

# Challenges in the Management of Laryngeal Stenosis

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**Abstract** Laryngeal stenosis is one of the most complex and challenging problems in the field of head and neck surgery. The management involves a multidisciplinary approach with multiple complex procedures. In this study we discuss our experience of laryngeal stenosis with regards to patient characteristics, cause and management. A retrospective analysis of 35 patients of laryngeal stenosis treated at a tertiary care centre was evaluated. Inclusion criteria were all patients with laryngeal stenosis who required surgical intervention. Exclusion criteria were patients with associated tracheal stenosis and laryngeal stenosis due to cancer. Demographic data was recorded and findings relating to aetiology, characteristics of stenosis and the various aspects of therapeutic procedures performed are discussed with review of literature. Among 35 patients, 24 were males and 11 females of the age group 2–79 years. 2 (5.7 %) patients had supraglottic stenosis, 11 (31.4 %) had glottis stenosis, 16 (45.7 %) had subglottic stenosis and 6 (17.1 %) had combined multiple sites stenosis. Each patient underwent an average of 3.22 surgical procedures like microlaryngoscopy and excision with cold instrument, CO<sub>2</sub> laser excision or open procedures like laryngofissure and excision and laryngoplasty. Montgomery t tube insertion was a common procedure in 17 patients (48.6 %). Of the total 35 patients with severe LS, 27 (77.1 %) patients were successfully decannulated. The results of glottic (100 %) and supraglottic stenosis (100 %) are excellent as compared to subglottic (68.8 %) and combined stenosis (50 %) of multiple sites. Laryngeal stenosis with airway compromise causes

significant morbidity to the patients and is a difficult condition to treat in both adult and pediatric population. The need for multiple surgical procedures is common in the treatment of laryngeal stenosis with the t-tube being an important aid in the management of this condition. Trauma especially post intubation trauma is the commonest cause of laryngeal stenosis and the involvement of subglottis has poor outcome as compared to other subsites.

**Keywords** Laryngeal stenosis · Montgomery t tube · Subglottic stenosis

## Introduction

Laryngeal stenosis (LS) is a congenital or acquired narrowing of the larynx causing airway compromise. The acquired causes may be due to endotracheal intubation, trauma, burns, inflammation, neoplasms, autoimmune disorders and collagen vascular disease. LS is one of the most complex and difficult condition to treat in the field of head and neck surgery and is a challenge for the otolaryngologist. The treatment would include observation, endoscopic treatment with cold instruments or laser, open airway expansion procedures and tracheostomy. Although numerous studies describe various treatment modalities, there is no standard approach to LS and repetitive procedures may often be required to restore satisfactory physiological function. The goals of any treatment modality are to maintain a patent airway, glottic competence for airway protection against aspiration and acceptable voice quality. We present a retrospective analysis of various etiological factors, treatment modalities and outcomes in cases of severe LS in relation to various sub-sites of larynx at a tertiary care centre in India.

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## Materials and Methods

We performed a retrospective analysis of patients of severe LS who were referred to our tertiary care centre for management between June 2010 and June 2013. The hospital ethical committee approved the study. Inclusion criteria were all patients with severe LS who required intervention. LS was considered severe if patient had dyspnea at rest and routine activity, was not able to decanulate from tracheostomy or endotracheal tube and/or there was endoscopic or radiological evidence of obstruction of glottis/subglottic lumen above 50 %. Exclusion criteria were patients with associated tracheal stenosis and LS secondary to malignancy. Demographic data was recorded and findings relating to etiology, characteristics of stenosis, various aspects of therapeutic procedures performed and outcomes are discussed in relation to various sub-sites of larynx. Descriptive analyses of data were performed by SPSS 18.

## Results

During the study period 35 patients with clinical history, radiological or endoscopic evidence of severe LS were identified from the case records, who underwent surgical intervention at our centre. Among 35 patients; there were 24 males and 11 females of the age group 2–79 years (mean 33.8 years). The commonest etiology in the study group was traumatic 24 patients (68.6 %) with post-prolonged intubation being the commonest cause 14 patients.

The various etiologies and sites of the larynx involved by the stenosis are described in Table 1. 2 (5.7 %) patients had

supraglottic stenosis (SGS), 11 (31.4 %) had glottis stenosis (GS), 16 (45.7 %) had subglottic stenosis (SS) and 6 (17.1 %) had combined multiple sites stenosis (CS). The commonest site was SS with involvement of subglottis in all patients of CS.

