Archives of Anesthesiology and Critical Care (Autumn 2020); 6(4): 167-174.

Available online at http://aacc.tums.ac.ir

Research Article

Comparison of the Skill of Emergency Medical Technicians in Terms of Advanced Airway Management Using Endotracheal Tube versus Laryngeal Mask Airway in an OSCE Using a Mannequin

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ARTICLE INFO

Article history:
Received 02 August 2020
Revised 24 August 2020
Accepted 09 September 2020

Keywords:
Emergency medical services;
Emergency medical technicians;
Intubation;
Intratracheal;
Laryngeal masks;
Manikins

ABSTRACT

Background: Supraglottic airway management tools such as the laryngeal mask airway (LMA) have recently emerged as the first choice in pre-hospital and hospital airway management guidelines as well as an alternative strategy after endotracheal tube (ETT) placement failure. However, the pros and cons of the LMA compared to endotracheal intubation are still debated.

Given that no study has been conducted to date on the skills of emergency medical technician (EMT) in airway management using LMA compared to endotracheal intubation, we decided to do a study in this regard.

Methods: In this objective structured clinical examination (OSCE), EMTs who had a degree of associate or bachelor were participated. The examiner asked the examinees the required information and entered it in the pre-prepared checklists. The participants took part in a two-stage exam. In the first stage, the airway management of the simulated trauma patient was performed by endotracheal intubation, and in the second stage, the same scenario was performed with LMA. At each stage, the examiner evaluated the examinee's performance in 4 fields of Preparation, Pre-oxygenation, Position and Placement, and Post-intubation management using a standard checklist. In addition, the duration of the procedure from the beginning to the time of fixing the ETT or LMA was recorded and compared.

Results: Totally, 105 EMTs participated in this study, of whom, 102 were male (97.1%). The mean age of the subjects was 36.4± 7.3 years old. Of the total participants, 72 passed both practical exams successfully, and they generally insert the LMA faster; so that the duration of intubation and LMA insertion in 1.4% and 30.6% were <1 min, respectively ($p< 0.001$). However, no significant difference was observed in terms of the mean time ($p= 0.427$).

Conclusion: In the present study, the skills of the technicians participating in the study in performing advanced airway procedures were moderate, and also, it was found that their skills in LMA insertion were less than endotracheal tube insertion.

The authors declare no conflicts of interest.

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Airway management is very important in the pre-hospital emergency setting. Patients with inadequate respiratory effort, inadequate or inappropriate ventilation, or altered level of consciousness require airway management at the scene [1]. Airway management can be basic (simple airway maneuvers, nasopharyngeal or oropharyngeal airway, breathing with bag-valve-mask (BVM)) or advanced (laryngeal mask airway (LMA) insertion, Combitube, endotracheal tube (ETT), and even in some cases cricothyroidotomy). Basic airway management is performed for all patients with airway disorders, but in some patients, it may not be sufficient. Outside the hospital, environmental issues may complicate airway management. BVM ventilation is undesirable for long maintenance of the airway, especially for challenging conditions such as in a moving ambulance. A particular problem is difficult access to trapped patients after car accidents. If these casualties need advanced airway management, the situation is very different from a controlled context [2]. In such cases, if a well-trained emergency medical technician (EMT) is available, advanced airway management should be performed prior to transfer to the hospital [3-4]. Although tracheal intubation is considered as the gold standard for airway management [5-6], its success rate, when performed by inexperienced individuals, is significantly lower so that its failure rate has been reported as 3-31% [7-8]. In previous studies, increased mortality and morbidity have been reported repeatedly following improper intubation. Frequent laryngoscopy has been shown to increase complications such as severe hypoxia, regurgitation and aspiration, bradycardia, and cardiac arrest [9-12]. Supraglottic airway management tools such as the LMA have recently emerged as the first choice in pre-hospital and hospital airway management guidelines as well as an alternative strategy after intubation failure [13-16]. However, the pros and cons of the LMA compared to endotracheal intubation are still debated [17-18]. In the Tehran Emergency Medical Service (EMS) center, people with different field of study and academic degrees, including the associate and bachelor degree in EMT, nursing, anesthesia technician with different work experiences are working; and according to notified protocols they are allowed to perform basic and advanced airway management for injured and patients in need. Airway management is done with basic maneuvers and BVM, which is sometimes very challenging and occasionally ineffective due to the patient or injured condition, environmental issues, during the transference in the moving ambulance, and concerning the fact that all missions are in pairs. Endotracheal intubation and classic LMA are alternative procedures if the basic maneuvers of airway management are failed, also in some cases, they are the preferred and first procedure for airway management in Tehran EMS, which is based on the judgment of technicians. Given that no study has been conducted to date on the skills of pre-hospital EMTs in airway management using LMA compared to endotracheal intubation, we decided to do a study in this regard.

