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Original Article

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The Effect of Stretcher Level and Angle on Successful First-Pass Orotracheal Intubation

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Abstract

Aim: Careful and appropriate preparation is essential for a successful intubation. In order to increase the success rate of orotracheal intubation (OTI), it is very significant to position the patient appropriately before intubation. There is no standard approach about stretcher positions in the guidelines. In this study, we aimed to investigate the optimal stretcher height and angle for a successful intubation in first attempt.

Materials and Methods: The study was planned as randomized, controlled and prospective. In the study, 3 different stretcher levels pelvic (P), umbilical (U) and epigastric level and 2 different stretcher angle positions (head angle of 0° and head angle of 30°) were used. OTI success and duration, glottic view and number of attempts to intubate were noted by an independent observer.

Results: As a result, a total of 284 participants, 65.1% (n=185) paramedic and 34.9 % (n=99) medical students, participated in the study voluntarily. Of these, 57.4% (n=163) were women. Of the 284 intubation attempts, 88.7% (n=252) were successful and 11.3% (n=32) were unsuccessful. The groups were examined in terms of intubation success. The most successful group was the U30° group with 96.1%; followed by P30° (94.2%), U0° (90.9%) and P0° (89.6%), respectively (p=0.002).

Conclusion: Checking different stretcher levels and stretcher head positions to establish optimum standards in intubation increases the success of first entry in OTI. This will also reduce OTI complications. Studies on this subject can contribute to updates in OTI standardizations.

Keywords: Stretcher, angle, level, successful, intubation, orotracheal

Introduction

Orotracheal intubation (OTI) is a very common method used in in-hospital and out-of-hospital arrests, emergency departments, and operating rooms to provide airway and respiratory care. Careful and appropriate preparation is essential for successful intubation. To increase the success rate of OTI, it is important to position the patient appropriately before intubation (1,2). During the preparation phase, it is recommended to elevate the patient to the operator's xiphoid level (3). Optimal patient positioning plays a critical role in the success of intubation. The primary goal of laryngoscopy is to align the pharyngeal and laryngeal axes, thereby providing an unobstructed direct view of the glottis and facilitating the passage of the endotracheal tube through the vocal cords. Almost all airway management guidelines recommend the sniffing position or jaw thrust (for trauma patients) to achieve a direct view of the glottis. Elevating the head to an optimal height and ensuring that it is sufficiently raised without obstructing blade insertion enhances the laryngeal view and minimizes the need for repositioning during intubation. Although there are many studies about positioning the patient properly, there are not enough studies on the effect of the angle and height of the stretcher on intubation success. A study by Lee BJ et al. (4) reported that 25° of elevation of the head of the stretcher provides a superior laryngeal view of the patient compared with the non-elevated stretcher (patient laying in supine position). In cases where the patient cannot be placed in the supine position (obesity, scoliosis, mass, ankylosing spondylitis, etc.), it may be necessary to secure the airway by changing the angle of the stretcher (5). The position of the patient during OTI may affect both the available oxygen volume of the patient (6,7) and the time required for intubation (4,8), thereby increasing the risk of hypoxemia and decreasing the intubation success rate. Although many studies have investigated optimal positioning of

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the head of the patient during rapid intubation, the uncertainty of the optimal stretcher height and angle remains (9,10). In this study, we aimed to investigate the optimal stretcher height and angle for successful intubation in the first attempt.

Materials and Methods

Study Design, Setting and Participants

Approval for this study was obtained from the Ethics Committee of Istanbul Medipol University (decision number: E-10840098-772.02-6120, date: 30.11.2021). The study was planned to be randomized, controlled, and prospective. The subjects included in the study were students of Istanbul Medipol University Faculty of Medicine (6th grade) and First and Emergency Aid (Paramedics 2nd grade) who wanted to be involved in the study voluntarily. Students who had experienced OTI or previous OTI lessons were not included in this study. Individuals who declined to participate in the study and those exhibiting anatomical incompatibilities that prevented appropriate adjustment of the stretcher height and angle (such as individuals with insufficient or excessive body length relative to the stretcher) were excluded from the study. An informed voluntary consent form was obtained from those who wanted to be included in the study. One hour of theoretical and practical OTI training was given to participants included in the study. The training was provided to the participants by an instructor who is an active educator in medical education and has 5 years of experience in the emergency department. The instructor used the Tintinalli's Emergency Medicine A Comprehensive Study as the training resource (3). In the study, 3 different stretcher levels [pelvic (P), umbilical (U) and epigastric (E) level] and 2 different stretcher angle positions (head angle of 0° and head angle of 30°) were used (Figure 1,2).

