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Factors Influencing Laryngotracheal Injury Following Endotracheal Intubation in Patients with Organophosphorus Poisoning: A Prospective Observational Study.

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Abstract

Background: Organophosphorus (OP) poisoning is a major public health concern in developing countries and is one of the leading causes of poisoning-related intensive care admissions. Patients with severe OP poisoning frequently require prolonged endotracheal intubation and mechanical ventilation because of respiratory failure and neurological impairment. Although life-saving, prolonged endotracheal intubation may result in laryngotracheal (LT) injuries ranging from transient mucosal edema to permanent airway stenosis. Limited literature is available regarding the incidence and determinants of these injuries in patients with OP poisoning. ***Objectives:*** To determine the incidence of laryngotracheal injuries following endotracheal intubation in patients with organophosphorus poisoning and to evaluate demographic and clinical factors associated with these injuries. ***Methods:*** A prospective observational study was conducted over 12 months (September 2022–August 2023) in the Department of Otorhinolaryngology, Karnataka Institute of Medical Sciences, Hubballi. Forty consecutive patients with confirmed organophosphorus poisoning requiring endotracheal intubation were enrolled. Following extubation, all patients underwent evaluation using 70° rigid endoscopy. Variables analyzed included age, sex, endotracheal tube size, duration of intubation, prehospitalization interval, Glasgow Coma Scale (GCS), and experience of the intubator. Associations between these variables and laryngotracheal injury were analyzed using the Chi-square test, with statistical significance defined as $p < 0.05$. ***Results:*** Among the 40 patients studied, five (12.5%) developed laryngotracheal injury after extubation. Voice change was the most common presenting symptom (60%), followed by sore throat (40%). Prolonged duration of intubation (>7 days) were significantly associated with laryngotracheal injury, whereas no statistically significant association was observed with endotracheal tube size. No statistically significant association was observed between injury occurrence and age, gender, Glasgow Coma Scale, prehospitalization interval, or intubator experience. ***Conclusion:*** Laryngotracheal injury is an important complication following endotracheal intubation in patients with organophosphorus poisoning. Larger endotracheal tube size and prolonged intubation duration significantly increase the risk of injury. Careful airway management, appropriate tube selection, and early extubation whenever clinically feasible may reduce airway morbidity.

Keywords: Organophosphorus Poisoning; Laryngotracheal Injury; Endotracheal Intubation; Mechanical Ventilation; Airway Injury; Endoscopy.

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INTRODUCTION

Organophosphorus poisoning remains one of the most common causes of acute poisoning in developing countries, particularly in South Asia, because of the widespread availability of agricultural pesticides. It contributes substantially to morbidity and mortality, frequently requiring intensive care management. Respiratory failure resulting from cholinergic crisis, excessive bronchial secretions, respiratory muscle weakness, and altered sensorium often necessitates endotracheal intubation and mechanical ventilation.

Endotracheal intubation is an essential life-saving intervention in critically ill patients. However, prolonged contact between the endotracheal tube and the laryngotracheal mucosa may lead to ischemia, pressure necrosis, ulceration, granulation tissue formation, and subsequent fibrosis. These pathological changes may manifest clinically as sore throat,

hoarseness of voice, vocal cord immobility, posterior glottic stenosis, subglottic stenosis, or even permanent airway compromise.

Previous studies have demonstrated that the incidence of post-intubation laryngeal injury ranges widely depending on patient characteristics, duration of intubation, endotracheal tube size, cuff pressure, and intubation technique. Nevertheless, evidence specifically evaluating these risk factors in patients with organophosphorus poisoning remains scarce. Because these patients often require prolonged ventilatory support and repeated airway manipulation, they may represent a particularly high-risk population. Early identification of risk factors associated with laryngotracheal injury is important for minimizing airway-related complications and improving patient outcomes. A better understanding of these factors may facilitate safer airway management practices, guide endotracheal tube selection, optimize timing of extubation, and reduce long-term morbidity.

Therefore, the present prospective observational study was undertaken to determine the incidence of laryngotracheal injury among intubated patients with organophosphorus poisoning and to evaluate demographic, clinical, and procedural factors associated with these injuries.

