RESEARCH ARTICLE

Laryngotracheal Trauma—Etiology, Treatment, and Outcome: An Indian Scenario

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Abstract

Background: Laryngotracheal trauma is a dangerous injury that needs a very high index of suspicion and prompt intervention to increase survival and maintain aerodigestive functions. The aim of our study was to determine the incidence, airway intervention, and aerodigestive outcome among patients with laryngotracheal trauma, and factors influencing these outcomes were statistically analyzed and results derived.

Materials and methods: In all, 31 patients were included in our study. The duration of the study was 2 years. In external laryngeal trauma group, patients were examined and classified according to the Schaefer–Fuhrman grading. The patient was followed up throughout the stay in hospital until decannulated or discharged.

In the internal laryngeal trauma group, previous history of intubation or tracheostomy or any other causes of internal injury was noted. The stenotic segment was graded based on Cotton–Myers grading and McCaffrey grading, and the outcome was measured in terms of airway phonation and swallowing and the results were statistically analyzed.

Results: Among the 31 patients, 12 patients (33.7%) were in a tracheostomy tube and the remaining were not in a tracheostomy tube (64.3%) of which 1 patient was not tracheostomized at all in the external laryngeal trauma group as she was managed conservatively. In the cutthroat group, 11 patients were successfully decannulated and 1 patient was not tracheostomized. In the stenotic segment group of 19 patients, 13 patients were in tracheostomy (68.4%) and the remaining 8 patients were successfully decannulated.

Conclusion: Males outnumber females in our study. Age less than 40 years leads to a good rate of decannulation. External laryngeal trauma has good rates of decannulation when compared to internal laryngeal trauma. All cases of supraglottic stenosis in our study were attributed to corrosive acid intake. In our study, tracheal stenosis has a good rate of decannulation.

Keywords: Cotton–Myers grading, Laryngotracheal trauma, McCaffrey grading, Shiann Yann Lee procedure, tracheostomy.

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Introduction

Laryngotracheal trauma is a dangerous injury that needs a very high index of suspicion and prompt intervention to increase survival and maintain aerodigestive function.[1] Laryngotracheal injuries can be classified as internal and external, and due to blunt or penetrating mechanisms. There are questions regarding the current incidence of laryngotracheal injuries in the Indian perspective, as well as the reasons and the pathogenesis of these injuries and their aerodigestive outcomes.

Swallowing, phonation, and airway are all at risk due to laryngeal injuries that potentially compromise the anatomical or neuronal integrity of the larynx and trachea. Butler et al. found there is poor swallowing, airway, and phonatory outcomes seen among patients with severe laryngotracheal trauma, indicating that early treatment (less than 48 hours after presentation) is associated with better phonatory and airway outcomes.[2] For patients with mild injury (grades I or II), the conservative line of management seems to be appropriate and not associated with adverse outcomes. The management of laryngotracheal injuries must be individualized for each patient.

The aim of our study was to determine the incidence, airway intervention, and aerodigestive outcome among patients with laryngotracheal trauma, as well as the factors influencing these outcomes.

Aims and Objectives

- To study the various etiology and pathogenesis of laryngotracheal trauma in our part of the country.
- To evaluate the outcome of the patients in our institution in terms of phonation, airway, and swallowing.

Materials and Methods

Informed and written consent for inclusion in the study as included in the pro forma in the patient's own language was obtained prior to the start of the study.

Detailed history about the nature of injury, manner of occurrence, and examination of injury was noted as per the items in the pro forma. The patients were divided into two groups as internal and external laryngeal trauma, and each group was followed up throughout the course of treatment.

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Inclusion Criteria

- Age between 15 and 70 years
- Both sexes (male and female)
- Blunt trauma
- Intubation injury
- Cutthroat injury
- Corrosive injury

Exclusion Criteria

- Age below 15 years and above 80 years
- Intrathoracic tracheal injury

Investigations

The following investigations were carried out:

- Video direct laryngoscopy
- Contrast-enhanced computed tomography (CECT) neck
- X-ray soft tissue neck: anteroposterior and lateral views

Data Collection: Clinical

In the external laryngeal trauma group of patients, the patient injury was examined and classified as thyroid cartilage injury, thyrohyoid membrane injury, cricothyroid membrane injury, and vocal cord exposed or not. The injuries were classified according to the Schaefer–Fuhrman grading. The intraoperative findings were documented and photographed. The patients were followed up throughout the stay in hospital until decannulated or discharged. Postoperative video direct laryngoscopy was done and findings were recorded. After discharge, patients were followed up in the outpatient department and outcomes were recorded in terms of decannulation, phonatory outcome, and able to swallow or not and the results were statistically analyzed.

