Impact of Stylet Bend Angle on the Performance of Orotracheal Intubation by Emergency Response Nurses: A Randomized Simulation Study

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Abstract

Aim: To determine the effect of stylet bend angle on the time to tracheal intubation and the success rate by emergency response nurses in a simulated situation.

Materials and Methods: A prospective randomized study was conducted. Each participant performed six intubation attempts, three with 30° and three with 60° stylet angles. Each stylet angle was tested totally 105 times. Generalized estimating equations were used to analyze data.

Results: The overall success rate of simulated tracheal intubations was 94%. The mean time to successful intubation (in seconds) was 10.99±18.80 and 13.04±18.82 for 30° and 60° stylet bend angles, respectively. The 30° stylet bend angle significantly reduced the time to intubation ($p<0.01$).

Conclusion: Using the 30° stylet bend angle resulted in faster tracheal intubation by the emergency response nurses in the simulated situation.

Keywords: Emergency response team, direct laryngoscopy, stylet, endotracheal intubation

Introduction

Orotracheal intubation (OTI) is considered the gold standard for securing and ensuring airway patency (1, 2). This procedure is commonly performed to facilitate airway control in critical situations, such as cardiac or respiratory arrest, failure to protect the airway from aspiration, inadequate oxygenation or ventilation, and an existing or anticipated airway obstruction (3). Studies have suggested that emergency tracheal intubations using standard techniques have resulted in more failures than the elective ones (4). A recent systematic review reported that the first-pass success rate in emergency intubation was 84.1% in all groups and 81.8% in the trauma-only group of the emergency departments (5). Ventilation-associated complications may occur if members involved in the emergency response teams have no adequate skills in airway management. Multiple intubation attempts might increase patient morbidity, including severe hypoxia and severe hypotension (6, 7). The investigations showed that the incidence of hypoxemia, with less than two intubation attempts, changed from 11.8%to 70% if there were more than two intubation attempts (8).

The emergency response teams usually comprise medical and nursing staff from anesthesiology and intensive care units. Nurses are usually the first responders during an in-hospital cardiac arrest and they must either initiate cardiopulmonary resuscitation or withhold it (9). Controversy exists regarding the level of provider required to perform tracheal intubation (10). In some institutions, non-physician practitioners are trained and permitted to perform laryngoscopic OTI when an anesthetist is not immediately available (11, 12). Authors suggest that OTI techniques should be developed

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for those who are involved in non-elective or emergency airway management where the incidence of a failed intubation is up to 20 times higher (13).

Although several optic devices have been introduced for successful management of tracheal intubations, the available data do not provide strong evidence that these devices supersede standard direct laryngoscopy for routine or difficult intubation (14). As the speed of intubation and the possibility of gastric aspiration is always a concern, it is preferred to use a stylet inside the endotracheal tube (ETT) (15, 16). A stylet is a malleable metal or plastic stent over which an ETT is passed and allows the curvature of the tube to be altered (17). The time to ventilation is considered a crucial criterion when evaluating airway management procedures (18). Although numerous studies have been published regarding the stylet shape for video laryngoscopy (19-21), few studies have investigated the ideal stylet angle for tracheal intubation under direct laryngoscopy. This study was performed to determine the effect of the stylet bend angle (30° vs. 60°) on the time to tracheal intubation by the emergency response nurses in a simulated manikin-based situation.

Materials and Methods

A prospective randomized study was conducted in which nurses registered as members of the emergency response team (adult code blue) in a university-affiliated hospital participated. The research setting is recognized as the primary adult resource center for trauma in the province. According to the hospital's operating protocols, the nurses in the hospital emergency response team are allowed to perform OTI when an anesthetist is not immediately available. The ethical committee of the university approved the study (No. 1394.154). Written consent was obtained from the participants at the beginning of the study. The participants were not obliged to participate and could withdraw from the study at any time. The data for each participant were recorded anonymously. Based on the standard deviations (SDs) reported in a study by Hilton et al. (22) for an effect size of 8 seconds, a total of 210 attempts (105 attempts for each angle) were needed for a study with a power of 0.80 for showing significance at a $p < 0.05$. Thus, 35 participants undergoing three attempts with 30° and three with 60° ETTs were required. Nurses who had at least 2 years of critical care experience, had received advanced airway management training, were appointed as members of the hospital emergency response team, had no physical impairment on their hands at the time of the study (to be able to handle a laryngoscope), had no back pain (to take the proper position for laryngoscopy), and had normal visual acuity were included in the study. The participants could be excluded whenever they decided to quit from the study. The study was conducted between February 2016 and September 2016. All intubations were performed in the morning and evening work shifts of the participants.

