Laryngotracheal Stenosis: Clinical Profile, Surgical Management and Outcome

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Abstract Despite the availability of various surgical options, management of laryngotracheal stenosis (LTS) still remains an enigma. Proper selection of surgical technique in each clinical setting is the key for successful outcome. The purpose of this article is to guide one in selection of appropriate surgical procedures depending upon various stenosis parameters. *Aim* To record the clinical profile of cases with LTS. To assess the outcome following various surgical interventions based on site, severity, cause of stenosis and to derive conclusions regarding treatment options in various stenosis. *Materials and Methods* It is a study of 60 cases with chronic LTS. It includes retrospective study of 30 cases treated from 2004 and prospective study of 30 cases from Jan 2007 to Dec 2009. A total of 60 cases with LTS were enrolled in the study. Patients were assessed clinically by eliciting detailed history and analyzing previous records. After assessment of extent of stenosis, they were subjected to surgical interventions (endoscopic/open approach). Outcome after surgical interventions was assessed. *Results* 60 patients were included in the study, in the age group of 2.5–50 years. There were 46 (77%) male patients and 14 (23%) female patients. Intrinsic trauma, secondary to prolonged intubation was the most common cause of LTS, seen in 23 (38%) cases followed by post traumatic stenosis (strangulation-18 (30%), blunt injury-15 (25%), penetrating neck injury-4 (7%)). Stenosis was divided into 6 types based

on subsite involvement. Of which, cervical trachea was the commonest site of involvement (25/60 cases). Majority of cases had fixed vocal cords at presentation (55%), more commonly due to post traumatic injury. 60 cases had undergone a total of 110 surgical procedures (endoscopic-56, open approach-54). In the end, overall decannulation rate is 93.3%. In site wise tracheal stenosis, isolated subglottis, combined glottis and subglottic stenosis had decannulation rate of 100% each and with mobile vocal cords, the success rate is 96%. *Conclusions* Post traumatic stenosis with fixed vocal cords is more common in our practice. Categorizing stenosis into various subtypes helps in treatment planning and predicts surgical outcome. Tracheal or subglottic stenosis with mobile vocal cords has better success rate.

Keywords Laryngotracheal stenosis · Tracheal resection anastomosis · Laryngotracheal · Reconstruction · Montgomery tube

Introduction

Laryngotracheal stenosis (LTS) is defined as partial or complete cicatricial narrowing of the endolarynx or trachea [1]. LTS is a recalcitrant disease with high morbidity. The complexity of the region, which contains delicate structures such as vocal cords, recurrent laryngeal nerve which coordinate the functions of respiration, deglutition, and phonation makes LTS, a difficult entity to manage [2]. Management of LTS has been a major challenge confronting head and neck surgeons for over a century.

In this study, we analyzed the clinical profile of patients with chronic LTS. These cases were managed using endoscopic and various external surgical procedures. The clinical profile of such cases and the outcomes of management in

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terms of attainment of a tracheostomy free airway are presented.

Materials and Methods

This study was conducted in a tertiary care facility at the Department of Otorhinolaryngology and Head and Neck Surgery of All India Institute of Medical Sciences. The study has been cleared by the Ethics Committee of our Institute. A total of 60 cases were enrolled over a 6 year period from 2004 to 2009. Patients of all age group with LTS were included.

Clinical evaluation included detailed history and clinic laryngoscopy for airway assessment and assessment of vocal cord mobility. This was supplemented with rigid endoscopic evaluation of the larynx and trachea under anesthesia. Radiological evaluation including X-ray soft tissue neck and NCCT neck was done to assess site, size, and grade of stenosis.

Patients with severe co-morbid conditions of COPD, bronchial asthma were excluded from the study. 60 cases were advised surgical intervention for reconstruction of the laryngo-tracheal lumen. Surgical interventions included endoscopic interventions and external (open) interventions. Following surgical interventions, initial review was schedule 1 week post-surgery to assess healing process and to look for post-operative complications (if any). Further review varied depending upon nature of surgery. In case of endoscopic interventions patients were generally reviewed once in 2–4 weeks and in open surgery, review is generally after 8–12 weeks. Surgical intervention was deemed successful if it resulted in decannulation from tracheostomy and restoration of the laryngo-tracheal lumen with nasal breathing. Once decannulated, patients were reassessed after 6–12 months to look for re-stenosis.

