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Original Article

Evaluation of the success rate of the semi-sitting position compared with the supine position in the emergency intubation of traumatic patients

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Abstract: Objectives: Tracheal intubation (TI) is an essential skill for various healthcare providers, including emergency medicine specialists and anesthesiologists. The ramped position has been hypothesized to facilitate TI. In this study, we assessed the success rate of the semi-sitting position compared with the supine position in emergency intubation. Methods: In this double-blind clinical trial, 162 traumatic patients admitted to the emergency department at Al-Zahra Hospital were randomly assigned to three groups. Patients in Group I underwent TI in the supine position. Patients in Group II underwent TI in a semi-sitting position at a 25-degree angle, while Group III underwent TI in a semi-sitting position at a 35-degree angle. The Cormack-Lehane (C-L) grade and the number of intubation attempts were compared among the groups. Results: Our findings showed a significant reduction in the number of intubation attempts in Groups II and III compared to Group I ($P < 0.001$). However, the semi-sitting positions (Groups II and III) were associated with a higher incidence of Grade III and IV C-L views, indicating poorer glottic visualization ($P < 0.01$). Conclusions: The semi-sitting (ramped) position improves the success rate of TI by reducing the number of intubation attempts. However, it significantly worsens glottic visualization, which may pose challenges during airway management. Further studies are needed to optimize patient positioning in emergency intubation.

Keywords: Semi-sitting position, supine position, tracheal intubation

Introduction

Tracheal intubation (TI) involves the placement of a flexible plastic tube into the trachea to maintain an open airway or to administer medications. Intubation is commonly performed in patients who are severely injured, critically ill, or have significantly reduced levels of consciousness to facilitate ventilation, including mechanical ventilation, and to manage airway obstruction [1]. In traumatic patients, emergency intubation is often required due to compromised airway patency, severe head injuries, facial trauma, or the need for rapid sequence intubation in cases of hemorrhagic shock [2, 3]. Trauma patients often present with factors that complicate airway management, such as maxillofacial injuries, cervical spine precautions, and airway contamination with blood or secretions. These challenges can significantly increase the risk of difficult or failed tracheal intubation, necessitating rapid and skilled intervention by experienced providers [2, 3]. The most common method of intubation is orotracheal, where the tube is inserted through the mouth, passing the vocal cords into the trachea. Alternatively, nasotracheal intubation involves inserting the tube through the nose and advancing it into the trachea after passing the vocal cords. Proper technique and positioning are critical to ensure successful intubation and to minimize complications [4].

The “ramped” or semi-sitting position, characterized by hip joint flexion and elevation of the head and torso, has been shown to improve glottic visualization during intubation. Positions at angles of 25° to 35° require less force to displace the tongue and other soft tissues, potentially enhancing the view of the larynx [5]. This positioning may also reduce discomfort for emergency medicine specialists by aligning

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the patient's xyphoid process closer to the physician's line of sight, thereby minimizing the need for excessive bending and improving ergonomics during the procedure.

Given the potential complications of tracheal intubation, particularly in trauma patients where cervical spine protection and rapid airway management are paramount, special attention to patient positioning and the use of adjunct maneuvers is essential. TI is a critical skill for a wide range of healthcare providers, including emergency medicine specialists, anesthesiologists, and physicians managing advanced airway care [6]. In emergency settings, the most common indications for intubation include acute respiratory failure, inadequate ventilation or oxygenation, airway protection in patients with decreased consciousness, and airway compromise due to traumatic injuries [7, 8].

Therefore, in this study, we aimed to assess the success rate of TI in the semi-sitting position at 25° and 35° angles compared to the traditional supine position during emergency intubation, with a particular focus on patients with traumatic injuries.

Methods

Study design

This phase 2, double-blind, randomized clinical trial was conducted on traumatic patients admitted to the emergency department of Al-Zahra Hospital between 2017 and 2018. The study aimed to compare the efficacy of different patient positions during TI, focusing on supine and semi-sitting positions at varying angles. The study protocol was approved by the ethics committee of Isfahan University of Medical Sciences (code: IR.MUI.REC.1396.3.864) and also by the Iranian Registry of Clinical Trials (IRCT) (code: IRCT20181203041838N1) (https://irct.behdasht.gov.ir/trial/39211).