The Determination of P, U and E Levels Involves the Identification of Specific Anatomical Landmarks

E Level: The E region is centered above the umbilicus and below the costal margins, approximately over the xiphoid process.

U Level: This corresponds to the midpoint of the U region, which is aligned with the umbilicus and the approximate midpoint of the abdomen.

P Level: This is centered in the hypogastric (or pubic) region, located below the U region, near the pubic symphysis, and in line with the intertubercular line.

These levels provide standardized reference points for clinical and anatomical studies (11).

The Stretcher Angle is Determined

The stretcher angle is determined by measuring the inclination of the stretcher relative to the horizontal plane.

This Was Achieved Using the Following Steps

Initial Positioning: The stretcher was placed on a flat surface to provide an accurate reference point.

Angle Adjustment: The backrest or surface of the stretcher was adjusted to the desired angle. The stretcher angle was set to 30°, which is also recommended for preoxygenation (4).

Measuring Tool: A protractor with a built-in angle measurement function was used to measure the angle between the inclined surface of the stretcher and the horizontal plane.

Recording the Angle: The exact angle was noted in degrees for documentation and use in clinical or study protocols.

Data Collection and Management

The stretcher levels and stretcher head positions determined for randomization were written on papers by a secretary who was not aware of the study and were placed in sealed envelopes. Two closed boxes were prepared, and the stretcher levels and the stretcher head angle positions were placed by the secretary. Each subject included in the study randomly selected two envelopes from two separate boxes for the stretcher level and head position. The stretcher level and head position were adjusted by an independent personnel. The Muka LC-5100 stretcher and Laerdal

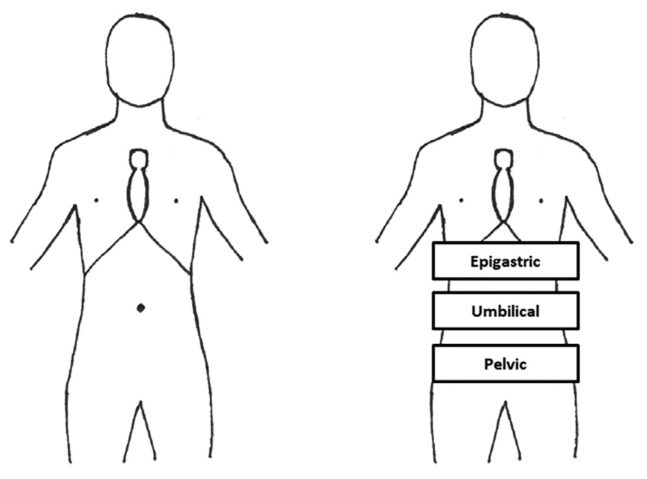

Figure 1. Body anatomy and stretcher levels

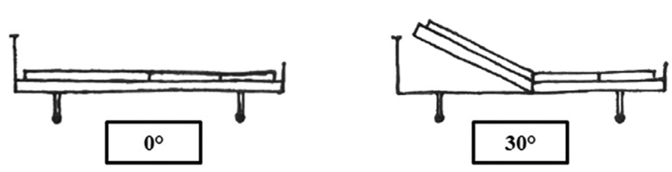

Figure 2. Stretcher angle positions

Megacode Kelly (Laerdal Nursing Adult Full Body CPR Intubation Airway Management Manikin) model were used in this study. Each participant attempted OTI on the manikin, and OTI success was evaluated by tracheal opening of the anterior neck of the manikin. The success and duration of OTI, glottic view, and number of attempts to intubate were noted by an independent observer.