MATERIALS AND METHODS

A prospective observational study design was conducted to evaluate risk factors for laryngotracheal injury in patients who required intubation due to OP poisoning. This design was chosen to systematically observe and record outcomes as they occurred in real time, ensuring that data were accurately captured and analysed. A consecutive sampling method was used, where all patients with OP poisoning who were intubated and admitted to the MICU in Karnataka Institute of Medical Sciences, Hubballi, over a period of 12 months from September 2022 to August 2023 were included in the study.

Inclusion Criteria

Patients with a confirmed diagnosis of OP poisoning. Patients who underwent intubation as part of their treatment.

Exclusion Criteria

Patients who died following intubation, Patients with a history of previous intubation, Patients with a history of voice alteration, Patients with pre-existing laryngotracheal conditions. Patients with incomplete medical records or those who were transferred from another facility after intubation. Data were collected using a combination of direct clinical observations, patient medical records, and structured interviews with healthcare providers involved in patient care.

RESULTS

Association of LT injury with age

Table 1: Showing association of LT injury with age

Age(years)	LT injury		Row total
	Yes	No	
<=20	1	8	9
21-40	4	24	28
41-60	0	2	2
>60	0	1	1
Column total	5	35	40(Grand total)

The chi-square statistic is 0.526. The result was not statistically significant (p= 0.4683). The LT injuries were more common among age group between 21 to 40 years.

Association of LT injury with gender

Table 2: Showing association of LT injury with gender

Gender	LT injury		Row total
	Yes	No	
Male	4	22	26
Female	1	13	14
Column total	5	35	40(Grand Total)

The chi-square statistic is 0.565. The result was not statistically significant (p= 0 .4523). In this study, the LT injuries were more common in males.

Association of injury with tube size

Table 3: Showing association of injury with tube size

Tube size(mm)	LT injury		Row total
	Yes	No	
7	0	4	4
7.5	2	14	16
8	2	15	17
8.5	1	2	3
Column total	5	35	40(Grand total)

The chi-square statistic is 1.77. The result was not statistically significant (p=0.1834) This study shows that no patient who was intubated with a 7 mm ET tube developed LT injury, 12.5% of pts had LT injury with tube size 7.5 mm, 11.76% of pts had LT injury with tube size 8 mm and 33.33% of pt. had LT injury with tube size 8.5 mm.

Association of injury with duration of intubation

Table 4: Showing association of injury with duration of intubation

Days	LT injury		Row total
	Yes	No	
<=7	3	34	37
>7	2	1	3
Column total	5	35	40(Grand total)

The chi-square statistic is 8.701 The result is statistically significant (p=0. 0032). The study shows 8.11% of the patients who were intubated for 7 days or less had LT injury while 66.67% of those who were intubated for more than 7 days had LT injury.

Association of injury with prehospitalization period

Table 5: Showing association of injury with prehospitalization period

Time(hours)	LT injury		Row total
	Yes	No	
<=3	2	12	14
4-6	3	18	21
>=7	0	5	5
Column total	5	35	40(Grand total)

The chi-square statistic is 0.817. The result is not statistically significant (p=0.3661).The study shows 14.29% of patients had LT injury with a prehospitalization period within 3 hours and 14.29% had LT injury with prehospitalization period of 4-6 hours.

Association of injury with GCS

Table 6: Showing association of injury with GCS

GCS	LT injury		Row total
	Yes	No	
13-15 (mild impairment)	1	11	12
9-12 (moderate impairment)	4	22	26
3-8 (severe impairment)	0	2	2
Column total	5	35	40(grand total)

The chi-square statistic is 0.6755. The result is not statistically significant (p=0.4113). According to the study, 9.09% of patients with mild impairment had LT injury, and 18.18% with moderate impairment had LT injury.

Association between Intubator experience and LT injury

Table 7: Showing association of injury with intubator's skills

Intubated by	LT injury		Row total
	Yes	No	
JR1	4	14	18
JR2	1	20	21
JR3	0	1	1
Column total	5	35	40 (Grand total)

The chi-square statistic is 2.848. The result is not statistically significant (p=0.0915).The study shows 22.22% of patients with LT injury were intubated by JR1 and 5% of patients with LT injury were intubated by JR2.