Methods

Study design

This study was conducted in February 2020 in Tehran, Iran. Before starting the project, the approval of the ethics committee was obtained from the Tehran University of Medical Sciences (code IR.TUMS.VCR.REC.1398.760). The anonymous test results were analyzed. Conscious consent was obtained from all technicians to participate in the study.

Study population

The study population included technicians of the Tehran EMS center. The selection of participants was done randomly using the personnel operational code. The only entry criterion was having a degree of associate or bachelor.

Data gathering

The examiner asked the examinees the required information and entered it in the pre-prepared checklists. Basic information regarding the technician, such as academic degree, work experience, the average number of intubations per month, was recorded in the same checklist. The participants took part in a two-stage objective structured clinical examination (OSCE). In the first stage, the airway management of the simulated trauma patient was performed by endotracheal intubation, and in the second stage, the same scenario was performed with LMA. At each stage, the examiner evaluated the examinee's performance in 4 fields of Preparation, Pre-oxygenation, Position and Placement, and Post-intubation management using a standard checklist. The first exam was performed to evaluate the skills of technicians in airway management of a simulated trauma patient by endotracheal intubation. The duration of the exam was 5 minutes. A checklist with 17 items was utilized for the endotracheal intubation station (min score: 0, max score: 25); For the LMA station, the same equipment was used with a checklist of 18 items (min score: 0, max score: 18). The checklists were designed based on available resources and finalized with the opinion of several professors of emergency medicine and anesthesia. Each station had an examiner (emergency medicine or anesthesiologist) and an observer. In addition to assessing knowledge and skills, the duration of the procedure from the beginning to the time of fixing the endotracheal tube was calculated and recorded. The

evaluation was done qualitatively and for each item, the correct performance and non-performance of that item were assessed and scored 0 or 1. Each question had equal weight with other questions in the final score. The mannequin used was a specific airway placement training mannequin, and the equipment available at each station included the following:

- Airway with different sizes
- Nelaton catheter and suction device
- Laryngoscope and blade in different sizes
- Tracheal tube with different sizes
- LMA
- Bag valve Mask
- 10cc syringe
- Cotton bandage
- Stethoscope
- Pulse oximeter
- Medications to facilitate tube intubation
- Lubricant gel
- Guide

Data analysis

All study variables were descriptively analyzed and the results were presented using statistics such as frequency and percentage, mean, and standard deviation. Tables and graphs were also used to better display the results. The Shapiro-Wilk test and graphical approaches were used to evaluate the normality of the variables. The Independent t-test was used to compare the means in the two groups and the ANOVA test was used in more than two groups. The Paired t-test was used to compare the mean score of technicians for LMA insertion and ETI procedures. The Spearman correlation coefficient was used to investigate the quantitative correlation between variables. All analyzes were performed using the Stata software version 14.