First and Emergency Aid (Paramedic) Students

Paramedics are health personnel who are able to provide basic and advanced life support based on current medical guidelines in the prehospital emergency health system; able to take the medical history of the sick/injured person with appropriate communication skills; able to recognize all kinds of system trauma; and able to transfer the sick/injured person safely by ambulance to target hospitals. The educational period in Türkiye is two years.

Medical Faculty Students

Medical faculty students in Türkiye take emergency medicine lessons during their fifth year (theory and practice). Final year students (6th grade) only take a practical emergency medicine internship for 2 months. The aim of the emergency medicine internship program is to train physicians who can provide differential diagnosis, emergency interventions, and necessary treatments and prevent and monitor diseases defined within the scope of the national core education program (NCEP) in primary care and emergency services at the levels specified in the NCEP.

Cormack-Lehane Classification

It is very useful to anticipate patients who will be difficult to intubate, but preoperative testing is not sufficient to identify most cases. In 1984, Cormack RS and Lehane J (12) described a four-grade scoring system for laryngeal appearance using direct laryngoscopy to predict difficult intubation. This scoring system is widely used in clinical trials and clinical practice to aid the subsequent management of patients who are intubated with difficulty (13).

Statistical Analysis

The descriptive statistics were presented in Mean±SD for the quantitative variables and as frequencies and percentages for the categorical variables. The frequencies of categorical variables were compared using Pearson's chi-square and Fisher's exact test as appropriate. Groups were formed according to the stretcher position and head angle. In the comparison of these 6 groups, 2x2 tables were obtained by the select case process. Since the minimum expected count values of the cells were appropriate (less than 25% of them were less than 5), the p value of the Pearson's chi-square test was used. A total of 15 subgroup analyses were conducted for 6 groups. To prevent type 1 error, Bonferroni's correction was used, and a p value <0.0033 was considered statistically significant in the subgroup analysis. Outliers were analyzed using the box-plot test. Shapiro-Wilk tests and Q-Q plot tests were used to evaluate normality. The homogeneity of variances was analyzed using Levene's test. After evaluating these prerequisites, Welch ANOVA and Games-Howell post-hoc tests were applied to compare the intubation times among the groups. All the analyses were 2-sided with an alpha of 0.05 (except subgroup analyses with Bonferroni's correction) and were performed using SPSS statistical software (IBM SPSS Statistics for Windows, version 26.0. Armonk, NY: IBM Corp.).

Results

The stretcher level could not be adapted to some participants (53 people, especially at the E level, where the stretcher level could not be raised in accordance with the practitioner's height). As a result, a total of 284 participants, 65.1% (n=185) paramedic and 34.9 % (n=99) medical students, participated in the study voluntarily. Of these, 57.4% (n=163) were women. Intubation success was analyzed according to the gender of the participants, type of education, stretcher height, and head angle on 6 different subgroups. There was no difference between intubation success and failure according to sex and education type ($p>0.05$ for both) Table 1.

Of the 284 intubation attempts, 88.7% (n=252) were successful and 11.3% (n=32) were unsuccessful. Six different groups were formed by adjusting the stretchers at 3 levels as P, U, and E and two different stretcher head angles (0° and 30°) for each stretching level. The groups were examined in terms of intubation success. The most successful group was the U30° group (96.1%; followed by the P30° (94.2%), U0° (90.9%), and P0° (89.6%) groups, respectively. The E0° (83.3%) and E30° (73.8%) groups were found to be more unsuccessful than the other groups. The mean number of trials was determined as 2.3±1.30 in total. The U30° group had the least attempts with 1.9±1.02, followed by the E30° group with 2.0±1.06. At the E level, more interventions were required in both head positions (0° and 30°) than at other levels (2.7±1.41 and 3.3±1.57, respectively). The mean time to successful intubation attempts was 29.4±21.1 seconds. The longest intubation duration occurred at the E level group (34.9±22.4 seconds for E0° and 43.6±26.4 seconds for E30°). Participants were asked to evaluate their effort by scoring between 1 and 10, with the mean effort was found to be 4.8±2.9. It was determined that the participants expended more effort at the E level compared to the other positions (5.8±2.8 for E0°, 7.1±2.9 for E30°). In total, 42 (14.8%) patients used the external laryngeal maneuver (ELM) while intubating. The number of participants in each group, Cormack-Lehane classification, intubation success, number of attempts, time, effort, and need for ELM, all variables according to the groups are shown in Table 1.