DISCUSSION

This study aimed to explore the factors influencing laryngotracheal injuries in patients with organophosphorus poisoning who were intubated. The study, conducted over a 12-month period, included 40 patients, with a focus on understanding how variables such as age, gender, tube size, duration of intubation, prehospitalization period, intubator's skill and GCS scores influenced the incidence of LT injuries. The age of the participants ranged from 17 to 65 years, with the majority of LT injuries occurring in the age group of 21-40 years. Although LT injuries were more common in this age group, the association between age and LT injury was not statistically significant (p =0.4683). The lack of significance may be attributed to the relatively small sample size and the wide age range of participants. In terms of gender distribution, LT injuries were more common in males (4 out of 22) compared to females (1 out of 14).

However, this difference did not reach statistical significance (p =.4523). This trend might be due to the higher representation of males in the study, as the male-to-female ratio was 1.86:1. The finding that males are more susceptible to LT injury could be related to their anatomical and physiological differences or possibly the variations in tube sizes used.[1] The size of the ETT used for intubation played a critical role in the development of LT injuries. LT injury occurred in 12.5% of patients intubated with a 7.5-mm tube, 11.76% of those intubated with an 8 mm tube and 33.33% of those intubated with an 8.5-mm tube. Although this trend was not statistically significant (p =0.1834), suggests that this may be due to a mismatch in tube size and tracheal diameter, especially in males. However, studies suggest that larger tubes could be less likely to cause injury due to better fitting or due to the operator's experience in placing such tubes. [2] Duration of intubation was found to be a significant factor influencing LT injuries (p =0.0032). Patients intubated for more than 7 days had a significantly higher risk of developing LT injuries (66.66%) compared to those intubated for less than or equal to 7 days (8.10%). This aligns with existing literature, which suggests that prolonged intubation increases the risk of subsequent LT injury.[3] The findings underscore the importance of minimizing the duration of intubation when possible, or considering alternative airway management strategies such as tracheostomy in cases where prolonged intubation is anticipated.[4]

The prehospitalization period, which refers to the elapsed between ingestion of the poison and hospital admission, did not show a statistically significant association with LT injuries (p = 0.3661). However, there was a trend indicating that earlier hospitalisation was associated with a higher incidence of LT injuries, possibly due to the higher urgency and difficulty in intubating these patients who might have been in a more critical condition upon arrival. This finding suggests that the timing of medical intervention and the patient's condition at the time of intubation may influence the risk of LT injury. The Glasgow Coma Scale was used to assess the neurological status of the patients at the time of intubation. The study found no significant association between GCS and LT injuries(p=0.4113), indicating that the neurological status, whether mild or moderate impairment, did not significantly influence the risk of LT injury in this study. This finding is interesting as it suggests that factors other than neurological status, such as the technical aspects of intubation or patient-specific anatomical factors, may play a more crucial role in the development of LT injuries. Among the 5 patients who developed LT injuries post-extubation, the most common complaints were change in voice (60%), and sore throat (40%). These symptoms are consistent with the expected sequelae of LT injury and highlight the need for careful monitoring and follow-up of patients after extubation, particularly those with prolonged intubation.

The association between patient age and the risk of laryngotracheal injury in this population, however, remains an area of active investigation. Older age may be a risk factor for the development of these iatrogenic injuries. Some studies have reported an association between increasing age and the severity of dysphagia following extubation or tracheostomy decannulation, potentially due to diminished laryngeal and pharyngeal function with aging. Furthermore, advanced age has been identified as a strong predictor of in-hospital mortality in patients who develop acute lung injury, a common complication of organophosphate poisoning. OP poisoning predominantly affects young adults aged 21-30 years, with males being more susceptible.[5,6] Conversely, other analyses have not found a significant relationship between patient

age and the incidence or severity of post-intubation dysphagia.[7,8] The heterogeneity in these findings may be attributed to variations in study populations, assessment techniques, and the specific end points evaluated. Further research is needed to clarify the role of age as a risk factor for laryngotracheal injury in intubated patients with organophosphate poisoning. Prospective studies with standardized outcome measures and longer-term follow-up are necessary to elucidate the complex interplay between patient age, intubation duration, and the development of these potentially debilitating sequelae. The incidence and severity of these injuries may be influenced by various factors, including the gender of the patient.[9] Existing literature has explored the potential association between gender and intubation -related injuries, but the findings have been somewhat inconsistent.