In the internal laryngeal trauma group, previous history of intubation or tracheostomy or any other causes of internal injury was noted. Video direct examination and CECT neck was done. The site, extent, and level of stenosis were noted. The stenotic segment was graded based on Cotton–Myers grading[3] and McCaffrey Grading[4] and patients were monitored throughout the intended surgical procedure or conservative management. The surgical procedure for subglottic stenosis in our patients was the Shiann Yann Lee procedure and for tracheal stenosis it was resection of stenotic segment and anastomosis.[5] The conservative management for subglottic stenosis for the patients in our study was endoscopic dilatation and topical application of mitomycin C.[6] The patients were monitored throughout the hospital stay and monitored as outpatient and the outcome was measured in terms of airway phonation and swallowing and the results were statistically analyzed.

Results and Statistical Analysis

This study was conducted and the data were statistically analyzed using the SPSS statistical software. Categorical variables were analyzed by Chi-squared test. *p*-value <0.05 was considered statistically significant.

The mean age in our study was 29.58 +/–15.28 years. There were 23 men and 7 women in our study. In our study, males outnumber females in cases of laryngotracheal trauma. Cutthroat injury was in 12 cases (38.7%), intubation injury was in 16 cases (51.6%), and corrosive acid intake was in 3 cases (9.7%). In our study, internal laryngeal trauma was quite frequent and intubation injury was more common.

In all cases, subglottis was the most frequent anatomical structure injured. In external laryngeal trauma, thyroid cartilage was frequently injured (Table 1). Most of the external laryngeal trauma group has Schaefer–Fuhrman grade III (12 cases, 38.7%). The most frequent sites of stenosis were subglottis and trachea, which occur in equal frequency (six cases each, 19.4%). Both subglottic and tracheal stenosis were found in three cases (9.7%). Supraglottic stenosis was seen in two cases (6.5%) and glottic stenosis in one case (3.2%).Most of the patients with stenosis were in Cotton–Myers grade III and grade IV (7 cases, 22.6%). Most of the patients with stenosis were in McCaffrey grade II (10 cases, 32.3%). Most of the patients of laryngotracheal trauma have normal vocal cord mobility (21 cases, 67.7%). Restricted mobility was seen in one patient (3.2%). Left vocal cord palsy is seen in five cases (16.1%) and right vocal cord palsy was seen in two cases (6.5%). In our study, a significant proportion of patients were decannulated (58.1%).

Good phonatory outcome occurred in 12 patients (38.7%), and hoarse voice was seen in 7 patients (22.6%) (Table 2). The difference in good phonatory outcome was due to Montgomery tube usage in patients who underwent the Shiann Yann Lee technique. Good swallowing outcome was found in all our patients (96.8 %) except one due to coloplasty failure. She was on feeding jejunostomy.

Good rates of decannulation were found in the external laryngeal trauma group (100%) (Table 3). Corrosive acid poisoning

Table 1: Frequency of anatomical site of injury

Anatomical structure injured	*Frequency*
Subglottis	9 (29%)
Thyroid cartilage injury	7 (22.6%)
Trachea	7 (22.6%)
Supraglottis	2 (6.5%)
Cricoid	1 (3.2%)
Glottis	1 (3.2%)
Injury to cricothyroid membrane	1 (3.2%)
Thyrohyoid Membrane rupture	1 (3.2%)
Thyroid cartilage and Cricothyroid membrane	1 (3.2%)
Thyroid cartilage injury and glottic stenosis	1 (3.2%)

Table 2: Etiology vs phonatory outcome

	Patient able to speak		
Etiology	*Yes*	*Yes, hoarse*	*No*
Cutthroat injury	5 (41.7%)	7 (58.3%)	0
Intubation	7 (43.8%)	0	9 (56.2%)
Corrosive acid intake	0	0	3 (100%)
Chi-squared (Fischer's exact)—21.025 *p* value—0.001 (significant)			

Table 3: Etiology vs patient on tracheostomy

	Patient on tracheostomy tube	
Etiology	*Yes*	*No*
Cutthroat injury	0	12 (100%)
Intubation	10 (62.5%)	6 (37.5%)
Corrosive acid intake	3 (100%)	0
Chi-squared (Fischer's exact)—15.5 *p* value—0.001 (significant)		

patients had poor decannulation. All our patients with corrosive acid intake could not be decannulated.

Phonatory outcome was better in the external laryngeal trauma group. In the internal laryngeal trauma group, phonatory outcome was better with subglottic stenosis.

Good swallowing outcome was seen in all patients except those who had corrosive acid intake (Table 4).

