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ORIGINAL RESEARCH

Video Laryngoscopy for Endotracheal Intubation: A Consideration for Manual In-Line Stabilization Without Cervical Collar Versus Full Immobilization

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Introduction: Traumatic patients with cervical spine motion restriction have difficulty with endotracheal intubation (ETI) due to the limitations of neck movement and mouth opening. Nevertheless, the removal of the cervical collar for ETI in a prehospital setting may lead to a deterioration in neurological outcomes. This study compares the success rate of ETI utilizing a video laryngoscope (VL) on a manikin, contrasting manual in-line stabilization (MILS) without a cervical hard collar against full immobilization.

Methods: A randomized, non-crossover study was conducted involving 56 paramedic students assigned by SNOSE to utilize various box sizes for VL intubation with MILS without a cervical hard collar or full immobilization technique on a manikin. The primary outcome was the intubation success rate. Secondary outcomes included attempts, time for successful intubation, and Cormack-Lehane classification.

Results: Fifty-six participants were evaluated; 28 were in the full immobilization group, and another 28 were in the MILS without cervical hard collar group. Baseline characteristics showed no difference between both groups. The success rate of VL intubation showed no difference between the full immobilization group and the MILS without a cervical hard collar group (28 [100%] vs 28 [100%]; 24 [85.71%] vs 27 [96.43%] on first attempt; 4 [14.29%] vs 1 [3.57%] on second attempt; p-value 0.352). Time required to perform successful intubation (median [IQR] 17.20 [12.53, 24.40] vs 17.53 [14.06, 23.73], p-value 0.694) and Cormack-Lehane classification (11 [39.29%] vs 10 [35.71%] in grade I; 16 [57.14%] vs 17 [60.71%] in grade II; 1 [3.57%] vs 1 [3.57%] in grade III, p-value 1.000) showed no statistical difference between the two groups.

Conclusion: It is unnecessary to remove the cervical hard collar when performing endotracheal intubation while using a video laryngoscope.

Keywords: video laryngoscope, full immobilization, success rate, endotracheal intubation

Introduction

Time is considered an essential deciding factor in the initial management of the trauma patient, according to an increase in pre-hospital time, including on-scene time and transport time associated with the worst outcomes.[1,2] National Model EMS Clinical Guidelines recommend minimizing scene time (goal is under 10 minutes) to do a rapid primary assessment and management of life-threatening injury without delay and transport patients to the appropriate level of trauma care.[3]

Traumatic spinal injury (TSI) is a major source of global mortality and disability. It is estimated that there are between 768,473 and 790,695 annually, and the incidence was higher in men.[4,5] Pre-hospital management, there are clinical guidelines for spinal stabilization in all patients with the possibility of a spinal cord injury.[6,7] In general, place patients in

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cervical collars and on long backboards (LBBs) combined with lateral head blocks and straps to achieve adequate spinal immobilization to prevent secondary spinal cord injury during extrication, transport, and evaluation by minimizing movement.[8]

Hypoxia is a reversible cause of cardiac arrest, and respiratory failure was the most common severe complication among polytraumatized elderly.[9,10] Pre-hospital providers should provide proper airway management to patients. Endotracheal intubation (ETI) is a standard for definitive airway in the pre-hospital setting. ETI can be performed under the following indications: failure to maintain a patent airway, inability to oxygenate and ventilate the patient adequately, and anticipating the clinical cause.[11] Emergency airway management continues to be a challenging task for pre-hospital care providers because trauma can be predicted to have a difficult airway due to both anatomy and physiology.[12] Common situations such as the application of cervical collar/improper MILS limit mouth opening and are related to worsened glottic visualization obtained with direct laryngoscope and led to failed intubation.[13] In addition, environmental and human factors include teamwork and individual intubation skills.

Video laryngoscope is an alternative intubation device for difficult airway management and is widely used in various settings. Many studies show video laryngoscope can improve glottic visualization, increase the intubation success rate, and make time to endotracheal insertion shorter compared with direct laryngoscope in patients with MILS.[14–17] Currently, practice recommendations for ETI team should consist of four trained providers at least according to composition and role.[18] ETI should be performed while the second provider MILS of the patient's head and neck without a cervical hard collar. This technique could increase the intubation success rate.[13]

ETI on the field seems unsuitable because of environmental restrictions and prolonged scene time. However, due to the limitations of ambulance team members, removing a cervical hard collar for ETI after full immobilization during transport may not be appropriate. This study aims to compare the intubation success rate obtained with video laryngoscope in manikin simulated with different immobilization techniques between MILS without cervical collar versus full immobilization.