Results

60 patients were included in the study and they were in the age group ranging from 2.5–50 years with median age being 22 years. There were 46 (77%) male patients and 14 (23%) female patients in the study. Patients were categorized according to the cause of stenosis into 4 groups. (i)-Intrinsic trauma, secondary to prolonged intubation was the most common cause of LTS, seen in 23 (38%) cases. Other causes include (ii)-extrinsic neck injury (RTA) in 18 (30%) cases, (iii)- strangulation injury in 15 (25%) cases and (iv)-cut throat injury in 4 (7%) cases.

All patients were tracheostomised at presentation. During initial evaluation 26 (44%) cases had normal mobility of vocal cords, 29 (49%) cases had bilateral vocal cord

palsy and 4 (7%) patients had unilateral vocal cord fixation. The patients were further categorized based on the site of stenosis. Cervical trachea was the commonest site of stenosis seen in 25 (42%) cases, followed by combined Subglottis and tracheal stenosis seen in 20 (33%) cases. Majority of cases had grade III, IV stenosis (80%). In 26 (47%) cases the length of stenosis was less than 2 cm, in 24 (43%) cases the length was between 2–4 cm and >4 cm was seen in 5 (10%) cases.

On analysis of relation between etiology and the site of stenosis it was found that, post intubation injury commonly resulted in tracheal stenosis (61%). Whereas blunt and strangulation injury, most commonly resulted in combined subglottic and tracheal stenosis (Fig. 1). Cases with post intubation stenosis usually retained their vocal cord mobility with only 13% demonstrating vocal cord fixation/immobility. Vocal cord fixation was, however, frequent in the subgroups with blunt neck injury (48%) and strangulation injury (42%).

A total of 110 surgical procedures were undertaken on the 60 cases. 56 cases could be success fully decannulated (93.3%). Table 1 lists the number of surgical procedures and decannulation rate as per different stenosis sites. Table 2 lists the patients still under treatment. In post intubation group, 95.6% (22/23) cases were successfully decannulated. All 25 cases with tracheal stenosis could be decannulated successfully. The experience as per different sites of stenosis is detailed below.

Tracheal Stenosis

All the 25 cases with tracheal stenosis could be successfully decannulated. Of which 16 cases had grade III/IV stenosis which was treated with resection anastomosis.

Fig. 1 Etiology correlated to Site of stenosis

7 patients had grade II/III soft stenosis and length was less than 2 cm which was treated with dilatation with stenting. In rest of 2 cases, laser excision along with dilatation and stenting was done.

Combined Subglottis and Tracheal Stenosis

Out of 20 cases, 17 (85%) cases could be successfully decannulated. Out of 17, eleven patients had grade III/IV stenosis involving lower half of cricoid ring along with adjacent tracheal involvement. They were treated with resection and anastomosis. 5 cases had failed dilatation with stenting finally they could be cured by luminal augmentation with rib grafting. Remaining one patient was treated with dilatation and airway stenting using Montgomery tube. Of the remaining 3 cases who are yet to be decannulated, two patient have persistent stenosis following repeat dilataion with fixed vocal cords and the remaining patient is a 2.5 year old child with trachomalacia following intubation injury.

Subglottic Stenosis

All the five cases with isolated subglottic stenosis could be successfully decannulated. All these patients required stenting and more than 2 interventions. Interventions included resection anastomosis, cricoid split, cricoid split with Rib grafting, dilatation.