A statistically significant difference was found between the intubation success of the 6 groups formed according to the stretcher position and the stretcher head angle (p=0.010). To identify which groups/groups caused the difference, subgroup analysis was performed by comparing the groups one by one. Accordingly, there was a significant difference between the U30° group, which had the highest success rate of 96.1%, and the E30° group. p=0.002; a total of 15 subgroup analyses were performed among 6 groups. For these results, p value <0.0033 was considered statistically significant (Bonferroni correction); there was no significant difference between the U30° group and the other groups (p>0.0033 for all). The second group, the P30° group, was the second most successful group (94.2%, but there was no significant difference between the other groups (p>0.0033 for all). The results of the analysis of variables and subgroup analyses according to intubation success are presented in Table 2.

Subgroups were also compared according to intubation time (unsuccessful attempts were excluded in this analysis). There was a significant difference between the U30° group, which had the shortest intubation time period, and the E0° and E30° groups (p=0.046, <0.001, respectively). The P30° and U0° groups also showed significantly faster values than the E30° group (p=0.003, p=0.006; respectively). No significant difference was found in the other subgroup comparisons in terms of intubation time (p>0.05 for all) (Table 3).

Discussion

The effectiveness of stretcher level and angle during OTI application was investigated. The participants were recruited from a population of particularly inexperienced practitioners. Therefore, the effect of experience on the success rate in the first attempt during the OTI application was removed. First-pass success in performing OTI in the emergency department has been associated with reduced intubation-related complications (14). In fact, international guidelines emphasize the importance of advanced airway management in out-of-hospital cardiac arrests and emphasize the effects of the number of intubation attempts on poor neurological outcomes (15). In this regard, although studies can be found widely in the literature to better visualize the glottic angle during OTI, no study has been conducted on the stretcher angle and height. There is no standard approach to stretcher positions in the guidelines. There have been studies on the ramp and sniffing positions in previous publications (16,17). Studies have also been conducted on intubation in the lateral position (18). This study is the first to investigate the relationship between different stretcher levels and angles and successful OTI attempts.

The primary outcome of the study was OTI success. The most successful stretcher levels were determined as U30° and P30°. In this study, we found that the OTI application at the U30° stretcher level was the most successful. There was a statistically significant difference between U30° and E30°. However, no significant differences were observed between the other groups. We believe that the lower success rate at the E level is due to less laryngeal vision and more effort.

Table 1. Classification of results according to stretcher position and stretcher head angle

Position	Total, n (%)	Pelvic		Umbilical		Epigastric	
Head-angle		0°	30°	0°	30°	0°	30°
Number of participants	284	48 (16.9)	52 (18.3)	55 (19.4)	51 (18.0)	36 (12.7)	42 (14.8)
C-L classification, n (%)							
1	159 (56.0)	29 (18.2)	33 (20.8)	35 (22.0)	38 (23.9)	15 (9.4)	9 (5.7)
2	96 (33.8)	15 (15.6)	17 (17.7)	16 (16.7)	12 (12.5)	16 (16.7)	20 (20.8)
3	27 (9.5)	3 (11.1)	2 (7.4)	3 (11.1)	1 (3.7)	5 (18.5)	13 (48.1)
4	2 (0.7)	1 (50.0)	0	1 (50.0)	0	0	0
Successful intubation rate (%)	252 (88.7)	43 (89.6)	49 (94.2)	50 (90.9)	49 (96.1)	30 (83.3)	31 (73.8)
Failed attempt, n (%)	32 (11.3)	5 (10.4)	3 (5.8)	5 (9.1)	2 (3.9)	6 (16.7)	11 (26.2)
Number of attempts, Mean±SD	2.3±1.30	2.1±1.13	2.0±1.06	2.1±1.17	1.9±1.02	2.7±1.41	3.3±1.57
Time, sec.* Mean±SD	29.4±21.1	30.5±24.4	26.1±18.1	27.1±17.7	21.3±13.9	34.9±22.4	43.6±26.4
Effort, 1-10 points, Mean±SD	4.8±2.9	5.1±2.7	4.1±2.5	4.5±2.9	3.1±2.3	5.8±2.8	7.1±2.9
Need for ELM, n (%)	42 (14.8)	5 (11.9)	6 (14.3)	8 (19.0)	5 (11.9)	6(14.3)	12 (28.6)