Method

Study Design and Setting

This study was a randomized, non-crossover experimental study to compare the success rate of endotracheal intubation using VL in a mannikin between MILS without a cervical hard collar and full immobilization techniques. The study was conducted at Ramathibodi Hospital, Mahidol University, on September 21, 2021. This study was advised by attending staff (emergency physicians) certified in resuscitative procedure courses and prehospital trauma life support (PHTLS) provider courses in the Medical Emergency Department, Faculty of Medicine, Ramathibodi Hospital, Mahidol University. The inclusion criteria were pre-clinical (3rd year) and clinical (4th year) paramedic students who signed their consent and received intubation training: 15 minutes of theoretical VL intubation training demonstration video and 45 minutes of practice for both VL intubation procedures on a full-body manikin (the same model used in the study). If the equipment was damaged, the participant could not continue the study, or the participant's research data were incomplete, it was excluded.

The researchers who are not involved in the direct supervision of paramedic students provide information about the research project, declare no conflict of interest, ensure voluntary participation and maintain confidentiality for research participants. Once the participants consented and signed the form, they were instructed to view the video of VL intubation and practice accordingly. Subsequently, we used computer-generated random blocks of varying sizes (blocks of 4 and 6) for randomization (reference; https://sealedenvelope.com) and stratified randomization matched 3rd and 4th-year paramedic students to these two VL intubation procedures using sequentially numbered opaque sealed envelopes, ensuring allocation concealment (SNOSE). Research intubation procedures among different cervical spine motion restriction techniques were allocated to MILS without a cervical hard collar group and full immobilization group. The study flowchart is depicted in Figure 1.

The simulation area is divided into two rooms with the same intubation equipment and a full-body manikin (Resusci Anne Advanced SkillTrainer, Laerdal Medical AS), including real-time feedback for breathing and ventilation

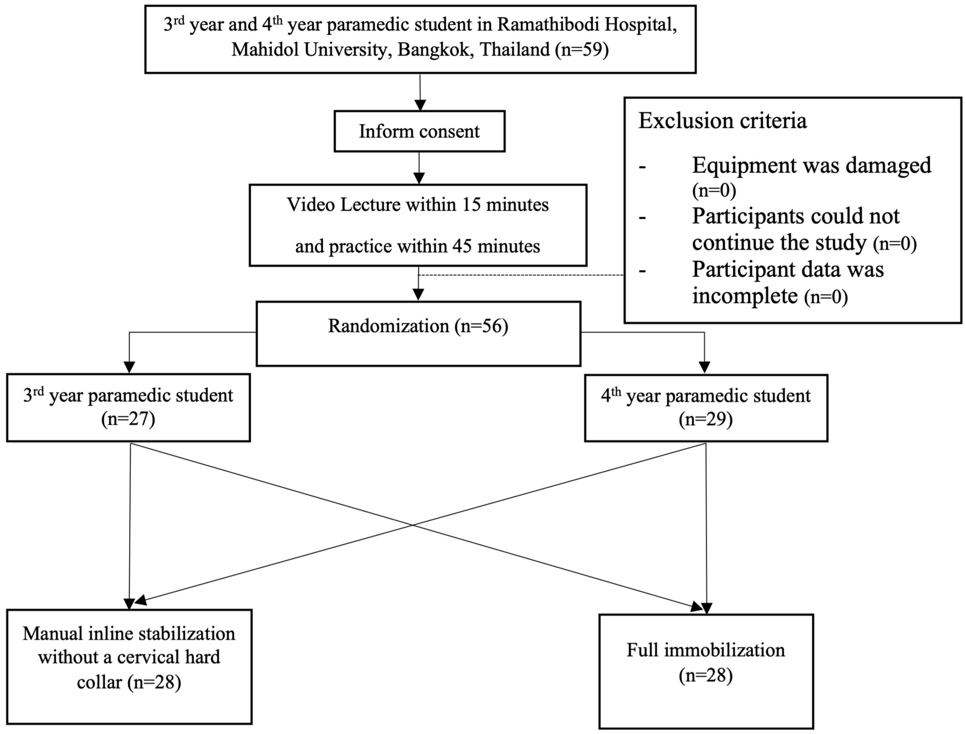

Figure 1 Study flowchart.

assessment: Room 1, the full-body manikin with restricted neck movement using manual in-line without a cervical hard collar, and Room 2, The manikin with restricted spinal movement using full immobilization including a cervical hard collar, head blocks, head straps, long spinal board, and immobilization strap as Figure 2. Both rooms have the same equipment, including intubation devices (endotracheal tube No. 7.5, stylet size M, KY-jelly, and a 10 mL syringe) and a portable video laryngoscope with a normal angulation blade No. 3; HugeMed VL3R (3.5-inch LCD display with built-in battery VL) throughout the study. The equipment was tested for readiness before each intubation procedure, and the manikin was fixed in its original location and position.

