosis. We set out to study our experience of patients who have undergone staged LTP in order to identify its utility in treating laryngotracheal stenosis.

Study design: Retrospective case series.

Methods: IRB approval was obtained. From January 1, 2000 to January 31, 2012, patients presenting with diagnoses of laryngeal or tracheal stenosis were identified. Medical records from adult patients were then inspected for the finding and severity of laryngotracheal stenosis as well as patient demographics. Patients undergoing unistaged LTP were included. Patients with a concurrent head and neck malignancy were excluded.

Results: A total of 61 patients were included in our study. Patient mean age was 47.1 (± 16.7) at time of first stage LTP and had a mean follow up of 4.1 (± 3.8) years from the first stage reconstruction. Etiology of stenosis included 46% intubation trauma, 15% autoimmune disease, 17% blunt laryngeal trauma, 17% idiopathic, and 7% other. Primary outcome measure was decannulation at last follow-up. 80.3% of patients were successfully decannulated, while 19.7% remain tracheostomy or T-tube dependent. Univariate analyses showed high significance association between decannulation and age, sex, history of intubation, surgeon, etiology of stenosis, or length of stenosis. There was a significant inverse relationship between grade of stenosis and probability of decannulation on multivariate logistic regression analysis.

Conclusions: Multi-staged laryngotracheoplasty is an excellent option for the reconstruction of severely stenosed airways. At our institution we have achieved excellent decannulation rates in patients with laryngotracheal stenosis who have often failed other treatment modalities. Further prospective studies are indicated.

Introduction

Etiology of Laryngotracheal Stenosis

- Laryngotracheal stenosis (LTS) is most commonly secondary to iatrogenic instrumentation including prolonged intubation and tracheostomy, which accounts for up to 80% of LTS in some series.
- Other etiologies include external trauma, autoimmune (granulomatosis with polyangiitis), and idiopathic.

Endoscopic Options

- Mild to moderate LTS may be treated with conservative endoscopic techniques, but these may suffer from high rates of recurrence.
- These include balloon dilation, CO2 laser ablation, and anti-neoplastic agent injections.

Cricotracheal Resection with Primary Anastomosis

- Cricotracheal resection with primary anastomosis has been shown to have high decannulation rates from multiple case series, but a high percentage of recurrence has been reported in patients with idiopathic progressive subglottic stenosis after this technique.
- Patients with long segment stenosis, typically beyond six tracheal rings, or stenosis extending within the larynx have limited success with primary resection.

Laryngotracheoplasty

- Laryngotracheoplasty (LTP) is currently performed with many different techniques and no standard treatment approach.
- Variations of LTP include single vs. multi-stage and various types of luminal grafting. Traditional homografts include costal cartilage, hyoid-sternohyoid my-o-osseous flap, nasal septum, and auricular cartilage.
- Some authors have described the use of titanium prostheses in the place of homografts with few complications in terms of anastomotic breakdown, restenosis, and granulation tissue formation.
- Our institution employs an anterior laryngofissure technique with buccal mucosa graft for demucosalized tracheal wall and mesh for anterior wall reconstruction.

Materials and Methods

Retrospective Study

Patients with a diagnosis of laryngeal or tracheal stenosis who underwent multi-staged laryngotracheoplasty between 2000 and 2012 at UCLA Medical Center were included if they met the following criteria:
- 18 years or older, stenosis below the vocal cords, at least two stages of LTP completed, and no history of concurrent head and neck malignancy.

Primary Outcome Measure

Decannulation at last follow-up

Surgical Technique

Stage One

- Anterior laryngofissure is performed with advancement of skin and subplatysmal flaps to the tracheal walls to create an open trough.
- Stenotic tissue is excised and buccal mucosa graft is placed if needed.
- A temporary stent (Montgomery T-tube or Coe-Soft) is placed to reinforce the graft and a period of seven days is allowed to elapse.

Stage Two

- Mucosal graft is examined and granulation tissue is cleared.
- If anterior augmentation is necessary, an absorbable (i.e. Vicryl) mesh is sutured into the subcutaneous tissue lateral to the open trough.
- The mesh is allowed to mature over several weeks.

Stage Three

- The skin, mesh, and subplatysmal flap complex is rotated medially and sutured to the contralateral tracheal wall, thereby recreating the anterior wall of the airway.
- The mesh complex is secured to the airway with inversion of skin edges into the lumen, and strap muscles are sutured at midline.
- Skin is closed and tracheotomy may be closed or T-tube may be placed to promote maturation of the reconstruction, to be removed later.

Figure 1. Multi-staged laryngotracheoplasty. Panel A shows a severely stenosed airway and panels B and C show the results after stages 2 and 3, respectively.

Results

Decannulation

- Forty-nine (80.3%) patients were successfully decannulated.
- Twelve (19.7%) patients failed decannulation and remain tracheostomy or T-tube dependent.

Univariate Analysis

Univariate analyses showed high significance association between decannulation and age, sex, history of intubation, surgeon, etiology of stenosis, or length of stenosis. There was a significant inverse relationship between grade of stenosis and probability of decannulation on multivariate logistic regression analysis.

Multivariate Logistic Regression

When controlling for age, sex, and previous intubation, multivariate analysis continued to show a significant association between grade of stenosis and rate of decannulation. There was a significant difference in probability of decannulation between patients with Grade I/II stenosis and those with Grade IV stenosis when controlling for other clinical characteristics.

Discussion

- In our 12-year institutional experience of sixty-one patents with LTS who underwent multi-staged laryngotracheal reconstruction, over 80% of patients were successfully decannulated.
- The probability of decannulation was significantly and inversely associated with grade of stenosis when controlling for other clinical characteristics. Decannulation was not significantly associated with age, sex, stenosis etiology, stenosis length, or history of intubation.
- There were few complications found including one case of pneumomediastinum with pneumothorax, one case of T-tube dislodgement requiring an emergent surgical extraction, and one case of mesh erosion into the airway.
- Patients with Grade I-III stenosis show high rates of decannulation when undergoing our technique of anterior laryngofissure with lumen augmentation using synthetic mesh graft.
- Patients with Grade IV stenosis are less likely to achieve long-term decannulation with this approach (albeit over half were decannulated in our study). Many of these patients have undergone multiple surgical interventions and present with intractable stenosis. At this time, there may not be a therapeutic option with a high probability of decannulation for these patients.

Table 1. Patient demographic and clinical data. Other etiologies include benign subglottic neoplasms in 3 patients and airway fire in 1 patient. Grade of stenosis is based on Myer-Cotton grading system for subglottic stenosis. Length of stenosis was categorized into short (≤2cm) or long (>2cm), p-values were generated using Fisher’s exact test, chi-squared test, and student’s t-test where appropriate.

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References