Comparison of Classical Laryngeal Mask, I Gel and Tracheal Intubation for Limited Experienced Users During Uninterrupted Chest Compressions

Sınırlı Tecrübesi Olan Kullanıcılar İçin Aralıksız Göğüs Kompresyonları Sırasında Klasik Laringeal Maske, I Gel ve Trakeal Entübasyonun Karşılaştırılması

Kemal Tolga SARAÇOĞLU,[a]
Leyla TOPCU,[a]
Zeynep ETİ[a]

[a]Department of Anesthesiology
and Reanimation,
Marmara University Faculty of Medicine,
İstanbul

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Yazışma Adresi/*Correspondence:*
Kemal Tolga SARAÇOĞLU
İstanbul Bilim University
Şişli Florence Nightingale Hospital,
Clinic of Anesthesiology
and Reanimation, İstanbul,
TÜRKİYE/TURKEY
saracoglukt@gmail.com

ABSTRACT Objective: Airway management is more difficult and time-consuming in emergencies as compared to elective procedures. The optimal method for airway management during cardiac arrest is unknown. We aimed to determine the most appropriate airway device in cardiopulmonary resuscitation for the medical staff with limited experience in airway management. **Material and Methods:** The 5th year medical students with limited prior experience, were invited to participate in this study. Students used three airway devices (classical laryngeal mask, I-gel or endotracheal tube) first on a normal manikin then repeated the same procedures on a cardiopulmonary resuscitation manikin during chest compressions. The duration of successful attempts, success rate, number of attempts, tidal volumes and airway pressures were recorded. **Results:** Time required for providing airway was significantly longer with endotracheal tube compared to classical laryngeal mask and I-gel during cardiopulmonary resuscitation with or without chest compressions ($p<0.001$ and $p<0.001$). Tidal volume values following the classical laryngeal mask insertion were significantly lower than the values recorded after endotracheal tube and I-gel insertion ($p<0.001$ and $p<0.001$). The airway pressure values on the anesthesia device were significantly higher after endotracheal tube insertion ($p<0.001$). I-gel had significantly higher success rate in providing airway on first attempt compared to classical laryngeal mask (86.9% versus 69.5%) (p=0.021). During chest compressions, the success rate in securing airway on the first attempt was the highest for I-gel (94.2%) (p=0.0034). **Conclusion:** Because novice users are not skilled personnel in advanced airway management the use of supraglottic airway devices may be an alternative for laryngoscopy and intubation during cardiopulmonary resuscitation.

Key Words: Intubation, intratracheal; cardiopulmonary resuscitation; airway management

ÖZET Amaç: Havayolu yönetimi elektif işlemlerle karşılaştırıldığında acil durumlarda daha zor ve zaman alıcıdır. Kardiyak arrest sırasında havayolu yönetimi için optimal yöntem bilinmemektedir. Havayolu yönetimi konusunda kısıtlı deneyimi olan tıbbi personel için kardiyopulmoner resusitasyonda en uygun havayolu aygıtını belirlemeyi amaçladık. **Gereç ve Yöntemler:** Kısıtlı deneyimi bulunan 5. sınıf tıp fakültesi öğrencileri bu çalışmaya davet edildi. Öğrenciler üç havayolu aygıtını (klasik laringeal maske, I-gel ya da endotrakeal tüp) önce normal bir mankende ardından bir kardiyopulmoner resusitasyon mankeninde göğüs kompresyonları sırasında kullandılar. Başarılı girişim süresi, başarı oranı, girişim sayısı, tidal volümler ve havayolu basınçları kaydedildi. **Bulgular:** Kardiyopulmoner resusitasyon sırasında göğüs kompresyonları varlığında ya da yokluğunda endotrakeal tüple havayolu sağlamak için gereken süre laringeal maske ve I-gel ile karşılaştırıldığında anlamlı olarak daha uzundu ($p<0,001$ ve $p<0,001$). Klasik laringeal maske yerleştirilmesini takiben tidal volüm değerleri endotrakeal tüp ve I-gel yerleştirilmesini takiben kaydedilen değerlerden anlamlı olarak daha düşüktü ($p<0,001$ ve $p<0,001$). Anestezi cihazındaki havayolu basınç değerleri endotrakeal tüp yerleştirilmesinden sonra anlamlı olarak daha yüksekti ($p<0,001$). Klasik laringeal maskeyle karşılaştırıldığında I-gel ile ilk girişimde havayolu sağlama başarı oranı anlamlı olarak daha yüksekti (%86,9 ve %69,5) (p=0,021). Göğüs kompresyonları sırasında ilk girişimde havayolu sağlama başarı oranı I-gel için en yüksekti (%94,2) (p=0.0034). **Sonuç:** Deneyimsiz kullanıcılar ileri havayolu yönetiminde eğitimli personel olmadığı için, kardiyopulmoner resusitasyon sırasında supraglottik havayolu aygıtları laringoskopi ve entübasyon için bir alternatif olabilirler.