Table 1 Average number of interventions in various sites of stenosis

Site of stenosis	Number of cases	Average number of interventions	Number of cases decannulated
Trachea	25	1.4	25
Subglottis + trachea	20	2.1	17
Subglottis	5	2.1	5
Glottis	3	2.3	2
Glottis + subglottis	6	4	6
Supraglottis	1	2	1
Total	60	–	56

Table 2 Details of cases still under treatment

Age (Yrs)	Etiology	Site of stenosis	Vocal cord status	Interventions	Current status
24	Strangulation	Subglottis + trachea	Bilateral fixed	Multiple dilatations, resection anastomosis	Persistent stenosis with fixed cords
32	Blunt injury	Glottis	Bilateral fixed	Laryngofissure + keelMultiple dilatations	Persistent stenosis
20	Blunt injury	Subglottis + trachea	Bilateral fixed	Multiple dilatations, dilatation + stenting	Persistent stenosis
2.5	Intubation	Subglottis + trachea	Bilateral mobile	Dilatation + stenting, resection anastomosis	Tracheomalacia

Glottic Stenosis

3 cases had isolated glottis stenosis. Interventions included laser release of web with stenting, dilatation with stenting, laryngofissure with stenting and posterior cricoid split with rib cartilage grafting. 2/3 cases (67%) were decannulated. Remaining one patient had persistent stenosis secondary to blunt neck injury with fixed vocal cords and distorted laryngeal framework.

6 cases had combined glottis and subglottic stenosis and all of them could be decannulated (100%). An average of four surgical interventions (Range 2–6) were required for establishment of adequate subglottic lumen with adequate lateralization and positioning of the vocal folds. Five out of six cases had undergone cricoid split with rib grafting.

Supraglottic Stenosis

There was a single case of supraglottic stenosis following suicidal cut throat injury. It was managed successfully with CO₂ laser excision in 2 sittings 6 weeks apart.

Follow-up period varied from 3 to 30 month (Median-12 month).

Complications

A total of 7 complications were encountered in 110 surgical interventions over the study group of 60 cases. Meticulous post operative care and regular suctioning of airway was felt to be the major factor in minimizing/avoiding post-surgical airway related complications.

Majority of complications occurred in the immediate post operative period and were related to T-tube stenting. Temporary aspiration was noted in cases where in the Montgomery T-tube stent was touching level of cords with an open upper end. Such aspiration could be successfully controlled with swallowing rehabilitation maneuvers in all except one wherein it became necessary to remove the Montgomery tube. Post operative pneumonia occurred in 2 cases because of persistent recumbent posture following resection anastomosis which was treated with intra venous antibiotics. Montgomery tube dislodgement or blockage occurred in 3 cases which were managed by immediate

removal of tube and insertion of an alternate tracheostomy tube to secure the airway.

Discussion

LTS is seen more commonly in the age group of 26–34 years [3, 4]. Majority of patients (67%) in our study were in their 2nd and 3rd decade with male predominance. Males are prone to road traffic accident, trauma to neck, thereby resulting in increased incidence of LTS in males.

LTS is most frequently secondary to prolonged intubation/tracheostomy with assisted ventilation [5]. Similarly, in our study Post intubation LTS was the commonest cause comprising 38% of cases. The duration of intubation in our study group ranged from 3–45 days. There is no safe time limit before considering for tracheostomy in an intubated patient. However 7–10 days seemed to be the safe period in our study as more than 70% had long term intubation of more than 7 days, which is similar to a report by Alpay Sarper et al. [6]. Fifteen patients in our series had strangulation injury (25%). Accidental strangulation is a surprisingly frequent cause of laryngotracheal injury in our practice. The muffler/dupatta around neck are traditional dresses for both women and men in India. The cloth may get entangled in moving parts of machinery like threshers, pumps, and fodder cutter in rural areas and two wheelers in suburbs or cities resulting in twisting around neck leading to strangulation injury. Like published reports blunt and strangulation injury commonly caused bilateral vocal cord fixity (48%) in our study [7].

Detailed clinical and endoscopic evaluation is the mainstay in the management of LTS. Our pre surgical evaluation mainly included flexible fiberoptic office laryngoscopy to assess site, grade of stenosis, vocal cord mobility and X-ray soft tissue neck. It was supplemented with Computed tomography of Neck with virtual bronchoscopy whenever required to assess cartilaginous framework, length of stenosis [8]. However CT scan may not be useful in isolated glottic stenosis.

Surgical management varies depending upon site, grade of stenosis. All the 25 cases with tracheal stenosis could be successfully decannulated. 16 of our patients who had grade III/IV tracheal stenosis were treated with resection anastomosis which is standard procedure for such stenosis [9]. Remaining 9 cases had soft, recent stenosis, with preserved cartilaginous frame work and they could be managed endoscopically [10]. It included endoscopic dilatation with rigid bronchoscope/gum elastic bougies in 7 cases and laser excision in 2 cases. T-tube stent was used in all these cases.

