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Original Research Article

A prospective clinical assessment of the laryngotracheal injuries following endotracheal intubation

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Abstract

Aim: The aim of the present study to evaluate the laryngotracheal injuries following endotracheal intubation.
Methods: A prospective study was conducted in the Department of Otorhinolaryngology, RVM Institute of Medical Sciences & Research Centre, Laxmakkapally, Telangana, India for the period of 1 year. 50 Patients intubated for more than 48 hours and admitted in medical ICU and aged more than 15 years were included in this study. To find the incidence, types of injury and to study the factors influencing LTI following intubation.
Results: Of 50, 32 were males and 18 were females with age ranging from 15 to 70 years. Majority of patients (70%) were between 15-29 years. Endotracheal tube of size 7.5 and 8 were used in 84% of patients. Majority of the patients (52%) were cases of organophosphorus (OP) poisoning followed by metabolic disorders like diabetic ketoacidosis and chronic kidney disease with encephalopathy. 36% of the patients were intubated for more than 10 days. The x-ray was normal in 36 patients (72%) while the abnormality was picked up in 14 (28%) patients. On 70-degree endoscopy, 4 patients (8%) had granulation tissue in the posterior commissure and one patient had bilateral vocal cord fixation. All the patients who had LTI were aged less than 45 years and 16 of 20 cases affected were males. Among the cases of LTI, 16 (80%) out of 20 cases were intubated with endotracheal tubes of size more than 7. 12 (60%) of the total cases of LTI had intubation for more than 10 days. OP poisoning was the etiology for LTI in 16 cases (80%).
Conclusion: A high incidence of LTI especially in cases of OP poisoning warrants one to be cautious in managing these intubated patients. Those patients requiring prolonged intubation should be considered for other alternative airway managements like tracheostomy in addition to using low pressure, high volume cuffed tubes.

Keywords: Endotracheal tubes, tracheostomy, LTI

Introduction

Laryngeal injuries following intubation have a reported incidence from 63 to 94% and permanent sequelae are reported to be about 10 to 20% in world literature. Common injuries following long term intubation can manifest in the form of erythema, ulceration, granulation,

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fibrous nodule, arytenoids dislocations, subglottic stenoses, recurrent laryngeal nerve paresis and vocal fold immobility [1]. After extubation laryngeal examination of such patients becomes necessary to assess the nature of airway injury. Laryngeal injury because of endotracheal intubation in the pediatric population continues to contribute to patient morbidity, in both elective and emergency settings. It has a wide range of presentations from minor laryngeal edema that heals spontaneously to a life-threatening airway obstruction.[2] Patients' co-morbidities (prematurity, cardiopulmonary defects) and hypoxia status play a role in the tissue healing process, which may increase the propensity for the development of chronic intubation-related laryngeal lesions [2, 3]. Various risk factors contributing to the development of laryngeal lesions in children are: patient-factors (prematurity, cardiopulmonary comorbidities), intubation technique (in emergency, inexperienced team), endotracheal tube (large size, cuffed tube), longer duration of intubation, infection and inadequate patient sedation [4-8]. Endoscopic visualization of the larynx is crucial in assessing the intubation trauma in children, as the severity of symptoms may not always correlate with the degree of laryngeal injury present. Laryngeal endoscopy provides a more sensitive guide in visualizing the laryngeal sub-sites and characterizing the damage done in them [9]. Various classification systems [2] exist to describe severity of the LIRLs ranging from mild erythema and edema to severe granulation tissue formation, mucosal ulceration, and cartilage exposure. Schweiger *et al*. [10] classified the injuries as per affection of laryngeal sub-sites and were able to prognosticate their outcomes.

Materials and Methods

A prospective study was conducted in the Department of Otorhinolaryngology, RVM Institute of Medical Sciences & Research Centre, Laxmakkapally, Telangana, India for the period of 1 year, after taking the approval of the protocol review committee and institutional ethics committee. After taking informed consent detailed history was taken from the patient or the relatives. The technique, risks, benefits, results and associated complications of the procedure were discussed with all patients. 50 Patients intubated for more than 48 hours and admitted in medical ICU and aged more than 15 years were included in this study. Patients with associated comorbidities which hamper examination, those taken for elective surgical procedures, pediatric age of less than 15 years which are admitted in pediatric ICU and those who underwent tracheostomy were excluded from the study.