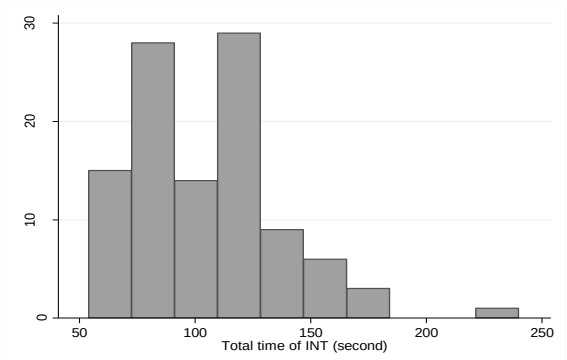
Results

Totally, 105 technicians participated in this study. Of the total participants in the study, 102 were male (97.1%) and only 3 were female. The mean age of the subjects was 36.4 ± 7.3 years old (a minimum of 23 years and a maximum of 54 years). In terms of marital status, 25 (23.8%) were single. The work experience varied between 1 month to 28 years and the average work experience of the participants was 11.7±6.7 years; the majority of individuals had a work experience of 10-20 years. In terms of academic degree, 40 (38.1%) had a associate degree, 62 (59.0%) had a bachelor's degree, and 3 (2.9%) had a master's degree or higher. In terms of field of study, 58.1% had a degree as an EMT, 21.9% had a degree in nursing, and 20.0% had a degree in anesthesiology.

The endotracheal intubation station

Of all subjects, 87 (82.9%) successfully passed the practical exam of endotracheal tube placement. In these participants, the minimum total time to insert the endotracheal tube was 54 seconds and the maximum time was 183 seconds. Of the total number of passed examinees, the duration of endotracheal tube placement in 1.1%, 70.1%, 25.3%, and 3.4% of participants were 1<min, 1-2 min, 2-3 min, and >3 min, respectively. Also, the average total duration of tracheal tube placement was 101.1 seconds (SD = 30.3) and the median of that was 96 seconds. Figure 1 shows a histogram of the total duration of endotracheal tube placement for all participants.

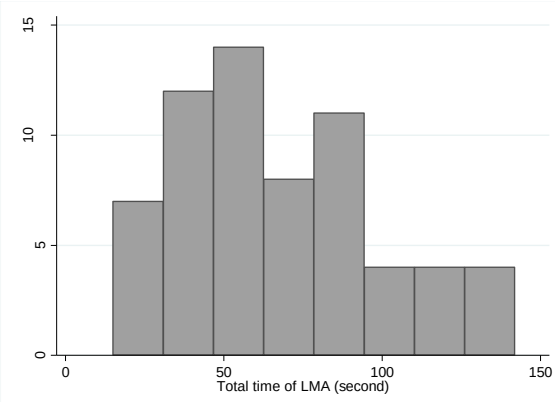
Figure 1- The total duration time of endotracheal tube intubation histogram



The LMA insertion station

Of the total population, 84 (80%) successfully passed the practical exam of LMA. In these people, the minimum time for LMA insertion was 15 seconds and the maximum time was 240 seconds. Of the total number of passed examinees, the duration of LMA insertion in 34.5%, 41.7%, 15.5%, and 8.3% of participants were 1<min, 1-2 min, 2-3 min, and >3 min, respectively. Also, the average total duration of LMA insertion was 68.1 seconds (SD = 31.4) and the median of that was 75.5 seconds. Figure 2 shows a histogram of the total duration of LMA insertion for all participants.

Figure 2- The total duration time of LMA insertion histogram



Comparing the results of 2 stations

Of the total participants, 72 passed both practical exams successfully, and they generally insert the LMA faster; so that the duration of intubation and LMA insertion in 1.4% and 30.6% were <1 min, respectively (P-value <0.001). However, no significant difference was observed in terms of the mean time (P-value = 0.427) (Table 1).

The comparison of the scores obtained in the two stations according to the basic variables of the participants is presented in (Table 2). Based on the findings, the scores obtained in the two stations did not differ significantly in terms of their marital status, field of study, academic degrees, and employment status. However, people with formal employment status scored somewhat better on the exam. Also, work experience was not significantly correlated with the test score.

Table 1- Comparison of the frequency of successful endotracheal intubation and LMA insertion by time duration

Time duration	Successful intubation	Successful LMA	P value
	Frequency (%)		
<1 min	1 (1.4)	22 (30.6)	<0.001
1-2 min	53 (73.6)	30 (41.7)	
2-3 min	15 (20.8)	13 (18.1)	
3-4 min	3 (4.2)	7 (9.7)	
Mean (SD)	98.9 (29.3)	92.6 (57.1)	0.427

Table 2- Comparison of the score obtained in the two stations according to the basic variables of the participants