A new Laerdal airway management trainer manikin (Laerdal Medical Ltd, Norway) was used. Laerdal manikins are recognized as suitable manikins for use in a wide variety of airway management studies (23). The manikin was placed in a sniffing position on a stretcher equipped with variable height frames. A metal Macintosh laryngoscope of size 3.0 blade (Riester Jungingen, Germany) and 7.0 cuffed ETT (NOVA TEX, Shanghai, China) loaded with adult malleable stylets sized 14 (Hangzhou Shanyo Medical, China) were used for all intubations. Each malleable stylet was used once in the attempts. The ETTs were reverse loaded with stylets (in the direction opposite to the concave side of the ETT natural curve) to minimize the stylet twisting (20). The angles were created at 6.5 cm from the distal end of the ETT using two mold-shaping devices specifically produced for the study (Figure 1). A single investigator loaded all ETTs and maintained lubrication, inflation of the ETT balloon, and connection of the ETT to the bag. The time to successful intubation was the time (in seconds) from the ETT entering the mouth and was measured with a similar mobile phone chronometer (Nokia, India). The stylets and ETTs were lubricated with lubricating jelly to ease the process of stylet removal and tracheal tube passage. The stretcher height was adjusted to ensure that the proximal surface of the manikin head was placed at the lower part of the participant's sternum. The laryngoscope blade and handle were pre-connected.

Each participant was primarily allowed to conduct a preliminary intubation on the same manikin. A random permuted blocking with a block size of 6 was used (i.e., AABBAB) to determine the sequence order of stylet angles (A=30° and B=60°). For each participant, one out of 20 sequence orders, written previously on uniform paper strips and provided in an envelope, was chosen randomly. Six stylet-loaded tubes were placed on a table, three with 30° and three with 60°, according to the randomly chosen block sequence. Each participant performed six consecutive intubations. The participants were asked to attempt tube passage once and avoid repetitive attempts to advance. They were also asked not to perform bimanual laryngoscopy or other manikin manipulation during insertion. The success of each intubation was approved by observing bilateral lung expansion of the manikin with a self-inflating bag. An attempt requiring over 90 seconds was defined as a failure.