C-L: Cormack-Lehane curve, SD: Standard deviation, sec: Seconds, ELM: External laryngeal maneuver, *Failed attempts were excluded from the time assessment

We predicted that providing the appropriate angle to the stretcher head would increase the visualization of the glottic angle without requiring the practitioner's physical posture, thus increasing the success of the first OTI entry. In this context, we found that the laryngeal visual angle (Cormack-Lehane classification) was better with U30° than U0°; we also found that P30° provided better laryngeal vision than P0°. With this result, the angulation of the stretcher showed that better laryngeal viewing angle was provided compared to the 0° position of the stretcher, which supports the suggestion of Lee BJ et al. (4) Lee HC et al. (19), on the other hand, did not find any difference in laryngeal view in their study with different stretcher levels in the supine position, and this was not compatible with our study.

The participants exerted greater effort in the E30° and E0° positions. This was attributed to the necessity of applying significant muscle strength to elevate the shoulders and arms to a higher level, as well as the challenges encountered during intubation due to the reduced laryngeal view angle. The prolonged elevation of the shoulders and arms during intubation may also contribute to physiological fatigue. Additionally, the weight of the laryngoscope was thought to be a contributing factor. Lee HC et al. (19) reported that OTI was less painful at a high stretcher level. This situation partially contradicts our study. When we go up from the P level to the U level, the amount of effort spent decreases, but the level of effort increases at the E level.

Semler MW et al. (16) reported that the ramp position during OTI caused a higher number of attempts it contradicts our study. Except for the E level, a 30° angle was found to provide a smaller number of attempts compared with a 0° angle of the stretcher head.

Semler MW et al. (16) reported that the ramped position during OTI resulted in a higher number of attempts, which contradicts the findings of our study. In our study, except at the E level, a 30° angle reduced the number of attempts compared with a 0° angle of the stretcher head.

Table 2. Analysis of variables associated with intubation success

Variables	Succeeded	Failed	p value
Gender			
Female	144 (88.3)	19 (11.7)	0.810*
Male	108 (89.3)	13 (10.7)	
Education type			
Paramedic student	163 (88.1)	22 (11.9)	0.649*
Medical student	89 (88.9)	10 (10.1)	
Position-angle$^{\alpha}$			
Pelvic-0º	$43_{a, b}$ (89.6)	$5_{a, b}$ (10.4)	**0.010***
Pelvic-30º	$49_{a, b}$ (94.2)	$3_{a, b}$ (5.8)	
Umbilical-0º	$50_{a, b}$ (90.9)	$5_{a, b}$ (9.1)	
Umbilical-30º	49_{b} (96.1)	2_{b} (3.9)	
Epigastric-0º	$30_{a, b}$ (83.3)	$6_{a, b}$ (16.7)	
Epigastric-30º	31_{a} (73.8)	11_{a} (26.2)	
Subgroup analysis$^{\beta}$			
Pelvic-0º-Pelvic-30º			0.475**
Pelvic-0º-Umbilical-0º			1.000**
Pelvic-0º-Umbilical-30º			0.259**
Pelvic-0º-Epigastric-0º			0.517**
Pelvic-0º-Epigastric-30º			0.051*
Pelvic-30º-Umbilical-0º			0.717**
Pelvic-30º-Umbilical-30º			1.000**
Pelvic-30º-Epigastric-0º			0.151**
Pelvic-30º-Epigastric-30º			0.006*
Umbilical-0º-Umbilical-30º			0.440**
Umbilical-0º-Epigastric-0º			0.333**
Umbilical-0º-Epigastric-30º			0.025*
Umbilical-30º-Epigastric-0º			0.061**
Umbilical-30º-Epigastric-30º			**0.002***
Epigastric-0º-Epigastric-30º			0.310**