	N=105	LMA Test score*	INT Test score*
Marital status			
Single	25	9.4±3.2	13.6±3.7
Married	80	9.5±3.4	14.2±3.2
P value		0.841	0.506
Academic degree, (%)			
Diploma or associate	40	9.4±3.5	13.8±3.3
Bachelor	62	9.4±3.1	14.0±3.4
Master and Doctorate	3	10.7±4.6	16.3±2.1
P value		0.820	0.464
Field of Study			
EMT	60	9.3±3.3	13.8±3.5
Nursing	21	9.7±3.4	14.1±3.1
Anesthesia technician	21	9.6±3.3	14.5±3.3
P value		0.860	0.699
Employment status			
Formal	54	9.8±3.2	14.5±3.3
Informal	51	9.1±3.4	13.6±3.3
P value		0.256	0.170
Work experience			
Correlation coef*	105	0.079	0.077
P value		0.426	0.434

ETI: endotracheal tube; LMA: laryngeal mask airway

*Nonparametric Correlations based-on Spearman's rho

In the endotracheal intubation group, the lowest and highest scores were 6 and 23, respectively, and the mean score of the participants was 14.0 ± 3.3 (Figure 3). In the LMA group, the lowest and highest scores were 1 and 16, respectively, and the mean score of the participants was 9.5± 3.3 (Figure 4). The mean standardized test scores (per number of questions) for LMA station (Mean ± SD= 0.53 ± 0.18) was significantly lower than the endotracheal intubation station (Mean ± SD= 0.56 ± 0.13) (P-value < 0.001).

Figure 3- The frequency distribution of scores obtained in the endotracheal intubation exam histogram

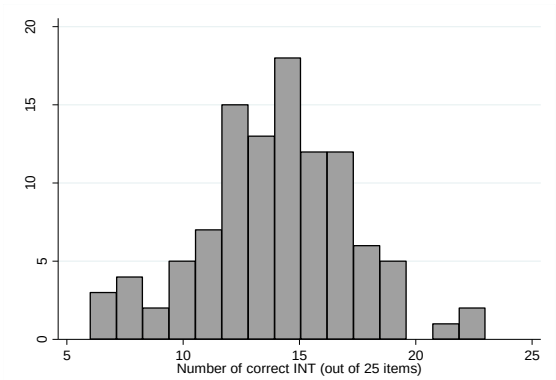
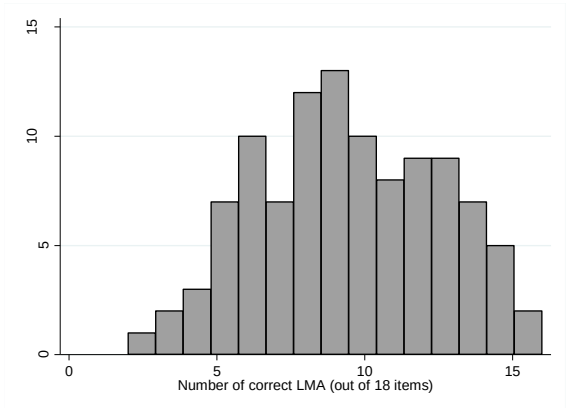


Figure 4- The frequency distribution of scores obtained in the LMA exam histogram



(Tables 3 and 4) show the frequency of successful completion of each item of the checklists in different subscales used at the ETT and the LMA stations, respectively. In the ETI exam, the lowest (1.0%) and highest (99.0%) correct items were "Evaluation of difficult airway and considering an alternative procedure (e.g. LEMON[1])" and "Choosing the appropriate size of laryngoscope", respectively, which were both in the category of preparation. Also, the lowest (12.4%) and highest (85.7%) correct item in the LMA exam were "Airway assessment for the possibility of difficulty in LMA insertion (RODS[2])" in the Preparation category and "LMA insertion until a resistance was felt" in the Position and Placement category, respectively.