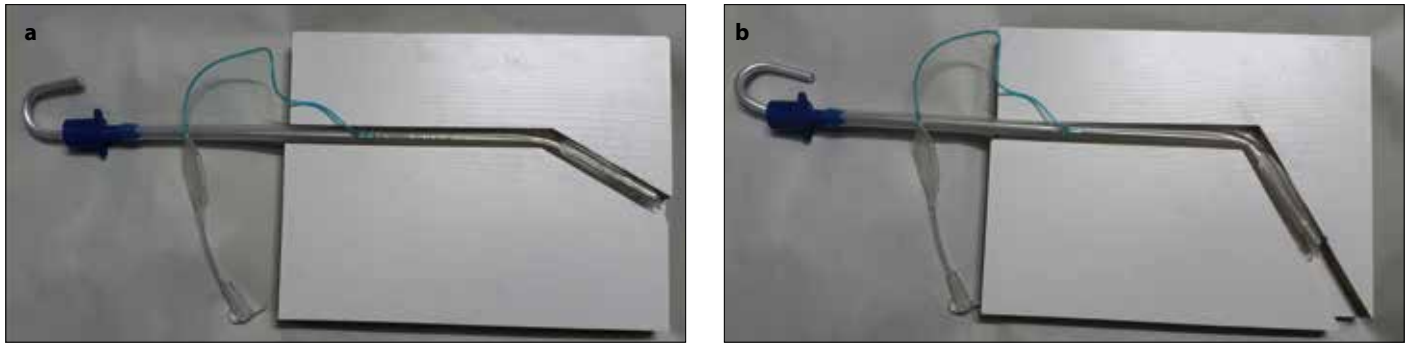

Figure 1. a, b. Two mold-shaping devices for 30° (a) and 60 ° (b) bend angles

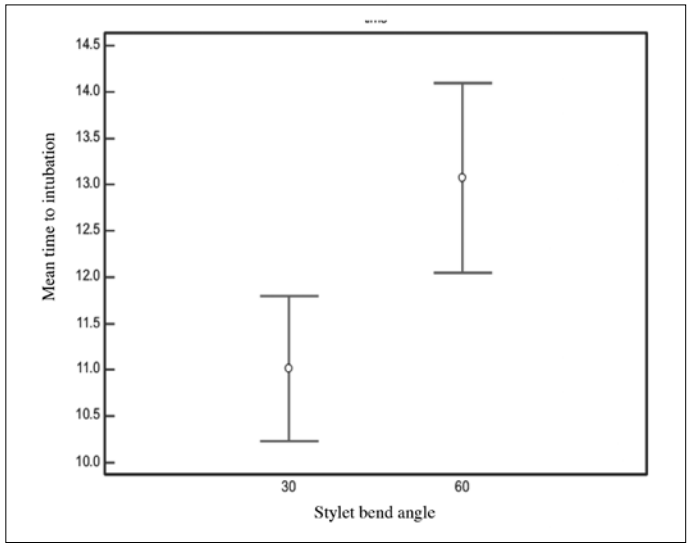

Figure 2. Mean time to successful intubation and its 95% confidence interval in two bend angles (30° vs. 60°)

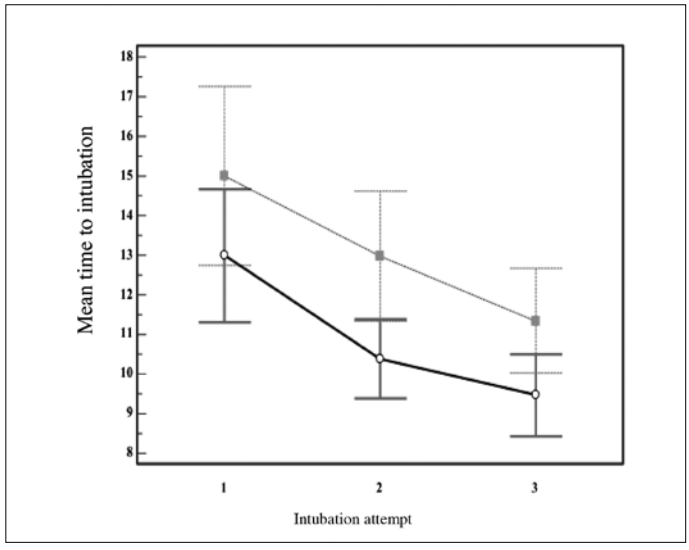

Figure 3. Mean time to intubation for the 1st, 2nd, and 3rd attempt in 30° vs. 60 ° stylet bend angles

Table 1. Characteristics of the nurses who participated in simulated orotracheal intubation

Characteristics	Detail	n	%
Gender	Male	7	20.0
	Female	28	80.0
Age	≤30 years	6	17.1
	31-40 years	22	62.9
	41-50 years	7	20.0
Years of experience	≤5	17	48.6
	6–10	15	42.9
	11–15	1	2.9
	16–20	2	5.7

A generalized estimating equation (GEE) with an autoregressive covariance structure was used to analyze the data because of an intracorrelation between measurements. In this analysis, the dependent variables were successful tracheal intubation and time to intubation. The independent variable was the tracheal tube angulation (30° vs 60°). Statistical analysis was performed using the STATA software ver. 13.0 (StataCorp. College Station, TX, USA).

Results

The characteristics of the nurses who participated in simulated OTI are shown in Table 1. They were predominantly females with a mean age of 35.9 years (SD=5.4). The overall success rate of tracheal intubations was 94%. The results showed that the mean time to successful intubation (in seconds) was 10.99±18.80 for the 30° and 13.04±18.82 for the 60° tube bend angles. GEE analysis with controlling of the confounding effect of the participants' age and work experience showed that the mean time to successful intubation was statistically different with regard to the two stylet angles ($p<0.01$). The mean times and 95% confidence intervals are shown in Figure 2. Bonferoni analysis showed a statistically significant mean time improvement ($p<0.05$) with respect to the insertion times in both bend angles (Figure 3). However, the success rates showed no significant differences for the 30° and 60° bend angles.