Most of the decannulated patients were in external laryngeal trauma especially in thyroid cartilage. Among the stenotic segment group, good rate of decannulation occurred in tracheal stenosis (Table 5).

In our study, among the stenotic group tracheal stenosis had a good rate of decannulation (Table 6).

Table 4: Etiology vs swallowing outcome

	Patient able to swallow	
Etiology	*Yes*	*No*
Cutthroat injury	12 (100%)	0
Intubation	16 (100%)	0
Corrosive acid intake	2 (66.7%)	1 (33.3%)
Chi-squared (Fischer's exact)—9.64 *p* value—0.09 (not significant)		

Table 5: Anatomical structure vs patient on tracheostomy

	Patient on tracheostomy tube	
Anatomical structure	*Yes*	*No*
Subglottis	8 (88.9%)	1 (11.1%)
Thyroid cartilage injury	0	7 (100%)
Trachea	1 (14.3%)	6 (85.7%)
Supraglottis	2 (100%)	0
Cricoid	0	1 (100%)
Glottis	1 (100%)	0
Injury to cricothyroid membrane	0	1 (100%)
Thyrohyoid membrane rupture	0	1 (100%)
Thyroid cartilage and cricothyroid membrane	0	1 (100%)
Thyroid cartilage injury and glottic stenosis	1 (100%)	0
Chi-squared (Fischer's exact)—23.8 *p* value—0.001 (significant)		

Table 6: Location of stenosis vs patient on tracheostomy tube

	Patient on tracheostomy tube	
Location of stenosis	*Yes*	*No*
Glottis	1 (100%)	0
Subglottis	5 (83.3%)	1 (16.7%)
Subglottis and trachea	3 (100%)	0
Supraglottis	2 (100%)	0
Trachea	1 (16.7%)	5 (83.3%)
Chi-squared (Fischer's exact)—20.36 *p* value—0.001 (significant)		

Table 7: VDL findings vs patient on tracheostomy tube

	Patient on tracheostomy tube	
VDL findings	*Yes*	*No*
Normal	9 (42.9%)	12 (57.1%)
Restricted	1 (100%)	0
Left VC palsy	1 (20%)	4 (80%)
Right VC palsy	0	2 (100%)
Chi-squared (Fischer's exact)—6.59 *p* value—0.166 (not significant)		

Patients with normal vocal cord mobility had good decannulation rates (Table 7).

Discussion

After excluding seven patients who died either during the procedure or in the immediate postoperative period following external laryngeal trauma, this study was conducted among those surviving patients and the outcomes were statistically analyzed based on patient was on tracheostomy or not, as well as phonatory and swallowing outcomes.

In our study, the mean age of patients in the external laryngeal trauma group was 36.5 years and standard deviation was 20.5. As per Bhojani et al.'s study, the mean age was 38.5 years.[7] Among the internal laryngeal trauma group, the mean age was 25.2 years with a standard deviation of 8.9 years. In Randall et al.'s study of external laryngeal trauma, the mean age was 37.3 years.[1] In Cerderia et al.'s study of laryngotracheal stenosis, the mean age of the patients was 29 years.[8]

In our study, there were 11 men (91.7%) and 1 woman (8.3%) in the external laryngeal trauma group. Males outnumber females in the external laryngotracheal trauma. In Randall et al.'s study of external laryngeal trauma, there are were 73 male patients (82%) and 16 female patients (18%). As per Bhojani et al.'s study of external laryngotracheal trauma, there were 11 males and 5 females.[7] In the internal laryngeal trauma, there were 12 males (63.2%) and 7 females (36.8%). In both external and internal laryngeal trauma, incidence is more in males compared to females (male, 23, 74.2% female, 8, 25.8%). In Cerderia et al.'s study of laryngotracheal stenosis, there were 39 males and 21 females.[8]

Etiology of laryngotracheal trauma in these patients was external laryngeal trauma in 12 patients (40%). Among the internal laryngeal trauma group of 19 patients, intubation injuries were seen in 16 patients (84.2%) and corrosive acid intake was seen in 3 patients (15.8%). Among the total incidence of laryngotracheal trauma, there was higher incidence of intubation-related injury compared to external laryngeal trauma [external laryngeal trauma, 12 (38.7%); internal laryngeal trauma, 16 (51.6%)]. So internal laryngeal injuries related to intubation were more common in the patients admitted in our institution.[9] In Cerderia et al.'s study of laryngotracheal stenosis, endotracheal intubation was the most common etiology consisting of 25 patients (41.7%), tracheostomy was in 21 patients (35%), and other causes were in 14 patients (23.2%).[8]