$^{\alpha}$Each subscript letter denotes a subset of position-angle categories whose column proportions do not significantly differ from each other at the p<0.05 level. $_{b}$Subgroup analysis was calculated by obtaining 2x2 tables by case selection process. A total of 15 subgroup analyses were performed among 6 groups. A p value <0.0033 was considered statistically significant for these results (Bonferroni's correction). *Pearson chi-square test, **Fisher's exact test

Table 3. Comparison of the subgroups in terms of intubation time

Subgroups	Mean difference (seconds)	p value**
Pelvic-0º-Pelvic-30º	4.41	0.930
Pelvic-0º-Umbilical-0º	3.29	0.970
Pelvic-0º-Umbilical-30º	9.18	0.255
Pelvic-0º-Epigastric-0º	-4.42	0.942
Pelvic-0º-Epigastric-30º	-13.10	0.070
Pelvic-30º-Umbilical-0º	-1.12	1.000
Pelvic-30º-Umbilical-30º	4.78	0.852
Pelvic-30º-Epigastric-0º	-8.83	0.416
Pelvic-30º-Epigastric-30º	-17.51	**0.003**
Umbilical-0º-Umbilical-30º	5.89	0.697
Umbilical-0º-Epigastric-0º	-7.71	0.566
Umbilical-0º-Epigastric-30º	-16.39	**0.006**
Umbilical-30º-Epigastric-0º	-13.61	**0.046**
Umbilical-30º-Epigastric-30º	-22.29	**<0.001**
Epigastric-0º-Epigastric-30º	-8.68	0.550

*Failed attempts were excluded from the time assessment, **ANOVA (Fisher) and Tukey's post-hoc test. The mean difference was significant at the p<0.05 level

The management of trauma patients should be conducted with careful consideration of possible spinal cord injury. Until proven otherwise, the continuous use of spinal boards and cervical collars is essential to ensure spinal cord stability. Although the findings of our study conflict with those of Semler, it must be noted that adjusting the stretcher angle may not be suitable for patients with suspected spinal trauma. The effect of 30° stretcher angle on spinal cord loading and spinal stability should be investigated in future studies.

If it is determined that the stretcher angle has no negative impact on the spinal cord, then the stretcher height and angle, as suggested by our findings, can be utilized to achieve optimal positioning for successful intubation in trauma patients.

Study Limitations

The recommendations of this study for trauma patients, especially those with spinal injury (especially at the P level), can be evaluated within the scope of limitations. In addition, information on OTI complications was not available because everything was performed on a manikin.

In clinical practice, the variability in intubation difficulty among patients (as assessed by the Mallampati classification, Cormack-Lehane classification, and the LEMON method) suggests that the findings of our study may yield different results when applied to real patient populations. However, the use of a single-type mannequin to ensure standardization in the study eliminated the potential negative effects of variations in anatomical structures.

Therefore, the criterion for evaluating the success of OTI was the number of attempts and first-pass success.

Current Knowledge

The stretcher should be raised to the xiphoid level of the surgeon performing the intubation. Although intubation and ventilation are traditionally performed with the patient in the supine position, aligning the external ear with the sternal notch may also help visualize the glottic.

The Contributions of This Paper

For successful first-pass intubation, the best results were achieved when the stretcher was placed at the level of the umbilicus and the stretcher angle was set to 30°.

Conclusion

Checking different stretcher levels and stretcher head positions to establish optimum standards for intubation can increase the success rate of the first entry in OTI. This will also reduce OTI complications. We recommend that these studies be included in updates to OTI standardizations and include direct recommendations for integrating this technology into clinical guidelines or training programs.

Ethics

Ethics Committee Approval: Approval for this study was obtained from the Ethics Committee of Istanbul Medipol University (decision number: E-10840098-772.02-6120, date: 30.11.2021).

Informed Consent: An informed voluntary consent form was obtained from those who wanted to be included in the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.Ş., Concept: M.Ş., B.G., Design: M.Ş., H.İ.Ç., B.G., Data Collection or Processing: M.Ş., H.İ.Ç., G.E.Y., Analysis or Interpretation: S.B., B.G., Literature Search: M.Ş., Writing: M.Ş.

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

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