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Original Research Article

An Observational Study to Investigate the Incidence and Diagnostic Validity of Difficult Airways in Emergency Department

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Abstract

Aim: The aim of the present study was investigating the incidence and diagnostic validity of difficult airways in emergency department.

Methods: The present study was conducted in the Department of Anesthesiology. Emergency physicians were able to perform intubation independently. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). 500 patients were included in the study.

Results: 350 (70%) of 500 patients intubated were male. Elderly patients aged 60 to 80 years old accounted for 45% of all cases. Intubation indications varied. The most common reasons were central nervous system diseases in 175 cases (35%), followed by cardiopulmonary arrest in 125 (25%), respiratory diseases in 100 (20%), and circulatory failure in 185 (18.8%). Emergency medicine physicians conducted most ED intubations 475 (95%). 390 patients (78%) were intubated immediately upon arriving at the ED. We utilized several kinds of simple examination methods (neck mobility, narrow oral opening, "3-3-2" evaluation, external look) to predict the possibility of difficulty. Given that different intubation devices may cause different ease of arriving at a satisfactory glottic exposure, we divided patients into two groups: those who underwent video laryngoscopy vs. those who received traditional direct laryngoscopy. The related parameters between the two groups were a sensitivity of 0.50 vs. 0.41, specificity of 0.80 vs. 0.72, AUC of 0.66 vs. 0.58 respectively. The combined test had a sensitivity of 0.72 (95% CI: 0.47–0.89), a specificity of 0.78 (95% CI: 0.76–0.81), a LR+ of 3.5 (95% CI: 2.5–4.6), a LR− of 0.38 (95% CI: 0.18– 0.71).

Conclusion: Despite an insufficient predictive ability for current difficult airway evaluation methods, there were relatively low rates of difficult airways during ED intubations. Continuing focus on the difficult airway problems and optimizing airway assessment are required.

Keywords: Difficult airway; diagnostic value; emergency department

Introduction

Recognition and management of a difficult airway are essential skills for anesthesia providers. However, a standard definition of the difficult airway remains elusive. Currently, the difficult laryngoscopy is defined as "not possible to visualize any portion of the vocal cords after multiple attempts at conventional laryngoscopy" whereas the difficult tracheal intubation is defined as requiring "multiple attempts, in the presence or absence of tracheal pathology". [1] Despite the efforts to standardize this complex concept, various definitions of difficult intubation have been used in previous studies. [2,3] In addition, many other factors, including clinician experience, the patient's medical conditions, institutional culture, airway management devices may influence the interpretation of a difficult intubation. [4,5]

The growing use of video laryngoscopy (VL) may further change and confound the interpretation of difficult intubation. [6,7] Overall, studies indicate that compared to traditional direct laryngoscopy (DL), VL has improved glottic visualization, increased success rates in tracheal intubation, and reduced failed intubations. [8,9] In addition to the already complex process of defining a difficult intubation, the widespread but not ubiquitous use of

VL may add another layer of discrepancy in the interpretation of a difficult intubation. [10]

Emergency physicians are frequently required to provide timely, definitive airway management in acutely ill patients. As the specialty has emerged and then matured over the last two and a half decades, practitioners of Emergency Medicine have become increasingly proficient in this skill, and have modified their approaches to airway management significantly, relying less and less on assistance from other medical specialists. [11] Residency training in Emergency Medicine, however, provides little training in the nonsurgical approach to the difficult airway. [12] Emergency physicians are expected to emerge from residency with competence in the surgical management of the airway, but with improved intubation rates have come reduced opportunity for cricothyrotomy. [13] Because patients presenting with difficult airways are uncommon but not rare, and because the very nature of emergency practice may predispose to difficulties with airway management, it behooves the emergency physician to become familiar with a range of airway management techniques, including direct laryngoscopy with rapid sequence intubation (RSI), alternatives to laryngoscopy for intubation, rescue ventilation techniques, and surgical approaches to the airway.

The aim of the present study was investigate the incidence and diagnostic validity of difficult airways in emergency department.