History was taken from reliable patient attenders regarding the need for intubation and duration of intubation, medical history to rule out associated co-morbid conditions like chronic-obstructive-pulmonary-disease, bronchial asthma, pulmonary tuberculosis, or any pulmonary disease compromising the ventilation.

The objectives of the study were to find the incidence, types of injury and to study the factors influencing LTI following intubation. The pressure of the cuff used in the endotracheal tube was 20 cm of water. All patients were evaluated for LTI based on the x-ray neck-anteroposterior and lateral view, 70-degree rigid endoscopy and flexible naso-pharyngo-laryngoscopy (NPL) 15 days following extubation.

Results

A total of 50 patients (Table 1) were inducted into the study of which 32 were males and 18 were females with age ranging from 15 to 70 years. Majority of patients (70%) were between 15-29 years. Endotracheal tube of size 7.5 and 8 were used in 84% of patients.

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Table 1: Characteristics and distribution pattern of patients with laryngotracheal injuries

Demographics		N (%)	%
Age (years)	15-29	35	70
	30-44	10	20
	>45	5	10
Gender	Male	32	64
	Female	18	36
Endotracheal tube dimension			
Size of tube (mm)	7	8	16
	7.5	24	48
	8	18	36
Indication for intubation			
Poisoning cases Non-poisoning cases	Organophosphorus poisoning	26	52
	Cerebro-vascular accidents	6	12
	Hypoxic ischaemic encephalopathy	4	8
	Acute respiratory distress syndrome	4	8
	Metabolic disorders	7	14
	Head injury	3	6
Length of intubation			
Duration (days)	2-5	16	32
	6-10	16	32
	>10	18	36

Majority of the patients (52%) were cases of organophosphorus (OP) poisoning followed by metabolic disorders like diabetic ketoacidosis and chronic kidney disease with encephalopathy. 36% of the patients were intubated for more than 10 days.

Patient was evaluated for LTI following intubation based on x-ray neck-antero-posterior view and lateral view, 70-degree endoscopy and flexible NPL. The x-ray was normal in 36 patients (72%) while the abnormality was picked up in 14 (28%) patients. On 70-degree endoscopy, 4 patients (8%) had granulation tissue in the posterior commissure and one patient had bilateral vocal cord fixation. Subsequently, when the flexible NPL was performed, additionally 14 cases (28%) of subglottic stenosis and 1 case of granulation tissue in the posterior wall of upper third of trachea was picked up (Table 2).

Table 2: Laryngotracheal findings in various investigative modalities

Investigation	Findings	N	%
X-ray	Normal	36	72
	Abnormal	14	28
Rigid endoscopy	Normal	44	88
	Bilateral vocal cord fixation	2	4
	Granulation tissue in posterior commissure	4	8
Flexible nasopharyngeal-laryngoscopy	Normal	29	58
	Sub-glottic stenosis	14	28
	Bilateral vocal cord fixation	1	2
	Granulation tissue in posterior commissure	5	10
	Granulation tissue in posterior wall of trachea	1	2

All the patients who had LTI were aged less than 45 years and 16 of 20 cases affected were males. Among the cases of LTI, 16(80%) out of 20 cases were intubated with endotracheal tubes of size more than 7. 12 (60%) of the total cases of LTI had intubation for more than 10 days. OP poisoning was the etiology for LTI in 16 cases (80%). However, none of the above factors were associated with the LTI statistically (Table 3).

Table 3: Associations of laryngotracheal injuries with various factors of interest

Factors		Injury	
		Present = 20	Absent (%) =30
Age	15-29	16(80)	19 (63.33)
	30-44	4 (20)	6 (20)
	>45	0	5 (16.67)
Gender	Male	16 (80)	16 (53.33)
	Female	4 (20)	14 (46.67)
Size of tube	7	4 (20)	4 (13.33)
	7.5	10(50)	14 (46.67)
	8	6 (30)	12(40)
	2-5 days	4(20)	12 (40)
Duration of intubation	6-10 days	4(20)	12 (40)
	>10 days	12 (60)	6 (20)
Cause of intubation	OP poisoning	16 (80)	10 (33.33)
	ARDS and CVA	1 (5)	5 (16.67)
	Metabolic disorder	0	7(23.33)
	Others (head injury, hypoxic ischemic encephalopathy)	3 (15)	8 (26.67)

Discussion

Patients requiring ventilation through artificial airways in the ICU is common. LTI following intubation have a reported incidence of 60% to 90% and permanent sequelae are reported to be about 15% in the world literature. The laryngeal injuries can be mucosal injuries like vocal cord erythema, edema, granulations or ulcerations to a more permanent sequelae like vocal cord palsy, arytenoids dislocation and subglottic stenosis [11-23]. In addition, the tracheal injuries can be granulations in the initial stages to tracheal stenosis in the later stages [24]. In the present study, LTI observed were subglottic stenosis, granulation tissue in posterior commissure, vocal cord fixation and granulation tissue in the tracheal wall.