Table 3- Frequency of successful completion of each item of the checklists used in the endotracheal intubation station

Category	Items	Frequency (%)
Preparation	Safety	61 (58.1)
	Asking help	18 (17.1)
	Difficult airway evaluation and considering alternative methods	1 (1.0)
	Preparing the necessary equipment for intubation and checking them	43 (41.0)
	An appropriate IV line placement	99 (94.3)
	Choosing the right medicine and dose	40 (38.1)
	The right dose of the medicine	15 (14.3)
	Choosing the appropriate size of the endotracheal tube	102 (97.1)
	Choosing the appropriate size of the laryngoscope	104 (99.0)
	Slow administration of drugs	5 (4.8)
	Total score, mean±SD	4.6±1.42
Pre-oxygenation	using the pulse oximetry	49 (46.7)
	connecting the BVM to oxygen	30 (28.6)
	doing the appropriate Jaw thrust airway maneuver with neck immobilization	74 (70.5)
	Suctioning secretions for a maximum of 10 to 15 seconds	78 (74.3)
	Placing the oral airway correctly	61 (58.1)
	Ventilating the patient with an BVM and mask before intubation	87 (82.9)
	Giving sufficient number of breaths to increase spo2	39 (37.5)
	Using the BVM correctly by controlling chest rising	87 (82.9)
	Total score, mean±SD	4.8±1.9
Position and Placement	Waiting 3 minutes after premedication before starting intubating the patient	4 (3.8)

[1]LEMON. Look externally; Evaluate 3-3-2 rule; Mallampati score; Obstruction; Neck Mobility

[2]Restriction, Obstruction/Obesity, Disrupted or Distorted anatomy, and Short thyromental distance

	Doing the right laryngoscopy procedure	101 (96.2)
	Appropriate depth of the endotracheal tube	77 (73.3)
	inflating the endotracheal tube cuff	87 (82.9)
	Total score, mean ± SD	2.6±0.82
Post intubation management	Checking the place of the endotracheal tube	91 (86.7)
	Fixing the endotracheal tube	63 (60.6)
	One breath every 6 seconds	57 (54.3)
	Total score, mean ± SD	2.0±0.89
	Successful intubation	87 (82.9)
	Number of attempts leading to successful intubation (once)	50 (47.6)

Table 4- Frequency of successful completion of each item of the checklists used in the LMA station

Category	Items	Number (%)
Preparation	Airway assessment for the possibility of difficulty in LMA insertion (RODS)	13 (12.4)
	Choosing the appropriate size of the LMA (4 or 5)	52 (49.5)
	Checking the LMA by deflating and inflating its cuff	23 (21.9)
	Total score, mean±SD	0.84±0.88
Pre-oxygenation	prescribing oxygen	30 (28.6)
	doing the appropriate Jaw thrust airway maneuver with neck immobilization	67 (63.8)
	Suctioning secretions for a maximum of 10 to 15 seconds	85 (81.0)
	Placing the oral airway correctly	40 (38.1)
	Appropriate size of the oral airway	24 (22.9)
	Ventilating the patient with an BVM and mask before LMA insertion	59 (56.2)
	One breath every 6 seconds	60 (57.1)
	Total score, mean±SD	3.5±2.1
Position and Placement	Using the BVM correctly by controlling chest rising	55 (52.4)
	Lubricating the LMA	65 (61.9)
	Using the index finger to insert the LMA	63 (60.0)
	Guiding the LMA in contact with the hard palate	82 (78.1)
	LMA inserting until a resistance was felt	90 (85.7)
	Inflating the LMA's cuff with 30 cc of air	81 (77.1)
	Total score, mean±SD	4.2±1.5
Post intubation management	Using the BVM correctly by controlling chest rising	77 (73.3)
	fixing the LMA	70 (66.7)
	Total score, mean±SD	1.0±0.26

Discussion

The results showed that the skills of the technicians participating in the present study in performing advanced airway procedures were moderate. It was found that technicians' skills in LMA insertion were less than the endotracheal tube placement. Although their strength was generally in the category of "position and placement", they had significant drawbacks in other categories. For example, in the category of Preparation, their weakness was particularly in airway assessment for the possibility of difficulty in the targeted tool insertion. Surprisingly none of the participants in the study had used the LMA in the missions during the 6 months before participating in the exam, and despite the existing recommendations, they still preferred to use the endotracheal tube through direct laryngoscopy. However, their number of successful LMA insertion in an acceptable time at the exam was assessed very well.

