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Can the ETView VivaSight SL Rival Conventional Intubation Using the Macintosh Laryngoscope During Adult Resuscitation by Novice Physicians?

A Randomized Crossover Manikin Study

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Abstract: The aim of this study was to assess the performance of the ETView VivaSight SL (ETView) single-lumen airway tube with an integrated high-resolution imaging camera in a manikin-simulated cardiopulmonary resuscitation scenario with and without chest compression.

This was a randomized crossover manikin trial. Following a brief training session, 107 volunteer novice physicians who were inexperienced with airway management attempted to intubate a manikin using a Macintosh laryngoscope (MAC) and an ETView, with and without chest compressions. The participants were instructed to make 3 attempts in each scenario. In this trial, we compared intubation time, intubation success rates, and glottic visibility using a Cormack & Lehane Grade. Dental compression and ease of use of each device were also assessed.

Median intubation times for the ETView and MAC without chest compressions were 17 (IQR, 15–19) s and 27 (IQR, 25–33) s, respectively ($P < 0.001$). The ETView proved more successful on the first intubation attempt than the MAC, regardless of compressions. Continuation of compressions caused an increase in intubation times for both the ETView ($P = 0.27$) and the MAC ($P < 0.005$).

The ETView VivaSight SL is an effective tool for endotracheal intubation when used by novice physicians in a manikin-simulated cardiac arrest, both with and without chest compressions.

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Abbreviations: AHA = American Heart Association, CC = chest compression, CPR = cardiopulmonary resuscitation, ERC = European Resuscitation Council, ETI = endotracheal intubation, ETView = ETView VivaSight SL, ID = inner diameter, ILCOR = International Liaison Committee on Resuscitation, IQR = interquartile range, MAC = Macintosh Laryngoscope, SD = standard deviation, VAS = visual analog scale.

INTRODUCTION

Cardiac events are a leading cause of death worldwide and despite our best life support efforts outcomes after cardiac arrest are still poor.[1,2] The European Resuscitation Council (ERC) cardiopulmonary resuscitation (CPR) 2010 guidelines emphasize the importance of minimizing the interruption of chest compression to maximize coronary and cerebral perfusion pressure.[1] Tracheal intubation is still considered the optimal method for maintaining a secure airway according to the ERC Guidelines 2010. These guidelines also suggest that the intubator should be able to secure the airway without interrupting chest compression (CC).[1] However, intubation during CPR is difficult and requires frequent practice to maintain the skill.[3,4] Accordingly, the new guidelines for dealing with ''difficult airway management'' which will be released in 2015, of which the most important details are already available in electronic form, assume that medical personnel have access to videolaryngoscopes as well as direct laryngoscopy devices.[5]

The ETView VivaSight SL (ETView; ETView Ltd., Misgav, Israel) is single-lumen airway tube with an integrated high-resolution imaging camera. The image is transmitted to the display in real time, so that the person performing the intubation is able to view the entrance to the larynx and insert the endotracheal tube into the trachea. In the case of flexible fiberscopes and videolaryngoscopes, visibility can be reduced by blood or other fluids in the throat. The ETView is equipped with an integrated flushing system that allows for rapid and efficient camera lens cleaning in situ. Increasing evidence indicates that the ETView may be suitable for tracheal intubation in various clinical settings.[6,7]

We hypothesized that the ETView VivaSight SL (ETView) could be an alternative to standard direct laryngoscopy (MAC) during intubation of adult manikins while performing CPR. In the present study, we compared the effectiveness of the ETView and MAC intubation in adult resuscitation with and without CC.