Materials and Methods

The present study was conducted in the Department of Anesthesiology at Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India for one year. Emergency physicians were able to perform intubation independently. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). 500 patients were included in the study.

Adult patients intubated in the emergency departments during the research period were screened for inclusion in this study. Patients with important information missing, data entry mistakes, or intubated outside the ED were excluded. Investigators recorded information in the survey instrument and did not intervene in the clinical treatment process. Double-check was performed by the person in charge of each hospital and the general investigator to mitigate the bias.

The difficult airway is a broad concept [14], which includes difficult face mask ventilation, glottic exposure, tracheal intubation, or difficult front of neck access. This paper only focused on difficult airway patients under non- invasive management. Difficult face mask ventilation is defined as the inability to ventilate with a face mask by one operator (i.e., needing two physicians or a change in ventilation techniques). Glottic exposure is a traditional prerequisite for tracheal intubation, and its classification under direct laryngoscopy can be divided into four grades. Grades III and IV (unable to see the glottic opening) imply difficulty. [15] However, the recent guideline did not emphasize the equipment used for evaluation. [16] As for the difficult tracheal intubation, the widely accepted definition is a failed intubation after multiple attempts. To quantify the criteria, we defined it as requiring more than two attempts. [17] Elective perioperative case with proper planning and airway preparedness versus emergent airway for an emergency department admission with borderline physiology. Authors defined difficult intubation as those needing more than two attempts, which may be suitable for the study but a little too generous to be labeled for difficult intubation.

The primary outcome was the incidence of difficult airways, including the difficult face mask ventilation, laryngoscope exposure, and intubation. Secondary outcomes were the sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of commonly used airway evaluation methods related to the latter two difficult airway situations.

We collected patient characteristics, including sex, age, intubation indications, the names of physicians' affiliated departments, physicians' past intubation experience, selected intubation equipment, and intubation context (whether it was emergent or not). The primary variable was the incidence of difficult airways. The secondary variables, including four physical examinations, were performed at the time of intubation [neck mobility, airway stenosis, facial appearance, and the "3-3-2" evaluation (mouth opening greater than three fingers, chin to mandibular hyoid bone more than three fingers, and mandibular hyoid bone to superior thyroid fossa more than two fingers)], and patients were divided into two categories based on the ease of the intubation process. To facilitate the evaluation process, we provided graphic illustrations in the questionnaire regarding the four examinations.

Most junior staff performed the intubation with video laryngoscopy in emergency departments. Preoxygenation was carried on in non-crash situations, and bag and mask ventilation was the most commonly used technique for preoxygenation patients before intubation.

Statistical Analysis

SPSS version 27 (IBM Corp., Armonk, New York, USA) was used to collate and analyze the data. Categorical variables were presented as frequencies with percentages. Values and 95% confidence intervals (CI) for sensitivity, specificity, positive

likelihood ratio, and negative likelihood ratio were calculated. The probability of diagnosis was calculated and illustrated as ROC (receiver operator characteristic) curves. The AUC (area under the curve) and P values were analyzed to evaluate diagnostic validity.

Results

Table 1: Patient characteristics

Characteristic	N (%)
Sex	
Male	350 (70)
Female	150 (30)
Age, years	
18–40	50 (10)
40–60	150 (30)
60–80	225 (45)
80–100	75 (15)
Cause	
Respiratory failure	100 (20)
Circulatory failure	90 (18)
CNS disease	175 (35)
Cardiopulmonary arrest	125 (25)
Others	10 (0.2)
Intubation department	
Emergency department	475 (95%)
Anesthesiology department	25 (5%)
Intubation experience	
>50	320 (64)
30–50	75 (15)
10–30	75 (15)
<10	30 (6)
Emergency intubation	390 (78)

350 (70%) of 500 patients intubated were male. Elderly patients aged 60 to 80 years old accounted for 45% of all cases. Intubation indications varied. The most common reasons were central nervous system diseases in 175 cases (35%), followed by cardiopulmonary arrest in 125 (25%), respiratory diseases in 100 (20%), and circulatory failure in 185 (18.8%). Emergency medicine physicians conducted most ED intubations 475 (95%). 390 patients (78%) were intubated immediately upon arriving at the ED.