Anahtar Kelimeler: Entübasyon, intratrakeal; kardiyopulmoner resusitasyon; havayolu yönetimi

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Airway management is more difficult and time-consuming in emergencies as compared to elective procedures.[1] While tracheal intubation is regarded as the gold standard for out-of-hospital resuscitation, in recent years other reasons — the variety of cases, intubation practiced by paramedics and emergence of various supraglottic airway devices (SAD) — have led us to question whether tracheal intubation is the best option in airway management following cardiac arrest.[2] Several studies reported that SADs are effective and can be successfully used to maintain the airway, while one study could not find any difference regarding success rate or duration of insertion.[3-5] Although endotracheal tube (ETT) insertion was found to be associated with higher survival rate and neurological outcome, the incidence of unrecognized oesophageal or endobronchial intubation is frequent and is associated with a high mortality rate.[6-8]

Airway management is a controversial issue in pre-hospital cardiopulmonary resuscitation (CPR).[9,10] It was stated in the European Resuscitation Council Guidelines for Resuscitation 2015 that SADs have potential to be used, but there are not enough comparative clinical studies for precise arguments.[11] Interruption of chest compressions for tracheal intubation increases the risk of poor cerebral and coronary perfusion. On the other hand, survival rate decreases inversely proportional to the time spent for intubation. For this reason, interruption of resuscitation is recommended only while the ETT passes through the patient's vocal cords.[11] The pause should not exceed 10 seconds. Otherwise the intubation attempt may be postponed until return of spontaneous circulation. Chest compressions, which cannot be practiced continuously and effectively, cause a significant decrease in survival rate.

This study analyzed the ability of medical students, who were trained in orotracheal intubation and SAD usage, on securing the airway during cardiopulmonary resuscitation. The primary aim of the study was to determine the most appropriate airway device in cardiopulmonary resuscitation for the medical staff who had limited experience in airway management. We hypothesized that higher success rate and/or shorter duration for insertion will be achieved using supraglottic airway devices during chest compressions.

MATERIAL AND METHODS

Following our University Medical School Research Ethical Committee approval (Reference no: 09.2013.0146), the 5th year medical students, at the end of their Anesthesiology course, were invited to participate in this study. Seventy students who agreed to participate gave written consent. During their two-week course in the operating rooms of the medical school, all students had received theoretical and manikin-based practical training about airway management. They also practiced 5 classical laryngeal masks (cLMA), 5 I-gel insertion and 5 endotracheal intubation in patients undergoing surgery.

Students used three airway devices (cLMA, I-gel or endotracheal tube) first on a normal manikin then repeated the same procedures on a CPR manikin during chest compressions. The chest compressions were sustained according to the European Resuscitation Guideline.[12] Each student used the devices in different orders. The order was randomized by sealed envelopes numbered from 1 to 3. All devices were used according to the manufacturers' instructions. We used supraglottic airway devices size 4 and Macintosh blade size 3, endotracheal tube size 8 with a rigid stylet for endotracheal intubation. When airway could not be secured within 30 sec, or oesophageal intubation was performed, it was considered a failed attempt. Also, when the manikin could not be ventilated after 3 attempts, it was regarded as failed intubation.

The duration of successful attempts were recorded by the same researcher. Tracking time was started when the participant handled the airway device which was ready for use and stopped when the manikin's lungs were ventilated successfully using anesthetic breathing circuit.

Mindray anesthesia machine (Mindray Bio-Medical Electronics Co, Ltd. Schenzen, China) was used for the ventilation of manikin's lungs. Lungs were manually ventilated five times, tidal volumes and airway pressures were recorded from the monitor of the anesthesia machine. Also success rate and number of attempts were recorded.