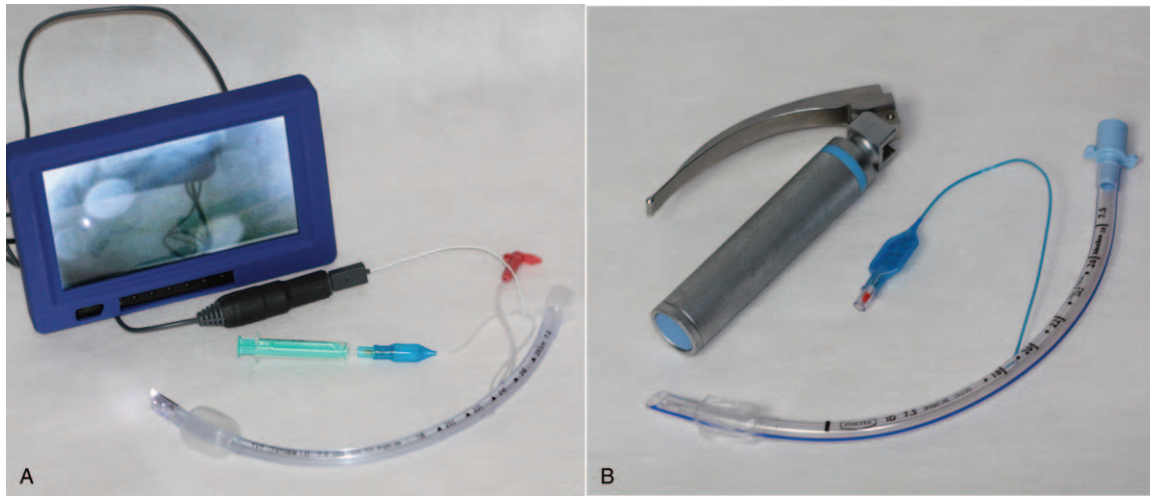

FIGURE 1. Laryngoscopes used for this study were (A) ETView VivaSight SL, (B) Macintosh Laryngoscope.

METHODS

This study has been approved by the Institutional Review Board of the International Institute of Rescue Research and Education (Approval 5.2014.12.32, November 3rd, 2014) and registered at the ClinicalTrials register (www.clinicaltrials.gov, identifier NCT02295618). This was a randomized nonblind crossover simulation trial that took place in November 2014. One hundred seven internal medicine faculty members who had less than 1-year experience in medicine participated in this study. Participants had limited experience in clinical intubation (less than 10 intubations) and none had prior experience with the ETView VivaSight SL. Voluntary informed consent was obtained from each participant before the study.

Before the study, all participants received a standardized audio-visual lecture lasting 45 minutes covering relevant aspects of anatomy and different techniques for securing an airway, including the MAC and the ETView. Following the lecture, physicians participated in a practical demonstration, during which intubations with the respective devices were demonstrated by an independent anesthesiologist. Participants were then given 30 minutes to practice intubation using the MAC and the ETView with a manikin. The same anesthesiologist was present during the practice session to give advice to participants.

Two tracheal intubation devices in this trial were used: the ETView VivaSight-SL (ETView; Size 7.0 ID) and the Macintosh Laryngoscope Blade no. 3 (MAC) (MERCURY MEDICAL, Clearwater, FL; Figure 1). In the adult intubation scenario, a SimMan 3G training manikin (Laerdal, Norway) was used, and a Lucas-2 device (Physio-Control, Redmond, WA) was used for chest compression (Figure 2). Endotracheal intubations (ETI) using the Macintosh laryngoscope were performed using a size 7.0-mm tracheal tube. The participants were directed to make 3 attempts in each scenario. After each device, participants took a 10-minute rest and then performed intubation using the next device. The participants were not allowed to watch each other so as to avoid learning through observation.

After the training session, each participant started their intubations using the ETView and the MAC in adult resuscitation scenarios in a randomized order. The order of interventions was randomized for each participant by a computer program (Research Randomizer [www.randomizer.org]; Figure 3). After completing the ETI procedure participants had a 30-minute break before performing intubation using another method.