Inclusion and exclusion criteria

Inclusion criteria consisted of: 1. Patients aged ≥ 16 years who required tracheal intubation in the emergency department or during prehospital trauma care. 2. Indication for tracheal intubation due to trauma-related airway compromise, including: (1) Airway protection in patients with altered mental status (e.g., GCS ≤ 8), (2) Inadequate oxygenation or ventilation (e.g., SpO_2 < 90% despite supplemental oxygen), (3) Anticipated clinical deterioration requiring definitive airway control. 3. Informed consent obtained from the patient or their legal representative (for prospective components of the study).

Exclusion criteria were: 1. Patients who underwent primary surgical airway (e.g., cricothyrotomy or tracheostomy) as the initial airway intervention. 2. Patients with non-traumatic indications for intubation (e.g., medical cardiac arrest, drug overdose). 3. Incomplete or missing clinical data related to airway management. 4. Patients who died before intubation could be attempted or completed.

Patient grouping

A total of 162 traumatic patients were randomly selected using a random number table. After assessing eligibility based on inclusion and exclusion criteria, patients were allocated into three equal groups (1:1:1 ratio): Group I (n = 54): Underwent TI in the supine position. Group II (n = 54): Underwent TI in a semi-sitting position at a 25° angle. Group III (n = 54): Underwent TI in a semi-sitting position at a 35° angle.

The 25° and 35° angles for the semi-sitting positions were selected based on prior studies and clinical practice guidelines that support head-of-bed elevation to improve laryngeal view, oxygenation, and intubation conditions [6-8]. These angles were chosen to represent commonly used semi-upright positions while ensuring patient safety and procedural feasibility in trauma settings.

Randomization was conducted through simple random sampling to minimize selection bias.

Collected data and outcomes

Demographic data, including age, sex, weight, heart rate, systolic blood pressure, and diastolic blood pressure, were collected using a standardized checklist. Clinical data related to the efficacy and quality of TI included: (1) Cormack-Lehane (C-L) grading: To assess glottic visualization. The C-L grading system classifies the laryngeal view obtained during direct laryngoscopy into four grades: Grade 1: Full view of the

Table 1. Demographic information of patients

Parameter	Group I (n = 54)	Group II (n = 54)	Group III (n = 54)	*p*-value
Age (Year)	56.48 ± 15.47	56.05 ± 16.07	57.16 ± 15.25	0.93
Sex (M/F)	29/25	27/27	29/25	0.9
Weight (Kg)	68.72 ± 9.13	68.94 ± 8.29	68.38 ± 8.29	0.94
HR (Per minute)	74.42 ± 6.52	74.33 ± 5.7	74.61 ± 5.56	0.88
SBP (mmHg)	132.5 ± 9.85	126.25 ± 13.4	130.96 ± 12.4	0.56
DBP (mmHg)	77.22 ± 5.74	76.79 ± 5.74	76.79 ± 5.76	0.9

HR = Heart Rate; SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure. Patients in group I underwent chest TI in supine position. Patients in group II underwent TI in a semi-sitting position at 25-degree angle, and group III in a semi-sitting position at a 35-degree angle.

Table 2. Comparison of patient's outcomes between groups

Parameter		Group I (n = 54)	Group II (n = 54)	Group III (n = 54)	*p*-value
C-L Grading (%)	1	38.9	18.5	7.4	< 0.01
	2	31.5	20.4	24.1	> 0.05
	3	14.8	29.6	35.2	< 0.01
	4	14.8	31.5	33.5	< 0.01
Number of examinations for TI		2.87 ± 1.22	1.77 ± 0.79	1.61 ± 0.87	< 0.01

C-L = Cormack-Lehane. Patients in group I underwent chest TI in supine position. Patients in group II underwent TI in a semi-sitting position at 25-degree angle, and group III in a semi-sitting position at a 35-degree angle.

glottis. Grade 2: Partial view of the glottis. Grade 3: Only the epiglottis is visible; no part of the glottis can be seen. Grade 4: Neither the epiglottis nor the glottis is visible. (2) Number of intubation attempts: Counted until successful TI was achieved.