The etiology of laryngeal stenosis following intubation is multifactorial. The mechanism of injury commonly associated with laryngotracheal intubation include duration of intubation, size of tube, pressure and rubbing of the shaft against the larynx, repeated intubation, foreign body reaction to the tube, use of a stylet during intubation, route of intubation, nursing care, and anatomic differences between the genders [25]. In the present study, majority of patients who sustained LTI were aged less than 45 years and were more common among male patients. Age of the patient plays an important role influencing site and degree of stenosis.

Neonates show predisposition for subglottic involvement but in our series, those cases have been excluded. It is an established entity that adults are more prone for posterior commissure lesions which is in concurrence with the present study. Nevertheless, combined stenoses account for about one-third of all laryngeal stenoses at any age [26-28].

The inappropriate diameter of the endotracheal tube and the difficulty in keeping the patient immobilized for a longer period are well known predisposing factors to the development of airway injuries. The posterior part of larynx specially the posterior commissure comes in contact with endotracheal tube due to the configuration of glottis being in the shape ‘V’ and the friction is more in this portion when the patient moves frequently. This is largely responsible for injuries in this area. Additionally, the compression on the mucosa by the tube causes prolonged ischemia which leads to ulceration followed by granulation tissue formation and later stenosis.

The determination of tube size of an adult patient is usually based on the physician’s assessment of neck morphology and external features of the larynx [17]. There is no standard formula to serve as a guide to appropriate tube size. A size of 8mm is generally used for

adults and 7 or 7.5mm for thinly built adults [17]. Following these measurements may not be possible in an emergency like OP poisoning LTI were found more commonly among patients intubated for more than 10 days. Thus, the duration of intubation is also a factor contributing to LTI following intubation. The constant movements of the neck in an agitated state cause friction of the larynx and tracheal mucosa. In the patient without sedation, reflected movements of deglutition can incite tracheal injury. The longer the duration of intubation, more the risk of injury.

In the present study, it was found that OP poison consumption was the most common cause of intubation induced LTI. This probably could be due to atropine induced reduced secretions in larynx and trachea associated with increased vulnerability of the mucosa to frictional injuries caused by ventilator through the endotracheal tube [29]. Therefore, proper sedation and paralysis of these patients wherever required can reduce the incidence of LTI. Additionally, the appropriate dosage of specific antidote (atropine) will also minimize the risk of dryness and irritability of the patient.

In the study, LTI were evaluated based on the x-ray neck, 70-degree rigid endoscopy and flexible NPL. Flexible trans-nasal endoscopy is widely available in many oto-rhino-laryngology offices [30]. Flexible NPL is generally well tolerated in majority of the patients with the use of topical/nebulized local anesthetic which allows evaluation of vocal cord mobility and other signs of LTI.

In the present study, flexible NPL was able to detect 80% of LTI in comparison to 70-degree endoscopy which detected only 20% of the lesions below the vocal cords. Thus, flexible NPL was found to be a more reliable modality in evaluating the LTI. As these lesions are intraluminal, a non-invasive modality like flexible NPL was preferred over Computed tomography or Magnetic resonance imaging. A basic investigation like x-ray neck was preferred prior to flexible NPL to assess the adequacy of airway which in turn would facilitate proceeding with the scopy.

Conclusion

A high incidence of LTI especially in cases of OP poisoning warrants one to be cautious in managing these intubated patients. Those patients requiring prolonged intubation should be considered for other alternative airway managements like tracheostomy in addition to using low pressure, high volume cuffed tubes. As the management of these LTI is challenging and associated with significant morbidity and mortality, an awareness of the same, adequate training of the emergency personnel in the intubation technique and its subsequent care is important especially in a tertiary referral center.

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