The primary outcome of the study was time to intubation, defined as the time from insertion of the laryngoscope blade between the teeth to the first manual ventilation of the mannequin's lungs. The secondary endpoint of the study was the success rate of intubation. If the oesopharyngeal tube was incorrectly placed or intubation lasted longer than 60 seconds, the airway-management attempt was defined as a failure. In many studies, this time is over than 120 seconds,[8,9] but for the good of the patient, we took a period of 60 seconds as the time required for intubation. After each attempt, participants were asked to rate the glottic view they had during the attempt using a Cormack & Lehane Grade.[10] Quantitative data are presented as mean and standard deviation. The severity of the potential dental trauma was calculated based on a previously described modified[11] grading scale. To assess subjective opinions about the difficulty of the procedure, participants were asked to rate it on a visual analogue scale (VAS) with a score from 1 (extremely easy) to 10 (extremely difficult). In addition, participants were asked which method they would prefer in a real-life resuscitation.

Statistical Analysis

Sample size calculations indicated that 107 participants would be sufficient to detect moderate differences in intubation time between the Macintosh and the ETView (using 5% level of

FIGURE 2. Simulation manikin with chest compression system Lucas-2.

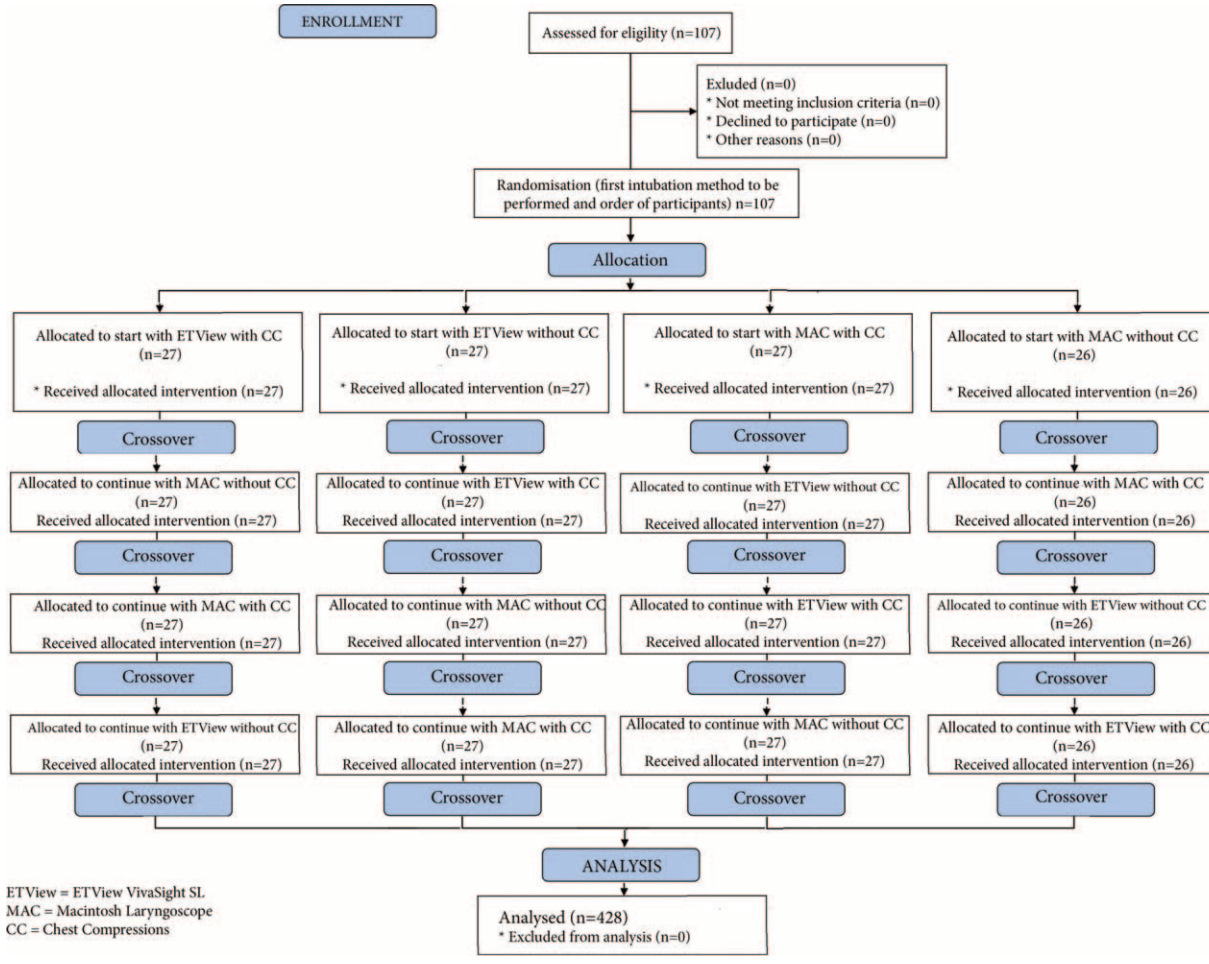

FIGURE 3. Flow chart of design and recruitment of participants according to CONSORT statement.

significance and 80% power). The *R* statistical package for Windows (version 3.0.0) was used for statistical analysis. As data were found not to be normally distributed, nonparametric data were applied. Times needed to successful intubation were compared using the Wilcoxon signed rank test. McNemar test was used to detect possible differences in success rates for ETI. A $P < 0.05$ was considered statistically significant. All results are shown as a number (%), mean and standard deviation (±SD), or median and interquartile range (IQR). A $P < 0.05$ was considered to be statistically significant.