STATISTICAL ANALYSIS

We calculated sample size from a preliminary study including 10 students. The mean (±SD) time required to ventilate the lungs after tracheal intubation in manikin was 10.5±4.5 s. We considered that a difference of 2.5 s (roughly one quarter of 10.8 s) between the groups would be clinically important. To detect this difference with a power of 80% (α=0.05, β=0.2 and effect size=0.46) approximately 70 participants would be needed.

Statistical package for the social sciences (SPSS) software version 21.0 (Armonk, New York: IBM Corp, USA) was used for statistical analyses. The frequency, rate, average and standard deviation values were used for the descriptive statistics of the data. Distribution of the variances was controlled by using the Kolmogorov-simirnov test. While the Friedman test was used for the analysis of repeated measurements, the Wilcoxon test was used for sub-analyses. A p <0.05 was considered statistically significant.

RESULTS

A total of 100 students who completed Anesthesiology course were informed about the study and invited to participate in the study. Seventy students accepted to participate and gave written consents. One participant who did not complete all the steps in the study was excluded from the study. Therefore, 69 participants' data were statistically analyzed. Time required for providing airway was significantly longer with ETT compared to cLMA and I-gel (p<0.001) (Table 1). Also, the time for providing airway was significantly longer in cLMA compared to I-gel (p<0.001). It took ETT significantly longer than cLMA and I-gel to secure airway during resuscitation (p<0.001) (Table 1).

TABLE 1: Time required for providing airway with and without chest compressions.

	ETT	cLMA	I-Gel
T1	9.64±3.68‡	6.24±4.47*	4.80±1.94*†
T2	10.4±4.88‡	5.17±6.44*	3.78±1.43*†

Friedman test

ETT: Endotracheal tube, cLMA: classical laryngeal mask airway.

T1: Time required for providing airway without chest compressions (sec).

T2: Time required for providing airway during chest compressions (sec).

* Comparison with tracheal intubation, p<0.001.

‡ Comparison with cLMA, p<0.001.

TABLE 2: Tidal volume and peak airway pressure after providing airway with and without chest compressions.

	ETT	cLMA	I-Gel
Tidal volume 1 (mL)	596.03±98.83†	453.69±124.91	556.34±151.77†
Tidal volume 2 (mL)	528.59±86.20†	468.26±103.38	531.16±119.24†
Peak airway pressure 1 (mmHg)	55.31±24.36	39.63±12.81*	39.66±3.71*‡
Peak airway pressure 2 (mmHg)	48.26±22.33	38.41±18.88*	39.04±9.67*‡

Friedman test

‡ Comparison with I-Gel, p<0.001.

* Comparison with ETT, p<0.001.

† Comparison with cLMA, p<0.001.

ETT: Endotracheal tube, cLMA: classical laryngeal mask airway.

Tidal volume 1: Tidal volume applied without chest compresions (mL).

Tidal volume 2: Tidal volume applied during chest compresions (mL)

Peak airway pressure 1: Peak airway pressure applied without chest compressions (mmHg).

Peak airway pressure 2: Peak airway pressure applied during chest compressions (mmHg).

Tidal volume following the cLMA insertion were significantly lower than the values recorded after ETT and I-gel insertion (p<0.001) (Table 2). However, the airway pressure values on the anesthesia device were significantly higher after ETT compared to the values recorded after cLMA and I-gel (p<0.001). Airway pressure values recorded following cLMA insertion were significantly higher than I-gel values (p<0.001) (Table 2).

I-gel had significantly higher success rate in providing airway on first attempt compared to cLMA (p<0.05) (Table 3). During resusciation, the success rate in securing airway on the first attempt was significantly lower for cLMA and endotracheal tube in comparison with I-gel (p<0.05) (Table 3). There was no significant difference between the

TABLE 3: Number of attempts for providing airway with and without chest compressions.

		ETT		cLMA		I-Gel		
	Attempts	n	%	n	%	n	%	p
T1	1	58	84.0	48	69.5	60	86.9‡	0.021
	2	7	10.1	17	24.6	9	13.0	
	3	4	5.7	4	5.7	0	0.0	
T2	1	55	79.7‡	56	81.1	65	94.2‡	0.034
	2	14	20.2	13	18.8	4	5.7	

Friedman test
ETT: Endotracheal tube, cLMA: classical laryngeal mask airway.
T1: Time required for providing airway without chest compressions (sec).
T2: Time required for providing airway during chest compressions (sec).
‡ Comparison with cLMA.

measurements carried out before and during the resusciation in terms of successful airway rate, number of intubation attempts, or tidal volumes and airway pressures (p>0.05).