In the context of organophosphate poisoning, which frequently requires emergency intubation, the impact of gender on laryngotracheal injuries remains an area of interest. Organophosphate poisoning often leads to respiratory failure, necessitating immediate airway management, which puts patients at a heightened risk of intubation-related complications.[9] Female gender and prolonged intubation (≥72 hours) are predictive factors for LTI.[10] Factors associated with increased mortality in organophosphate poisoning include male gender, age >50 years, and certain treatment regimens.[5] Risk factors for airway injury include difficult intubation, age over 60, female gender, diabetes, larger body habitus, and endotracheal tube size greater than 7.0 mm. Notably, endotracheal tube size plays a crucial role, with tubes larger than 7.0 mm associated with impaired survival or recovery from critical illness.[11] To mitigate LTI risk, healthcare providers should consider using smaller ETT sizes.[12] 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. There is no standard formula to serve as a guide to appropriate tube size. An 8-mm tube is generally used for adults and size 7- or 7.5-mm tubes for small built adults.[13]

Santos et al. reported a 20% incidence of vocal cord immobility associated with ETT size.[14] However, other studies have reported no significant association between ETT size and laryngeal injury.15,16,17] Prolonged intubation (>72 hours) and female gender are significant predictors of laryngeal injury.[10] The mortality rate in OP poisoning patients requiring mechanical ventilation is directly proportional to the severity of poisoning, delay in starting pralidoxime treatment, and duration of mechanical ventilation.[18] Early tracheostomy (48 hours to 7 days) in OP poisoning patients is associated with shorter duration of mechanical ventilation, earlier weaning, fewer complications, and reduced hospital stay compared to late tracheostomy (8-15 days).[19] These findings emphasize the importance of careful management of intubated OP poisoning patients, including consideration of alternative airway management techniques like tracheostomy and the use of low-pressure, high-volume cuffed tubes.[3] Intubation difficulty is associated with Glasgow Coma Scale scores, with maximum difficulty observed in patients with GCS 7-9.[20] The GCS and International Program on Chemical Safety Poison Severity Score (IPCS PSS) are similarly effective in predicting outcomes in OP poisoning cases, with a GCS ≤13 indicating a need for intensive monitoring.[21] However, the predictive value varies depending on the specific OP pesticide ingested, emphasizing the importance of identifying the poison for accurate prognosis. The skill and technique of the person performing the intubation can also influence injury risk.[22,23] However, in this study it was not statistically significant.

CONCLUSION

This study aimed to identify factors influencing laryngotracheal injuries in patients with organophosphorus poisoning who required intubation. Among the 40 patients studied, several factors were assessed, including age, gender, tube size, duration of intubation, prehospitalization period, intubator's skill and Glasgow Coma Scale scores. The results indicate that while certain demographic factors such as age and gender showed trends in the prevalence of LT injuries, they were not statistically significant. However, duration of intubation was significantly associated with an increased risk of LT injury, whereas endotracheal tube size showed non-significant trend toward increased injury risk. Patients intubated with larger ETT sizes, particularly 8.5 mm, and those intubated for more than seven days appeared to have a higher risk of developing LT injuries. These findings suggest that careful consideration should be given to the choice of ETT size, particularly in male patients who generally require larger tubes, and efforts should be made to minimize the duration of intubation whenever possible to reduce the incidence of LT injuries. Additionally, the results underscore the importance of ongoing assessment and monitoring of intubated patients to identify and mitigate potential complications early. In conclusion, while factors such as prehospitalization period and Glasgow Coma Scale score at presentation did not show a significant direct influence on the development of LT injuries, the study highlights the need for vigilant airway management strategies in OP poisoning cases. Further research with larger sample sizes and more diverse populations is recommended to validate these findings and develop more comprehensive guidelines for the prevention of LT injuries in this vulnerable patient population.

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