Discussion

Compared with elective intubation in the operating room, providers in the emergency non-operating room setting have limited time for assessment and often must act quickly (24). Our study showed that the mean time to successful intubation was statistically shorter when a 30° bent stylet was used. Levitan et al. in his investigation on human cadavers found that the odds ratios of impossible tube passage for 35°, 45°, and 60° vs. 25° were 1.52, 5.32, and 48.72, respectively. They concluded that with bend angles greater than 35°, the long-axis dimension of the tube exceeded the diameter of the trachea, and the tip interacts with the tracheal rings at an extremely steep angle to advance. Some authors believe that the tip deflection of the stylet helps enhance the anterior movement of the distal tip underneath the epiglottis, maximizing the chance of it passing into the glottis and hence the trachea (16). However, the results of a study conducted by Hilton et al. (22) on manikins showed that ETTs loaded with a hockey stick (45° bend angle) did not affect the attempt time compared with no stylet use in a simulated difficult airway. Also, Kong et al. (25) reported no significant difference between conventional malleable stylets (30° bend) and GlieRite (70° bend) for direct laryngoscopy in a simulated difficult intubation.

In our study, the mean time to intubation with a 30° stylet bend by the nurses (10.99 seconds) was approximately similar to that reported in the Hilton et al. (22) study for anesthesiologists and emergency physicians (10.89 seconds). It was apparently faster than the time reported by Wahlen et al. (11) for the anesthesia nurses (28.8±12.6 seconds) conducting intubation in a simulated situation. It seems that the emergency response nurses would be able to promote their skills of tracheal intubations if the institutional policies provide the appropriate preparedness. We did note a significant decrease in the time to intubation with repeated attempts for both angles, the most

likely explanation of which is the practice effect. This is consistent with the results of the study conducted by Wahlen et al. (11).

Our study showed no difference in the success rates between the two bend angles (30° vs. 60°). The non-significant differences might have resulted from free exertion of the force by the person performing the intubation to pass the tubes forward regardless of any resistance against the intubation. Alternatively, the participants might have no concerns regarding injuring the airway by the styletted ETTs in the simulated situation. This is consistent with the results of the manikin-based studies conducted by Hilton et al. (22) and Kong et al. (25) comparing the outcomes of the tracheal intubation with and without the use of stylets. Our study showed a statistically significant improvement in the time to intubation when using a 30° stylet for tracheal intubation by emergency response nurses. However, this statistically significant difference in the average time to intubation does not necessarily imply clinical improvement. It is important to note that performing OTI with an appropriate bent ETT (loaded with a stylet) needs an aseptic angle-shaping device to obtain a precise angle. Therefore, further clinical investigation is required to transfer the finding in an actual setting.

Study limitations

There were some limitations to our study. We were unable to quantify previous tracheal intubation experiences of the participants. Also, this study did not address the participants' reports of the perceived resistance when passing the two different bend angles of the tracheal tubes. The simulation study may not represent the clinical practice because recreating the stressful working environment of a real resuscitation is impossible. However, there are several differences between humans and manikins, including the proportion of pharyngeal air space and tissue fidelity (26, 27).

Conclusion

Using the 30° stylet bend angle showed a statistically significant time improvement in simulated tracheal intubation by the emergency response nurses. There was no significant association between the intubation success rate and the stylet angle. Further studies are required to validate these findings in real settings.

Ethics Committee Approval: The ethical committee of the Arak University of Medical Sciences approved the study (No.1394.154) in September 2015.

Informed Consent: Written informed consent was obtained from nurses who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – R.M., H.J.; Design – R.M., F.G.; Supervision – F.G.; Resources – H.J.; Materials – R.M.; Data Collection and/or Processing – R.M., F.R.; Analysis and/or Interpretation – F.G., F.R.; Literature Search – R.M., H.J., F.G.; Writing Manuscript – F.G.; Critical Review – M.G., M.G.

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Conflict of Interest: The authors have no conflict of interest to declare.

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