Each patient underwent an average of 3.22 surgical procedures like microlaryngoscopy and excision with cold instrument, CO2 laser excision or open procedures like laryngofissure and excision and laryngoplasty. In addition adjunctive treatment like t tube placement was done in 17 patients, placement of laryngeal stent in 2 patients and placement of laryngeal keel in 1 patient. The various treatment performed are described in Table 2.

Montgomery t tube insertion was a common procedure in 17 patients (48.6 %) during post intervention follow-up before successful decanulation. The patients required t tube for a period of 6–14 months (mean 7.4 months). Of the patients on t tube, successful decanulation was done in 13 patients (76.5 %); four patients (23.5 %) could not be decanulated; which included two patients of post intubation stenosis, one patient of trauma with associated injuries and a patient of subglottic amyloidosis.

Of the total 35 patients with severe LS in this series, 27 (77.1 %) patients who were decanulated, asymptomatic on routine daily activities with normal fibreoptic flexible bronchoscopy (FFB) were considered cured. The patients who are successfully decanulated have been followed up for an average period of 34.2 months (17–62 months) without recurrence of stenosis. The various cases that could not be decanulated are described in Table 3.

Of the 35 patients, 29 (82.9 %) needed tracheostomy at our centre or were referred to our centre with prior tracheostomy. The patients had tracheostomy for a period of

**Table 1** Aetiology of laryngeal stenosis

Sl. no	Cause	Supraglottic (S)	Glottic (G)	Subglottic (SG)	Combined (C)	Total
1	Congenital		1	1		2
2	Traumatic	2	6	10	6	24
	(a) Post intubation		3	8	3 (G + SG)	14
	(b) Post external trauma			1	2 (G + SG)	3
	(c) Post surgical intervention (recurrent respiratory papillomatosis)		2	1	(S + G + SG)	3
	(d) Post radiotherapy	1	1			2
	(e) Corrosive poisoning	1			1 (S + G + SG)	2
3	Granulomatous conditions			2		2
	(a) Scleroma larynx			1		1
	(b) Wegeners granulomatosis			1		1
4	Miscellaneous		4	3		7
	(a) Idiopathic		3	1		4
	(b) Laryngeal amyloidosis		1	2		3
	Total	2	11	16	6	35

**Table 2** Various treatment done on the patients

Cause	Rigid scopy and microlaryngeal surgery with cold instruments/dilatation	CO2 laser excision	Open procedure	T Tube/Stent/Keel placement	Total no of cases	Decanulated (%)
Congenital		2			2	1 (50 %)
Traumatic	25	46	5	18	24	19 (79.1 %)
(a) Post intubation	21	26	3	11 (T tube 9 and Stent 2)	14	10 (71.4 %)
(b) Post external trauma	1	4	2	4 (T tube 2, Keel 1 and Stent 1)	3	2 (66.7 %)
(c) Post surgical intervention	1	6		1 T tube	3	3 (100 %)
(d) Post radiotherapy		4		1 T tube	2	2 (100 %)
(e) Corrosive poisoning	2	6		1 T tube	2	2 (100 %)
Granulomatous conditions	8	13			2	1 (50 %)
(a) Scleroma larynx	3	5		1 T tube	1	1 (100 %)
(b) Wegeners granulomatosis	5	8			1	0 (0)
Miscellaneous	2	12			7	6 (85.7 %)
(a) Idiopathic		5			4	4 (100 %)
(b) Laryngeal amyloidosis	2	7		2 T tube	3	2 (66.7 %)
Total	35	73	5	17 T tube, 3 Stent I Keel	35	27 (77.1 %)

7–79 days (mean 42.2 days). The various aetiology for which the patients needed tracheostomy were congenital (1), post prolonged intubation (9), post traumatic (13), post radiotherapy (1), corrosive poisoning (2), scleroma larynx (1), Wegeners granulomatosis (1) and subglottic amyloidosis (1). Most of these patients were either decanulated or placed on t tube except 4 patients.

The outcomes of treatment in the various sites of larynx are described in Table 4. It is seen that the results are excellent in cases of GS and SGS as compared to SS (68.8 %) and CS (50 %) of multiple sites. All the combined stenosis also involved subglottis, which in turn suggests that a low successful outcome is seen in cases involving subglottis.

## Discussion

Laryngeal Stenosis (LS) with airway compromise causes significant morbidity to the patients and is a difficult condition to treat in both adult and pediatric population. Successful outcome of treatment entails adequate airway with maintenance of function of protection and phonation.