Table 2: Physical examinations in difficult laryngoscopy exposure patients

Physical examination	Sensitivity (95% CI)	Specificity (95% CI)	LR+ (95% CI)	LR− (95% CI)
Neck mobility limitation	0.17 (0.09–0.28)	0.95 (0.94–0.97)	3.8 (2.0–6.9)	0.87 (0.79–0.97)
Airway stenosis	0.14 (0.07–0.24)	0.96 (0.95–0.98)	4.3 (2.1–8.5)	0.91 (0.82–0.98)
Outlook	0.14 (0.07–0.24)	0.94 (0.91–0.95)	1.8 (1.0–3.6)	0.94 (0.85–1.02)
3-3-2 evaluation	0.26 (0.16–0.37)	0.88 (0.85–0.90)	2.0 (1.3–3.2)	0.87 (0.75–0.98)
Any one of the above positive	0.45 (0.32–0.57)	0.78 (0.77–0.82)	2.3 (1.6–2.9)	0.71 (0.57–0.87)

We utilized several kinds of simple examination methods (neck mobility, narrow oral opening, “3-3-2” evaluation, external look) to predict the possibility of difficulty. Among all four tests, any one of them showed low sensitivity and relatively high specificity.

Table 3: The predictive value of different equipment groups in assessing difficult laryngoscope exposure

Validity	Video laryngoscopy group	Direct laryngoscopy group
Sensitivity	0.50 (0.33–0.63)	0.41 (0.19–0.61)
Specificity	0.80 (0.78–0.83)	0.72 (0.66–0.80)
LR+	2.7 (1.8–3.5)	1.7 (0.8–2.7)
LR−	0.68 (0.49–0.85)	0.86 (0.60–1.18)
AUC	0.66	0.58

Given that different intubation devices may cause different ease of arriving at a satisfactory glottic exposure, we divided patients into two groups: those who underwent video laryngoscopy vs. those who received traditional direct laryngoscopy. The related parameters between the two groups were a sensitivity of 0.50 vs. 0.41, specificity of 0.80 vs. 0.72, AUC of 0.66 vs. 0.58 respectively.

Table 4: Physical examinations in difficult airway patients

Physical examination	Sensitivity (95% CI)	Specificity (95% CI)	LR+ (95% CI)	LR− (95% CI)
Neck mobility limitation	0.28 (0.12–0.52)	0.94 (0.94–0.97)	6.2 (2.9–12.8)	0.76 (0.57–0.98)
Airway stenosis	0.39 (0.19–0.61)	0.96 (0.96–0.98)	12.4 (6.4–23.4)	0.66 (0.46–0.89)
Outlook	0.28 (0.12–0.52)	0.91 (0.91–0.95)	4.2 (2.0–8.4)	0.78 (0.59–1.0)
3-3-2 evaluation	0.39 (0.19–0.61)	0.88 (0.85–0.89)	3.1 (1.7–5.3)	0.72 (0.51–0.99)
Any one was positive	0.72 (0.47–0.89)	0.78 (0.76–0.81)	3.5 (2.5–4.6)	0.38 (0.18–0.71)

The combined test had a sensitivity of 0.72 (95% CI: 0.47–0.89), a specificity of 0.78 (95% CI: 0.76–0.81), a LR+ of 3.5 (95% CI: 2.5–4.6), a LR− of 0.38 (95% CI: 0.18– 0.71).

Table 5: The predictive value of different equipment groups in assessing difficult intubation

Validity	Video laryngoscopy group	Direct laryngoscopy group
Sensitivity	0.72 (0.39–0.93)	0.71 (0.35–0.92)
Specificity	0.82 (0.77–0.83)	0.76 (0.68–0.81)
LR+	3.7 (2.4–5.3)	2.8 (1.7–4.5)
LR−	0.36 (0.13–0.90)	0.7 (0.15–1.03)
AUC	0.78	0.71

Compared with video laryngoscopy, direct laryngoscopy had a sensitivity of 0.72 vs. 0.71, specificity of 0.76 vs. 0.82, AUC of 0.78 vs. 0.71 respectively.