Statistical analysis

Data analysis was performed using SPSS software, version 25 (SPSS Inc., Chicago, IL). The normality of numerical variables was assessed using the Kolmogorov-Smirnov Z-test. Based on the distribution, parametric or non-parametric tests were employed for quantitative data analysis. Comparative analysis: The Chi-square test was used to evaluate associations between categorical variables. A *p*-value of < 0.05 was considered statistically significant in all analyses.

Results

Demographic characteristics

A total of 162 patients were included in the study, with 54 patients in each group. Group I underwent TI in the supine position, while Group II and Group III underwent TI in the semi-sitting position at 25° and 35° angles, respectively. The mean age of patients was similar across the groups (Group I: 56.48 ± 15.47 years, Group II: 56.05 ± 16.07 years, Group III: 57.16 ± 15.25 years, P = 0.93). Sex distribution (M/F) was comparable between groups (P = 0.90), as were weight (P = 0.94), heart rate (P = 0.88), systolic blood pressure (P = 0.56), and diastolic blood pressure (P = 0.90), indicating no significant baseline differences among the groups (**Table 1**).

Cormack-Lehane grading

The distribution of Cormack-Lehane (C-L) grades differed significantly between the groups (**Table 2**; **Figure 1**). Patients in the supine position (Group I) had a higher proportion of Grade 1 views (38.9%) compared to Group II (18.5%) and Group III (7.4%), with a statistically significant difference (P < 0.01). Conversely, higher grades (Grade 3 and 4), indicative of poorer glottic visualization, were more common in the semi-sitting groups, particularly in Group III (Grade 3: 35.2%, Grade 4: 33.5%). As shown in **Figure 1**, the frequency of grade 1 of Cormachke-Lehane was significantly higher in group I (P < 0.01, **Figure 1A** and **1B**), while grade 3&4 of Cormachke-Lehane were significantly higher in group II and group III

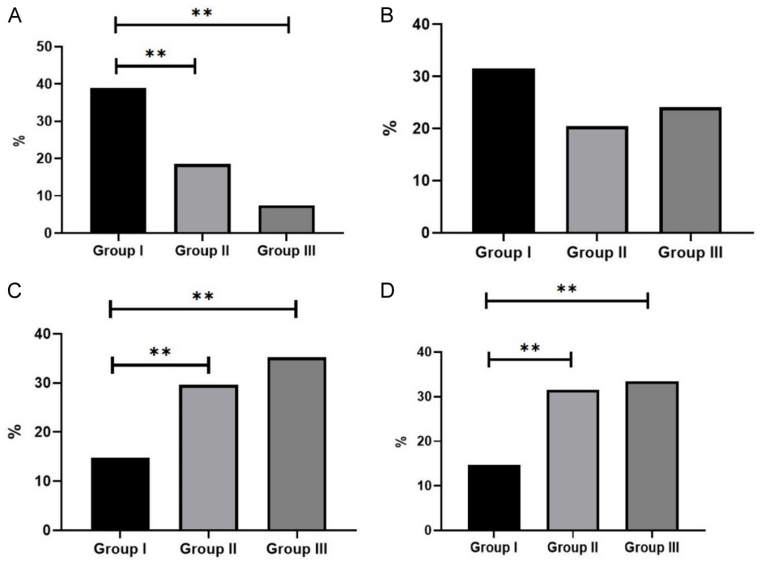

Figure 1. Comparison of Cormack-Lehane grading (A = Grade 1, B = Grade 2, C = Grade 3, D = Grade 4) between three groups of the study. Patients in group I underwent TI in supine position. Patients in group II underwent TI in a semi-sitting position at 25-degree angle, and group III in a semi-sitting position at a 35-degree angle.

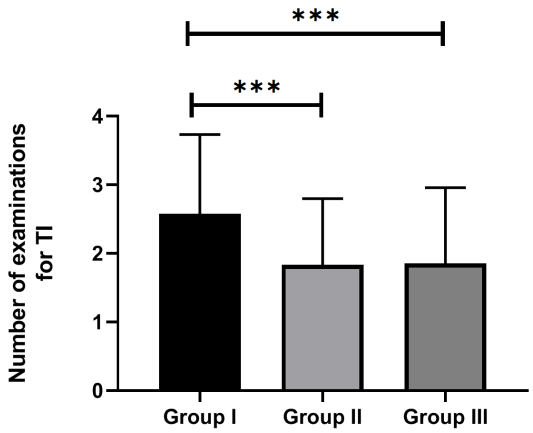

Figure 2. Comparison of the number of examinations for the TI between three groups of the study. Patients in group I undergo TI in supine position. Patients in group II underwent TI in a semi-sitting position at 25 angles, and group III in a semi-sitting position at a 35-degree angle.