The pathogenesis of LS is due to it being a semi-rigid tubular structure and injury to it causes concentric scar formation as a normal process of healing. This healing process causes progressive narrowing of lumen causing airway compromise, which may require multiple and varied surgical interventions. A large number of patients do develop minor degree of granulations on prolonged

intubation and are usually asymptomatic. ‘Severe Stenosis’ is defined as the presence of symptomatic airway compromise, usually consisting of dyspnea, voice changes, or cough. The functional compromise in an individual with LS depends on the pathology, location, and severity of the stenosis. Our study included patients who had significant or severe stenosis requiring surgical intervention.

The commonest cause of LS is trauma, which may be due to external injury or due to intubation. In cases with no history of trauma, the aetiology is difficult to identify and a systematic evaluation of the other causes need to be performed. Other causes include congenital, infective conditions (tuberculosis, sarcoid, scleroma, diphtheria), benign (chondroma, fibroma, squamous papilloma), malignancy (squamous carcinoma, adenocarcinoma), autoimmune conditions (Wegeners granulomatosis, Amyloidosis) and idiopathic. In our series of cases, 68.6 % were due to trauma and post-intubation trauma amounted to 40 %. This was in concurrence with other studies done on the subject, which have also highlighted trauma and specially post intubation trauma as the leading cause for LS [1].

LS can involve the supraglottis, glottis or subglottis separately or may involve multiple sub-sites. The aetiology, clinical features, pathogenesis, treatment and prognosis vary among these sites. Severe Supraglottic Stenosis (SGS) are usually rare, caused due to inhalational/corrosive injury, external trauma or infective conditions like tuberculosis. Severe Glottic Stenosis (GS) is a commoner condition than supraglottic stenosis and is caused by trauma (external/iatrogenic), infective conditions like

**Table 3** Cases who could not be decanulated

Sl. no	Site	Aetiology	Intervention	Present status	Remarks
1	Subglottic	Congenital	Multiple attempts of excision by CO2 laser	Tracheostomy tube	Not tolerating t tube Recurrent restenosis Generalised atopy and connective tissue disorder
2	Subglottic	Post intubation	Multiple attempts of excision by CO2 laser and t tube insertion. Open resection and cricotracheal anastomosis done with narrowing at anastomotic site	t tube	Not tolerating decanulation due to recurrent restenosis
3	Subglottic	Post intubation	Multiple attempts of excision by CO2 laser	Tracheostomy tube	Not tolerating decanulation or t tube due to recurrent restenosis
4	Subglottic	Wegeners granulomatosis	Multiple attempts of excision by CO2 laser	Tracheostomy	Persistent local and systemic disease in immunocompromised patient
5	Subglottic	Laryngeal amyloidosis	Multiple attempts of excision by CO2 laser and t tube placement	t tube	Not tolerating decanulation due to persistent disease and recurrent restenosis
6	Combined (Glottic + Subglottic)	Post Intubation	Multiple attempts of excision by CO2 laser, t tube insertion and open surgery	Laryngeal stent and tracheostomy tube	Not tolerating decanulation due to recurrent restenosis
7	Combined (Glottic + Subglottic)	Post intubation	Multiple attempts of excision by CO2 laser, t tube insertion and open surgery	t tube	Not tolerating decanulation due to recurrent restenosis
8	Combined (Supraglottic + Glottic + Subglottic)	Post traumatic	Open surgey (Laryngofissure) and t tube insertion	t tube	Thyroid and cricoid cartilage fracture with vocal cord palsy

**Table 4** Outcome of cases of laryngeal stenosis

Site	No of patients	Dekanulated (%)	Remarks
Supraglottis	2	2 (100 %)	
Glottis	11	11 (100 %)	
Subglottis	16	11 (68.8 %)	One case of congenital subglottic stenosis on tracheostomy tube Two cases of post intubation subglottic stenosis with significant cartilage necrosis on t tube and tracheostomy tube One case of Wegeners Granulomatosis on tracheostomy tube One case of Laryngeal Amyloidosis on t tube
Combined	6	3 (50 %)	One case of post intubation glottis + subglottic stenosis on t tube One case of post intubation glottis + subglottic stenosis on laryngeal stent with tracheostomy tube One case of post traumatic supraglottis + glottis + subglottic stenosis on t tube

papillomatosis and post radiotherapy. Subglottic Stenosis (SS) is the most common of the sites causing severe LS due to its anatomical architecture and narrow lumen. The commonest cause of SS is postintubation trauma followed

by external trauma, infective, congenital and inflammatory conditions. Combined Stenosis (CS) involving multiple sites is usually severe and caused due to trauma (external, intubation, inhalational) and systemic inflammatory

conditions. In our study the commonest site with severe stenosis was SS (45.7 %) followed by GS (31.4 %) and CS (17.1 %). 100 % of SGS and CS, 62.5 % of GS and 54.7 % of SGS in this study were due to traumatic aetiology which included most commonly postintubation trauma followed by external trauma, post intervention, radiotherapy and corrosive poisoning. Other studies have also shown that subglottis is commonly involved in symptomatic laryngeal stenosis. The next common presentation is combined or multiple site stenosis than involvement of supraglottis and glottis independently. [2]

Evaluation of a case of LS includes fiberoptic laryngoscopy followed by direct laryngoscopy and bronchoscopy. Imaging with a high resolution CT scan of the larynx and trachea is important in evaluation of severe cases of LS with complete stenosis in whom direct evaluation is not possible, in patients with cartilage loss, those with associated injuries to trachea and oesophagus and in planning of open surgical treatment procedures.