DISCUSSION

The current study compared the efficacy of I-gel, classical LMA, and ETT in providing airway during cardiopulmonary resuscitation. I-gel insertion required less time and provided higher successful attempt rate, lower airway pressure and sufficient tidal volume.

The optimal method for airway management during cardiac arrest is unknown.[13] Tracheal intubation used to be considered the gold standard for resuscitation following the out-of-hospital cardiac arrest. However, it might not be the optimal choice especially when tracheal intubation attempts were performed by an inexperienced staff.[14] Success of endotracheal intubation is directly related to the experience and ability of the rescuer, and this application requires training, because serious complications such as unrecognized oesophageal intubation and tracheal laceration may occur and result in death.[7] Even in the hands of experienced physicians, the frequency rate of oesophageal intubation may be significantly high.[15] Studies have shown that becoming an expert on this requires 50-100 tracheal intubation performance.[16] Therefore SADs have been preferred recently.[17-19] Besides, SAD training has become mandatory in England for paramedic registration.[2] Ideal SAD must enable quick insertion and secure controlled ventilation with minimal training.[17]

In a randomized manikin study performed by paramedics, compared times to successful intubation and intubation success rates for tracheal intubation using Supraglottic Airway Laryngopharyngeal Tube and Macintosh, during CPR with and without chest compression.[20] Mean intubation times for conventional Laryngopharyngeal Tube and laryngoscopic intubation without chest compressions were 17.97±5.33 vs 31.52±7.23 sec respectively (P<0.001). Similar to our results conventional laryngoscopic intubation was not as successful as Laryngopharyngeal Tube insertion. On the other side there are several studies that conclude continuous chest compression increases difficulty in either tracheal intubation or I gel insertion.[21,22]

Previous studies reported high success rates for I-gel.[23,24] In two series of Duckett et al., I-gel was used with success rates of 94% and 92% in out-of-hospital resuscitation cases, and indicated a higher success rate as compared to ETT insertion.[2] In a series of 12 patients, I-gel was used for prehospital CPR and characterized as easy to insert.[25] Researchers found insufficient ventilation in 58% of patients. However in this study, the ability to create a visible increase in the chest wall was accepted as the criterion for sufficient ventilation. We consider that this data is subjective. In our study, we could ventilate lungs by using approximately 556 cc tidal volume with I-gel. This value was the lowest for classical laryngeal mask (approximately 453 cc). Our study also indicated that I-gel is appropriate for cardiopulmonary resuscitation in recognition of low airway pressures and ensuring sufficient ventilation. We suggest that, as these results offer enough data for providing sufficient oxygenation for patients, they can be adapted to clinical practice.

In the present study, we indicated that airway could be secured without interruption in CPR and, when ETT was used during resuscitation, airway could be provided on the first attempt and lasted almost 10.5 sec in approximately 82% of the cases. However, I-gel and laryngeal mask airway required shorter time as 3.7 sec and 5.1 sec, respectively. Laryngeal mask airway seems to be basically a good alternative to ETT. Nevertheless, as the amount of tidal volume required for cLMA was found to be lower in comparison with I-gel and ETT, using I-gel as SAD in resuscitation may be more favorable. We concluded that I-gel's soft, non-inflatable cuff and its natural oropharyngeal curvature provides ease-of-use and high success rate.

LIMITATIONS

There are noteworthy limitations of this study. We believe that, as our study is a manikin-based study, the results should be supported by clinical studies before adapting these airway devices to the clinic. Potential clinical conditions such as gastric inflation and aspiration could not be simulated. The second limitation is that manikin-based studies cannot evaluate the fact that airway devices may displace during the transfer of the patient. In fact, it has been reported that LMA and I-gel can circuit or laterally displace during CPR.[26] Following airway device insertion the manikin was ventilated five times by the same anesthesiologist manually using the ventilation bag. The airway pressure and tidal volume results might be more accurate if we set the anesthesia machine for standard ventilation parameters. First we recorded the results of students using airway devices for providing airway without chest compressions. Then we recorded the results under chest compressions. We concluded that the participants gained experience about the use of supraglottic airway devices and even performing under chest compressions, better outcome was obtained.

CONCLUSION

In conclusion, this study indicated that SADs including I-gel and classical LMA can be successfully taught to most novice users during uninterrupted chest compressions. Because they are not skilled personnel in advanced airway management the use of SADs may be an alternative to laryngoscopy and intubation in course of cardiopulmonary resuscitation.

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