Out of 20 cases with subglottic stenosis along with tracheal involvement in our study, 17 (85%) cases could be

successfully decannulated. Out of 17 patients, eleven patients required resection and anastomosis for grade III, IV stenosis involving lower half of cricoid ring along with upper tracheal involvement as is the standard treatment option in such cases [11]. Remaining 6 cases were initially treated with endoscopic dilatation with stenting. However, due to the rigid, non-expansile nature of cricoid ring [12] all these patient developed restenosis after dilatation. In the end, five of them required cricoid split with rib grating/stenting for restoring adequate airway.

In case of subglottis, upper half of the subglottis differs from the lower subglottis as it is bordered by the under-surface of the vocal folds and the cricovocal membrane. Scarring in this area may lead to fixation of the vocal folds and aspiration [13]. Thus the option of resection anastomosis is unavailable here. Of the 5 cases with subglottic stenosis, in three cases as there was upper half of subglottic involvement they required cricoid split and rib cartilage graft interposition for luminal augmentation. The remaining 2 cases could be dealt easily by resection and primary cricotracheal anastomosis stenosis as stenosis was confined to lower half of subglottis.

Presence of glottis stenosis in addition to significant stenosis of the upper 1/3 to 1/2 of the subglottis presents a still more challenging situation [14]. All 6 cases with combined glottis and subglottic stenosis had undergone multiple interventions. In our practice currently all these cases are managed by cricoid split with costal cartilage augmentation. Insinuation of the cartilage graft serves to interpose non-scar tissue between the edges of the surgically divided posterior commissure scar, and thus prevents its recurrence [14, 15]. Finally Anterior/posterior cricoid split with rib cartilage grafting was used in all of those 6 cases, which made successful decannulation possible (100%) which is similar to published reports [14, 15].

Glottis stenosis is more challenging to treat. In our setup isolated glottis stenosis with no lumen is managed by incision and release of stenosis with CO₂ laser followed by stenting for 6 weeks, whereas keel insertion is done for anterior glottis web. For posterior glottis or glottis stenosis with subglottic involvement we prefer posterior cricoid split with rib cartilage grafting.

Overall decannulation rate is 93.3%. In site wise tracheal stenosis had decannulation rate of 100%, which is similar to the published reports of decannulation for tracheal stenosis [16]. Also in isolated subglottis, combined glottis and subglottic stenosis, we could decannulate all cases. In these subsites it is found that luminal augmentation was mainly enhanced by cricoid split and rib graft interposition. Also with mobile vocal cords decannulation rate was 96%, it decreased to 82% with vocal cord fixation. Thus post intubation tracheal stenosis with mobile vocal cords is more favorable. Whereas presence of subglottis or

glottic stenosis following strangulation/blunt injury to neck, with vocal cord palsy has negative influence on the outcome.

Prevention

In view of the complexity of the problem and the difficulty in management, prevention is always better than cure. Prevention is possible to a large extent by use of high volume, low pressure cuffs [17]. High tracheostomy should be avoided as far as possible [18]. Adequate precaution should be taken while working in machinery or while traveling in two wheelers to prevent the neck cloth getting entangled. Road safety measures like avoiding high speed traveling and using seat belts should be strictly followed. In case of acute airway trauma, early intervention is required after stabilizing the general condition of patient to avoid chronic LTS.

Summary

- LTS is more common in males. M:F = 3:1.
- Post intubation injury commonly results in tracheal (65%) and subglottis + Tracheal stenosis (26%).
- In grade III/IV tracheal or a combination subglottis and tracheal stenosis resection and anastomosis gives better outcome.
- In glottic or a combination of glottic and subglottic stenosis multiple interventions are required for cure. Cricoid split with rib grafting gives promising results in these cases.
- Successful decannulation is favored in post intubation injury especially tracheal stenosis with bilateral mobile vocal cords.
- Presence of glottic stenosis and fixity of vocal cords adversely affected the outcome.

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