Discussion

Difficult airways are a challenge for those who perform endotracheal intubations. The incidence of the difficult airway is lower in surgical patients[18] but is higher in non- preoperative (e.g., emergency department, ED) patients. The consequences of the worst-case difficult airway, the "cannot intubate and cannot ventilate" situation, can be catastrophic. [19] Understanding and anticipating the difficult airway is of paramount importance for intubators, including emergency medicine physicians.

Bag-valve mask ventilation before intubation is supposed to improve pre-intubation oxygen storage and lower the incidence of hypoxia during intubation. [20] Bag-valve masks are relatively affordable medical devices, and are thus commonly used in the ED. Nevertheless, difficult bag-valve mask ventilation may reduce ventilation efficiency and lead to oxygen desaturation. Nowadays, commonly used evaluation parameters include: obesity, age over 55 years, snoring, lack of teeth, having facial hair, a Mallampati Class > II, and abnormal mandibular protrusion. Since many patients who need emergent intubation in the ED have one or more of these characteristics (e.g., age >55 was very common in our study), it is not surprising that the highest rate of difficulty in our study was with bag-valve mask ventilation. Further research effort is needed for better screening methods for difficult bag-valve mask ventilation. [21] 350 (70%) of 500 patients intubated were male. Elderly patients aged 60 to 80 years old accounted for 45% of all cases. Intubation indications varied. The most common reasons were central nervous system diseases in 175 cases (35%), followed by cardiopulmonary arrest in 125 (25%), respiratory diseases in 100 (20%), and circulatory failure in 185 (18.8%). Emergency medicine physicians conducted most ED intubations 475 (95%). 390 patients (78%) were intubated immediately upon arriving at the ED. We utilized several kinds of simple examination methods (neck mobility, narrow oral opening, "3-3-2" evaluation, external look) to predict the possibility of difficulty. Among all four tests, any one of them showed low sensitivity and relatively high specificity. Given that different intubation devices may cause different ease of arriving at a satisfactory glottic exposure, we divided patients into two groups: those who underwent video laryngoscopy vs. those who received traditional direct laryngoscopy. Despite the low incidence of difficult airways, adequate evaluation still plays an essential role before intubation. Some of the four have been checked for their diagnostic value or had been previously recommended in other studies. [22,23]

The related parameters between the two groups were a sensitivity of 0.50 vs. 0.41, specificity of 0.80 vs. 0.72, AUC of 0.66 vs. 0.58 respectively. The combined test had a sensitivity of 0.72 (95% CI: 0.47–0.89), a specificity of 0.78 (95% CI: 0.76–0.81), a LR+ of 3.5 (95% CI: 2.5–4.6), a LR− of 0.38 (95% CI: 0.18– 0.71). Compared with video

laryngoscopy, direct laryngoscopy had a sensitivity of 0.72 vs. 0.71, specificity of 0.76 vs. 0.82, AUC of 0.78 vs. 0.71 respectively. This suggests that the combined test is on-par with other studies but does not seem particularly better or worse as far as its sensitivity. As for difficult intubation, our data showed a sensitivity of 0.71 and a specificity of 0.79. In contrast, other assessments ranged from 0.24 to 0.51 in sensitivity and 0.87 to 0.91 in specificity. [24] This suggests a better sensitivity to the combined technique for finding difficult airways without sacrificing too much specificity. In addition, the predictive value (AUC) in difficult laryngoscopy and intubation presented certain value but were not ideal when compared with recent evidences. [25] In recent years, related researches are also increasing with the widespread application of video laryngoscopy. [26,27] Although the evaluation indicators of the difficult airway of different types of laryngoscopes overlap, there are still differences. This phenomenon is consistent with the different predictive values of the two groups of evaluation indicators in this study.

Conclusion

Despite an insufficient predictive ability for current difficult airway evaluation methods, there were relatively low rates of difficult airways during ED intubations. Continuing focus on the difficult airway problems and optimizing airway assessment are required.

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