In the last decade, many studies have been performed to confirm the efficiency and low side effects of LMA insertion compared to endotracheal intubation. For example, Jonathan et al. conducted a study in the UK to determine the preference of the supraglottic airway over the endotracheal tube in the out-of-hospital cardiac arrest cases and published the results in 2018. In this experimental study, paramedics randomly used endotracheal tube or supraglottic devices with a one-to-one probability. The primary outcome was the revised classification scale score on discharge from the hospital or 30 days after cardiac arrest. The secondary outcome

was successful ventilation, regurgitation, and aspiration. The results showed that there was no significant difference in functional outcomes between the two groups [19]. Another study to assess the feasibility of LMA as the primary airway method in unconscious patients by trained paramedics in the pre-hospital setting was conducted in 2015 in Finland with the participation of 40 paramedics. Adults >18 years, having a GCS of 3-5, and in need of airway management were entered the study. In all cases, the LMA was correctly inserted in the first attempt with the mean time of 9.8 seconds. Paramedics found it easy to place. The results of this study showed that LMA insertion is easier and faster in unconscious patients. However, there were problems with ventilation that need further studies [20].

A study was conducted in the Netherlands in 2013 in which a theoretical and practical training course about the LMA use were held for paramedics and then the date was gathered. All paramedics were quite positive about the ease of placement and general use of LMA and emphasized the need to use it as a useful tool for patients in need. The conclusion was that reliable supportive ventilation using LMA by paramedics is effective and safe in the EMS's missions [21]. In Iran, Farhadloo et al. conducted a study in 2016 entitled "A Comparison of Insertion and Success Rate in the Use of Two Methods of Endotracheal Intubation and Laryngeal Mask Airway". The placement time of the endotracheal tube was 28.73 seconds and in the laryngeal mask airway was 5.05 seconds. Due to the shorter time in establishing the airway with the LMA method, a few number of errors, and its ease of placement compared to the ETT (endotracheal tube), the use of this method as a suitable alternative for endotracheal intubation is recommended, especially in emergency situations [22].

Although the results of previous studies showed that the laryngeal mask is an accepted tool in the airway management of patients, the results of the present study showed that this method is still not acceptable and common among technicians working in our country's pre-hospital emergency system. However, it should be noted that most of the previous studies were performed with the participation of technicians at the level of paramedics and in dealing with cases of out-of-hospital cardiac arrest, or basically in a hospital setting where the context and participants were different from that in the current study. Given that in Iran's EMS, people with different field of studies (EMT, nurse, and anesthesia technician), academic levels, work experiences, are working, so these factors certainly affect the skills of airway management, success rate, and side effects. Also, the type of laryngeal mask used in previous studies was different from that in the present study. The type of laryngeal mask used in the Tehran EMS is the first generation of this product, which is associated with higher complications and less effectiveness. On the other hand, one of the most common cases that requires airway management is trauma, which is very challenging in pre-hospital settings. It requires high knowledge and skills, sufficient experience, and in some cases drugs to facilitate intubation. Due to the limited presence of paramedic personnel in most missions and the lack of medicine to facilitate intubation in our country's EMS system, intubation alternatives should be considered. In all respects, it seems that further training in advanced airway management, setting clear guidelines and algorithms, as well as careful monitoring of the implementation of the guidelines is necessary.

Limitations

Given that airway management at the scene is a much more complex procedure than performing it during an OSCE exam on a mannequin, it may not be easy to generalize the results of this study to the conditions during a mission.

Conclusion

In the present study, the skills of the technicians participating in the study in performing advanced airway procedures were moderate, and also, it was found that their skills in LMA insertion were less than endotracheal tube insertion. Although their strengths were generally in the category of Position and Placement, they had significant drawbacks in other categories, including Preparation, Pre-oxygenation, and Post intubation management.

Funding

This study was funded with a grant from Tehran EMS Center.

Authors' contribution

The conception and design of the work by PS, MoS, and MeS; Data acquisition by EK, MR and PHS; Analysis and interpretation of data by EK, PHS and MeS; Drafting the work by MR, PHS, and MeS; Revising it critically for important intellectual content by PS, EK and MoS; All the authors approved the final version to be published; AND agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work.

Acknowledgments

We would like to express our obligations to the Pre-hospital and Hospital Emergency Research Center affiliated to Tehran University of Medical Sciences.

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