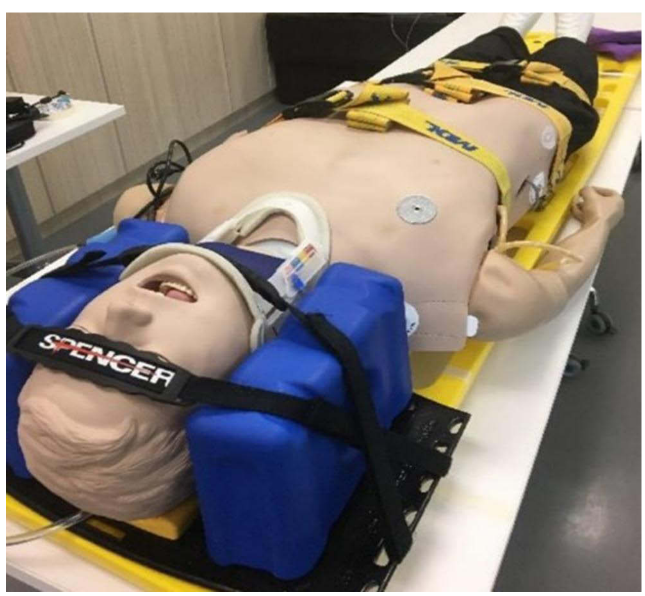

Figure 2 Full immobilization technique.

This study was approved by the Faculty of Medicine, Committee on Human Rights Related to Research Involving Human Subjects, at Mahidol University's Ramathibodi Hospital (IRB COA. MURA2021/723).

Data Gathering and Outcome Measure

Participants' baseline characteristics were gender, age, weight, height, study year, successful intubation, time to successful intubation, attempts of successful intubation, and Cormack-Lehane classification of laryngeal view using a predesigned checklist. Successful intubation is defined as the position of the end of the tracheal tube in the tracheal position of the manikin. Chest expansion was observed, and the lung sound was heard when assisted breathing. This requires not more than three intubation attempts to succeed. The duration of intubation is not to exceed 120 seconds for successful intubation. Time to successful intubation is defined as the time from when the tip of the video laryngoscope passes through the plane of the anterior teeth until the end of the tracheal tube can be inserted into the tracheal position of the manikin, which is confirmed by adequate ventilation volume in real-time feedback monitoring system.

Study Size Estimation

For sample size estimation, data from a pilot study of 20 paramedic students were used. The pilot showed a 100% success rate for MILS and 95% for full immobilization, with mean intubation times of 17 and 20 seconds, respectively (SD ± 3). Using a 95% confidence interval, 80% power, a two-sided test ($p = 0.05$), and a 1:1 sample size ratio, the minimum required sample size was calculated to be 56 participants (28 per group).

Statistical Analysis

The categorical data was analyzed using the Chi-square formula and Fisher's exact tests, and the results were shown as frequency and percentage. Continuous data was analyzed using independent *t*-tests and rank-sum tests and displayed as the mean and standard deviation for normally distributed data. Moreover, the data with non-normal distribution is expressed in the median, followed by the 25th percentile and 75th percentile values (interquartile range; IQR). Statistical data analysis using the Stata version 17.0 program (StataCorp, College Station, TX, USA) determined that p-value <0.05 was statistically significant.

Results

Fifty-six participants were evaluated: 28 in the full immobilization group and 28 in the MILS without a cervical hard collar group. Baseline characteristics of participants including age, gender, weight, height, and study year (intubation experience) shown in the following table (Table 1). There were no statistically significant differences between groups.

Percentage of successful intubation was no statistically significant differences between full immobilization groups and MILS without a cervical collar (28 [100%] vs 28 [100%]). Moreover, time to successful intubation, number of attempts, Cormack-Lehane classification of laryngeal view and time to first attempt successful intubation were not different significantly between two groups (Table 2).

Discussion

This prospective randomized non-crossover study in manikin found no significant differences between the groups regarding intubation success rate. Although the cervical rigid collar should be removed due to the shorter intubation time, this study proved that when novice paramedics used video laryngoscope and performed ETI in full immobilization, the time to successful intubation was short as well and just only one to two attempts for successful intubation. Moreover, most laryngeal views were graded I/II, and few were graded III.