(P < 0.01, **Figure 1C** and **1D**). These findings suggest that the semi-sitting position may be associated with a more challenging airway visualization compared to the supine position.

Number of attempts for intubation

Our findings regarding the number of examinations for the TI showed that semi-setting position cause decrease in the number of examinations for the TI (P < 0.01, **Figure 2**). The number of attempts required for successful intubation was significantly lower in Groups II and III compared to Group I (P < 0.01) (**Table 2**; **Figure 2**). Patients in the supine position required an average of 2.87 ± 1.22 attempts, whereas those in the semi-sitting 25° and 35° positions required 1.77 ± 0.79 and 1.61 ± 0.87 attempts, respectively. All 162 patients (100%) ultimately underwent successful tracheal intubation. This suggests that despite the potentially more challenging laryngeal view in the semi-sitting positions, the overall success rate of intubation may be higher, potentially due to improved ergonomics and patient alignment for the incubator.

Discussion

Our findings indicate that the semi-sitting position at 25° and 35° angles may improve intubation efficiency by reducing the number of required attempts, despite an increase in higher-grade C-L views. These results highlight the importance of optimizing patient positioning for emergency intubation, particularly in trauma patients where airway management is critical. Further studies are warranted to explore the clinical implications of these findings in real-world emergency and trauma settings.

Our findings are consistent with previous studies [9]. Semler et al. reported that the ramped position may worsen glottic visualization and increase the number of laryngoscopy attempts required for successful intubation [9, 10]. Hey demonstrated that the ramped position appeared to increase the incidence of Grade III or IV Cormack-Lehane views, which aligns with our results in the present study. In another similar study, Lee et al. found that laryngeal exposure during laryngoscopy was better in the 25° back-up position than in the supine position [11, 12]. They reported that the percentage of glottic opening (POGO) score significantly increased from 42.2% (± 27.4) in the supine position to 66.8% (± 27.6) in the 25° back-up position. The results of Lee's study support our

findings in the present study. Similarly, Lee and his colleagues compared the rate of successful endotracheal intubation between the sniffing and ramped positions in patients with an expected difficult airway. They reported that the ramped position had a higher success rate for endotracheal intubation and provided a better laryngeal view than the sniffing position [13, 14].

In line with our findings, Turner et al. observed improved intubation success with upright positioning compared to supine positioning [15, 16]. They found that upright positioning was associated with significantly shorter time to intubation, a higher likelihood of achieving a Grade I Cormack-Lehane view, a higher POGO score, lower perceived difficulty, and greater provider satisfaction. Turner et al. also reported a high success rate for intubation in the upright position [17, 18]. The authors found that first-pass success rates were 65.8% in the supine group, 77.9% in the inclined group, and 85.6% in the upright group (P = 0.024). Furthermore, for every 5-degree increase in angle, there was a greater likelihood of first-pass success (AOR = 1.11; 95% CI = 1.01-1.22, P = 0.043). They suggested that further investigation into optimal positioning during emergency department intubations is warranted.

Conversely, Hirabayashi et al. found no significant differences in the success rate and time to intubation between the in-line head and neck position and the sniffing position [19, 20]. However, the authors observed that preference scores on a visual analog scale favored the in-line head and neck position over the sniffing position. They concluded that the in-line head and neck position was preferable for TI with the Airtraq laryngoscope compared to the sniffing position.

Our study was conducted in a single-center setting, which may limit the generalizability of the findings to other emergency departments and trauma centers. Additionally, the study did not assess long-term clinical outcomes related to different intubation positions. The experience level of the intubators was not standardized, which could have influenced the success rates. Finally, while we controlled for key variables, unmeasured confounders may have affected the results.

Conclusion

Taken together, our data suggest that the ramped or semi-sitting position leads to a higher rate of successful tracheal intubation. However, it should be noted that this position has a considerable adverse effect on glottic visualization. Future studies are needed to confirm our findings.

Disclosure of conflict of interest

None.

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