With respect to the structures damaged during internal laryngeal trauma, it was subglottis in nine patients (47.4%), trachea in six patients (31.6%), and supraglottic stenosis in two patients (6.7%). Thyroid cartilage and glottic injury were seen in one patient (5.3%). Glottic injury due to intubation causing intubation granuloma was observed in one patient (5.3%). In external

laryngeal trauma, injury to the cricoid cartilage was found in one patient (8.3%), injury to the cricothyroid membrane in one patient (8.3%), thyrohyoid membrane injury in one patient (8.3%), thyroid cartilage injury in seven patients (58.3%), trachea in one patient (8.3%), and thyroid cartilage and cricothyroid membrane in one patient (8.3%).In Bhojani et al.'s study, the larynx constituted in four patients (21.1%) and tracheal injury was seen in two patients (10.5%).[7] The most common anatomical structure injured leading to stenosis was the subglottis (nine patients, 29%) followed by trachea (seven patients, 22.6%). Among the external laryngeal injury group thyroid cartilage and trachea were most commonly injured (each had seven patients and had an incidence of 22.6%).

Among the patients with cutthroat injury, all 12 patients (100%) were in grade III according to the Schaefer–Fuhrman grading.[9]

The site of injury in the external laryngotracheal trauma were mainly thyroid cartilage injury in seven patients (58.3%) and others were cricoid cartilage injury, tracheal injury, cricothyroid membrane, thyrohyoid membrane, and thyroid cartilage with cricothyroid membrane injury with one patient each. In Lambert et al.'s study, 12 patients had laryngeal injury and tracheal injury was seen in 11 patients.[10]

The location of stenotic segment in cases of laryngotracheal stenosis was in the subglottis in nine patients (20%), trachea in six patients (16.7%), and supraglottic stenosis in two patients (10.5%). Glottic stenosis with thyroid cartilage fracture was seen in one patient (5.3%). In Cerderia et al.'s study, it was 10 patients (16.7%) with subglottic stenosis, tracheal in 16 patients (26.7%), and supraglottic stenosis in one patient (1.6%).[8]

The Cotton–Myers grading was grade II for two patients (10.5%), grade III for seven patients (36.8%), and grade IV for seven patients (36.8%) for internal laryngeal trauma sequelae. In our patients, grade III and grade IV stenosis were common (22.6%).

The McCaffrey grading is grade I for one patient (5.3%), grade II for 10 patients (52.6%), and grade III for five patients (26.7%) in the internal laryngeal trauma group. So the most common grade of lower extent of disease was grade II (32.3%).

The video direct laryngoscopy was normal for 6 patients (50%) among the 12 patients in the cutthroat injury group in the postoperative period. Left vocal cord restricted mobility was seen in four patients (33.3%), and right vocal cord restricted mobility was seen in two patients (16.7%). In the stenotic segment group of 19 patients, one had restricted mobility of both vocal cords (5.3%) and one patient had restricted mobility of the left vocal cord (5.3%). All other patients had normal vocal cord mobility (78.9%). The restricted mobility among these patients could be due to fibrosis with underlying glottic involvement or arytenoid disruption or dislocation during insertion of the endotracheal tube. In the cutthroat injury group, it could be due to injury to the recurrent laryngeal nerve due to trauma itself or due to inadvertent injury during exploration. In our study, normal vocal cord mobility was seen in 21 patients (67.7%).

Among the 31 patients, 12 patients (33.7%) were in tracheostomy tube and the remaining were not in tracheostomy tube (64.3%) of which 1 patient was not tracheostomized at all in external laryngeal trauma group as she was managed conservatively. In the cutthroat group, 11 patients were successfully decannulated and 1 patient was not tracheostomized. In Randall et al.'s study, 49 patients had good airway (94.2%), and 3 patients were on tracheostomy tube (5.8%).[1] In Lambert et al.'s study of external laryngeal trauma patients, four were in tracheostomy tube.[10] Among the stenotic segment group of 19 patients, 13 were in tracheostomy (68.4%) and remaining 8 patients were decannulated (31.6%). In our study, 17 patients were successfully decannulated and 1 patient had a cricothyroid injury and was managed without tracheostomy (58.1%).

In our external laryngeal trauma group of 12 patients, 5 patients had normal phonation (41.7%) and hoarse voice was seen in 7 patients (58.3%) (Table 8). In Randall et al.'s external laryngeal trauma group, 45 patients (78.9%) had normal phonation and 12 patients had hoarse voice (21.1%).[1] In Lambert et al.'s study of 23 patients, 9 patients had a hoarse voice.[10] In the internal laryngeal trauma group, 7 patients had good phonation (36.8%) and 12 patients had no phonation as they were in tracheostomy (63.2%). This is because of the higher incidence of restenosis in patients managed conservatively. Therefore, in our study 19 patients had phonation (60.3%) in which normal phonation was seen in 12 patients (38.7%) and hoarse voice was seen in 7 patients (22.6%) suggesting a good phonatory outcome in these patients.