The treatment of laryngeal stenosis is difficult with requirement of multiple interventions before successful outcome can be achieved [3]. There should be a sense of realism both for the surgeon as well as for the patient regarding the expected results of surgery. Patients with minor stenosis should also realise that laryngeal manipulation may occasionally lead to additional scarring and requirement of tracheostomy. Often the patients suffering from this condition undergo multiple surgeries and should be warned that results of treatment of chronic laryngeal stenosis may be unrewarding and that their tracheostomy may be permanent.

The choice of treatment is based on the patients characteristics and on evaluation of the merits of each procedure. The surgical interventions can be endoscopic or open depending on the type, site and severity of stenosis [1, 2, 4]. Endoscopic methods include mechanical dilatation, excision with cold steel or CO2 laser excision and balloon dilatation. The endoscopic methods are more effective in initial stages of laryngeal stenosis where the stenotic segment is soft and pliable. The success rate of treatment of LS with endoscopic procedures is of the range of 66–80 %. Open surgical procedures are indicated in cases with mature and hard tissue, loss of cartilage framework (especially cricoid), scar tissue of more than 1 cm length and in cases with associated tracheal stenosis [5]. In a meta analysis of studies describing various modalities of treatment for sub glottis stenosis it was concluded that the rate of success of laryngotracheal resection was higher than that of endoscopic procedures but endoscopic procedures are worth trying in early and small lesions [6]. Other studies have also recommended endoscopic procedures in selective cases with limited pathology [7, 8]. In our study most of the patients required multiple episodes of endoscopic surgical

intervention using CO2 laser as well as microsurgical instruments. A total of 35 surgeries using micro-surgical instruments and 73 surgeries using CO2 laser were performed in management of these patients averaging approximately 3 procedures per patient. Open procedures were required for 5 patients all of whom had post-traumatic laryngeal stenosis with extensive stenosis involving multiple sub-sites of larynx and/or with cartilage loss.

T-tube introduced by Montgomery, provides a stable and physiologic airway to the patient and can be kept in place for long periods of time to follow up the progress of patients till the time decanulation can be considered [9]. It can be used primarily as a definitive treatment or in the management of inoperable conditions or as an adjunct after resection anastomosis till adequate healing is achieved [10–13]. It is also used as a definitive treatment, in selective cases with grade early stenosis, and soft stenosis not requiring open resection anastomosis. The versatility of use of a t tube in various conditions makes it the most common procedure in the management of laryngotracheal stenosis. T tube placement was required in 17 of the 35 patients in our study for a period of 6–14 months (mean 7.4 months). Of the 17 patients on t tube in our study, 13 (76.5 %) were successfully decanulated. Normally the t tube is placed for a minimum of 6 months but the optimal period of placement of t tube depends on the patient and disease characteristics.

In our study, 27 patients (76 %) had a successful outcome in terms of decanulation of the tracheostomy tube/T-tube. The results of surgical treatment were excellent in supraglottic and glottic stenosis with all patients being decanulated. In the case of subglottic stenosis the success was lower due to the inherent nature of pathology causing concentric re-stenosis and also the difficulty in management of them. Combined stenosis involving multiple sites usually had a severe disease with multiple surgeries and difficult decanulation.

## Conclusion

Laryngeal stenosis is a complex issue, which presents a challenge for its management. Large numbers of endoscopic and open procedures are currently in use for treatment of this condition, which implies that no single method of treatment is universally successful. Endoscopic and open surgical management have their own indications and advantages.

From the results of our study we can conclude that trauma, especially post intubation trauma is the most common causative factor for laryngeal stenosis in general and subglottic stenosis in particular. We also found that multiple surgeries are required for treatment of laryngeal stenosis especially when endoscopic procedures are used.

The T tube plays an important aid in the treatment of laryngotracheal stenosis. It was also seen that the site of laryngeal stenosis especially subglottic and combined stenosis had poorer outcomes as compared to lesions involving other sub-sites.

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