RESULTS

This study was conducted in November 2014. One hundred seven novice physicians (46 women and 61 men, age 31.2 ± 7.4 years) participated in the study.

Results for intubation time are shown in Figure 4. Performing chest compression did not significantly increase intubation time with the ETView (17(IQR, 15–19) s without chest compression versus 19 (IQR, 15–22) s with chest compression). Intubation times were significantly longer using the MAC when chest compression was being performed (27(IQR, 25–33) s without chest compression versus 38 (IQR, 31–46) s with chest compression, $P < 0.005$). There was a statistically significant

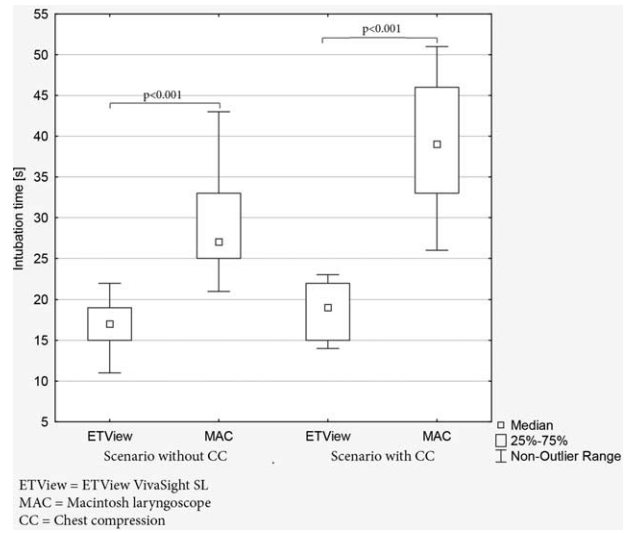

FIGURE 4. Time to intubation.

TABLE 1. Success Rates of Intubation According to Laryngoscopes and Intubation Attempts

Scenario	Laryngoscope	Tracheal Intubation Attempts			
		First (%)	Second (%)	Third (%)	Failed (%)
Without chest compression	ETView	100	100	100	0.0
	MAC	83.4	96.2	100	0.0
With chest compression	ETView	100	100	100	0.0
	MAC	46.7	62.6	68.2	31.8

ETView = ETViewVivaSight-SL; MAC = Macintosh Laryngoscope.

difference in intubation time between ETView and MAC in both scenarios: without chest compressions ($P < 0.001$) and with uninterrupted chest compressions ($P < 0.001$).

Table 1 shows the number of successful intubations for each trial. In the scenario without CC, the overall effectiveness of intubation using MAC and ETView was 100%. However, the success rate after the first attempt using the MAC and ETView varied and amounted to: 83.4% versus 100%, respectively ($P = 0.017$). In the chest compression scenario, the success rate after the first attempt using the distinct laryngoscopes varied and amounted to: 46.7% versus 100% (MAC and ETView, respectively). There was a statistically significant difference between MAC and ETView in first intubation attempt effectiveness ($P < 0.001$) and overall effectiveness ($P < 0.001$).