Among our patients, all had good swallowing (96.7%) except one patient (3.3%) with a history of corrosive acid intake with coloplasty done and it was stenosed and the patient was on feeding jejunostomy. Swallowing was not much affected due to laryngotracheal trauma in our study. In Randall et al.'s study of external laryngeal trauma, 47 patients (85.8%) had good swallowing outcome whereas 8 patients had dysphagia (14.5%).[1]

In our study, patients on tracheostomy tube mostly were males—nine patients (39.1%) as compared to four female patients. Among the patients not on tracheostomy, most were males (14 patients, 60.9%).

In our study, the mean age of decannulation was 24.5 years and among the decannulated patients one patient was over 47 years. In Cerderia et al.'s study age less than 40 years of those who were decannulated was 87.9%.[8] So age is an independent predictor of decannulation.

External laryngotracheal trauma had a good rate of decannulation among all cases of laryngotracheal trauma—12 patients (33.7%). In Bhojani et al.'s study, airway patency was good in 50 patients (85.7%).[7] All the patients with corrosive acid intake could not be decannulated (100%).

Phonatory outcomes are better in cutthroat injury patients 12 patients (100%). In Bhojani et al.'s study, voice quality was good in 43 patients (71.4%). Among the stenotic group, phonatory outcome is poorer in 9 out of 16 patients (56.2%). In the corrosive acid intake group it is still worse because of stenosis and morbidity of the coloplasty procedure.

Table 8: External laryngeal trauma—our study compared with other studies

Study	*Number of patients*	*Airway good*	*Voice outcome good*	*Swallowing good*
Gerald et al.	12	10	3	
Douglas Mathieson	17	16	2	13
Gold et al.	21	16	13	
Satler et al.	15	12		
Our study	12	12	12	12

Table 9: Internal laryngeal trauma—our study compared with other studies

Study	*Number of patients*	*Airway good*	*Voice outcome good*	*Swallowing good*
Glenn et al.	23	21	12 (9 has hoarse voice)	22 (1 patient had tracheoesophageal fistula)
Rehal et al.	71	50	43	
Rea et al.	65	54	49 (5 patients had hoarse voice)	
Marie et al.	60	42		
Our study	19	8	9 (1 patient on Montgomery tube)	18

Among the patients in subglottic stenosis, 88.9% of patients are in the tracheostomy tube whereas all the supraglottic stenosis and glottis stenosis are in tracheostomy tube (Table 9). All the patients with external laryngeal trauma are decannulated. Among the patients with tracheal stenosis, 83.3% patients are decannulated. In Cerderia et al.'s study, decannulation rate of intubation injury was 69.6%.[8] External trauma rate of decannulation was 88.9%. In our study, all patients of external laryngotracheal trauma were decannulated.

Among the patients with subglottic stenosis, 66.6% patients could not speak whereas in glottic and supraglottic stenosis all patients could not speak showing the poor phonatory outcome of stenosis in these locations.

Among the stenotic patients with normal vocal cord mobility, 57.1% patients are decannulated whereas 42.9% patients are in tracheostomy tube. This is because most of the patients of the Shiann Yann Lee procedure await the Montgomery tube. Only one patient received the Montgomery tube and was able to speak.

Summary and Conclusion

Thirty-one patients of laryngotracheal trauma were followed up for 2 years and their outcomes were statistically analyzed and following conclusions were reached.

- Age is an independent predictor of outcome. Patients aged less than 40 years have a good rate of decannulation when compared to age greater than 40 years.
- Patients with normal vocal cord mobility in the preoperative period in both external and internal laryngeal trauma groups have good rates of decannulation and good phonatory outcome.
- Patients with internal laryngeal injury due to corrosive acid intake have poor outcome with respect to decannulation and swallowing.
- Among the surviving patients, external laryngeal trauma has the better prognosis than internal laryngeal trauma.
- The most common site of external laryngeal trauma is the thyroid cartilage.
- In internal laryngeal trauma, tracheal stenosis patients have good rates of decannulation when compared to subglottic and supraglottic stenosis patients.
- Most of the internal laryngeal trauma occur in the subglottis and the next common site is the trachea.
- Glottic stenosis does not occur in isolation, associated thyroid cartilage injury should be ruled out.
- In our study, all the cases of supraglottic stenosis occur due to corrosive acid intake.

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