The XABCs are exsanguination, airway, breathing, and circulation arranged by severity related to mortality and morbidity. Pre-hospital providers should focus on these four top priorities in all trauma patients. Life-threatening injuries should be stabilized first. Out-of-hospital ETI focuses on ensuring airway protection and maintaining airway patency. In addition to critical airway compromise, the necessity for ventilation, oxygenation failure and the decreasing level of consciousness are common reasons for endotracheal intubation (ETI) in traumatic patients.[19,20] Formerly, a Glasgow Coma Scale score (GCS) of 8 or less indicates a need for ETI. A recent study revealed that some patients with a GCS of 8

Table 1 Baseline Characteristics of Participants

Variables	Intubation Groups		P-values
	Full Immobilization (n = 28)	MILS Without Cervical Hard Collar (n = 28)	
Age			
Mean ± SD	23.04±4.72	21.61±2.64	0.168
Gender, N (%)			
Male	10 (35.71)	9 (32.14)	1.000
Female	18 (64.29)	19 (67.86)	
Weight (kg)			
Mean ± SD	61.84±14.83	60.75±13.24	0.774
Height (m)			
Mean ± SD	164.82±8.95	164.14±8.72	0.775
Study year, N (%) (Intubation experience)			
Pre-clinical year Paramedic student	14 (50.00)	13 (46.43)	1.000
Clinical year paramedic student	14 (50.00)	15 (53.57)	

Abbreviations: MILS, manual in-line stabilization; SD, standard deviation.

Table 2 Comparing the Intubation Characteristics Between Groups

Variables	Intubation Groups		P-values
	Full Immobilization (n = 28)	MILS Without Cervical Hard Collar (n = 28)	
Successful intubation, N (%)	28 (100)	28 (100)	N/A
Time to successful intubation (seconds)			
Median (IQR)	17.20 (12.53, 24.40)	17.53 (14.06, 23.73)	0.694
Attempts of successful intubations, N (%)			
1	24 (85.71)	27 (96.43)	
2	4 (14.29)	1 (3.57)	0.352
3	0	0	
≥ 4 (failed intubation)	0	0	
Laryngeal view grade*, N (%)			
Grade I	11 (39.29)	10 (35.71)	
Grade II	16 (57.14)	17 (60.71)	1.000
Grade III	1 (3.57)	1 (3.57)	
Grade IV	0	0	
Time to first attempt successful intubation (seconds)			
Median (IQR)	17.20 (12.41, 23.87)	17.50 (14.05, 23.87)	0.559

Notes: *Cormack-Lehane classification.

or less have intact airway reflexes and may be capable of maintaining their airways, while many patients with a GCS of more than 8 have impaired airways.[21] Thus, decision-making for intubation cannot depend on GCS alone and should consider the individual circumstance in risk of aspiration.[2,22]

Many studies compare the intubation success rate between a video laryngoscope and a conventional or direct laryngoscope in various clinical scenarios and settings. When video laryngoscope use has been demonstrated in patients

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associated with a higher success rate, few attempts for intubation and reduced time to intubation.[23–25] In trauma patients who need cervical motion restriction and need to be intubated emergently, a video laryngoscope had a significantly higher success rate than a direct laryngoscope. Many studies suggest that a video laryngoscope is superior to a direct laryngoscope in this circumstance.[14–17,26] Additionally, video laryngoscope improved visualization of the glottis according to the Cormack- Lehane grading system when compared with ETI by direct laryngoscope in many settings, including prehospital care, which requires quick decision-making, successful intubation for the first time, and the lowest ETI complications, especially hypoxia and esophageal intubation.[11,27–30]

The study by Tienpratarn W. et al[13] a comparative study aims to estimate the success rate between MILS and MILS with cervical collar while using direct laryngoscope for ETI performed by senior paramedic students, showed that it seems to be a higher successful intubation in MILS alone compared to MILS with cervical hard collar (96.80% vs 88.75%; p-value 0.048), respectively. Time to successful intubation was shorter in the MILS group, but there were no significant differences between the groups. According to our study, the rate of successful intubation using a video laryngoscope between MILS and mechanical immobilization or full immobilization was no significant difference between the groups.

For trauma patients with cervical motion restriction who need ETI in the ambulance with limited personnel and space, pre-hospital care providers, including emergency physicians and paramedics, can use a portable video laryngoscope with a normal angulation blade to ETI without removing a cervical hard collar after full immobilization during transport to the trauma center or definitive care.

There are some limitations to this study. First, the overall outcomes in this experimental study on manikin may not apply to real clinical situations. We will use the data in this study for the next further research. Second, individual novice paramedic practice influences inadequate VL with standard angulation blade placement at the correct position, which may make the glottic view difficult to interpret. Deterioration of the equipment, such as an endotracheal tube and stylet, might have caused bias and confounded our study results. Last, the research participants were all paramedic students. Their experience with ETI may differ from that of qualified paramedics, emergency physicians or anesthesiologists.

Conclusion

High intubation success rate (first-pass success rate) when performing ETI by using video laryngoscope between both cervical spine immobilization techniques. Removing the cervical hard collar when performing ETI while using a video laryngoscope is unnecessary.

Disclosure

The authors report no conflicts of interest in this work.

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