Dental compression was observed during intubation when the MAC was used. Dental compression during MAC intubation in CC scenarios was observed in 6.5% of intubation attempts, whereas 12 of 107 participants (11.2%) caused dental compression during chest compression ($P < 0.001$). Dental compression was not observed during intubation when the ETView was used in scenarios both with and without CC.

The Cormac & Lehane grade for each laryngoscopy method is shown in Table 2. Glottic view quality was best with the ETView, with 100% of participants reporting a quality of glottic view corresponding to a Cormack & Lehane grade classification of I, regardless of whether chest compressions were being performed.

Participants' ratings of their subjective opinions about the difficulty of the intubation procedure using the ETView and the MAC varied and amounted to: 2.1 versus 3.2 points ($P = 0.027$) for intubation without chest compression, and 2.3 versus 3.9 points ($P = 0.009$) for ETI with uninterrupted chest compression. When participants were asked which laryngoscope they would prefer in real-life intubation with uninterrupted chest compression, 100% selected the ETView.

DISCUSSION

Interruption of chest compression during CPR is associated with reduced cardiac arrest survival rates.[1,12] Ensuring adequate airway management and adequate oxygenation are integral parts of resuscitation. The European Resuscitation Council 2010 guidelines for cardiopulmonary resuscitation indicate that tracheal intubation is the ''gold standard'' for securing airways and providing effective ventilation.[1] These guidelines also suggest that skilled operators should be able to secure the airway either without interrupting chest compression, or with only a brief pause to view the vocal cords to allow passage of the tracheal tube. American Heart Association guidelines are considered the gold standard for airway management – ETI.[13] However, they emphasize that bag-mask ventilation should be used if a person does not have the right skills to perform direct laryngoscopy. However, it is important to note that in prehospital care all patients should be treated as if they have a full stomach as incompetent ventilation using a bag-mask can cause vomiting. The use of alternative methods to direct laryngoscopy intubation may avoid this problem.[14,15]

The conducted study is the first study comparing the efficacy of endotracheal intubation using the ETView VivaSight SL (ETView) and the Macintosh laryngoscope during simulated adult resuscitation with and without chest compressions.

All participants were able to intubate the trachea with the ETView during resuscitation with and without chest compression. The reason for this outstanding 100% success rate is presumed to be the characteristic tube guide system. ETView is a single-lumen airway tube with an integrated high-resolution

TABLE 2. Grade of Glottic View According to the Cormack & Lehane Classification That Was Achieved with the Different Devices. Data Are Given in Absolute Numbers and Percentage

Scenario	Laryngoscope	Cormack & Lehane Grade			
		C/L I	C/L II	C/L III	C/L IV
Without chest compression	ETView	107 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	MAC	98 (91.6%)	9 (8.4%)	0 (0.0%)	0 (0.0%)
With chest compression	ETView	107 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	MAC	74 (69.1%)	26 (24.3%)	7 (6.6%)	0 (0.0%)

ETView = ETViewVivaSight-SL; MAC = Macintosh Laryngoscope.

imaging camera that provides continuous real-time images of tube position on an LCD screen. Even in the resuscitation with an uninterrupted chest compression scenario, the median time to complete intubation was 19 (IQR, 15–22) s, which is approximately 1 cycle of CPR. This result suggests that the ETView might be able to establish tracheal intubation without interruption of chest compression during cardiopulmonary resuscitation. This facilitates the minimal interruption in chest compressions suggested by the current 2010 European Resuscitation Council guidelines for CPR. There are a few reports showing the effectiveness of ETView during different clinical situations,[6,7] however, none of them refers to intubation using ETView during resuscitation.

In our study, the overall effectiveness of intubation using the MAC is 100% in scenarios without chest compression and only 68.2% in scenarios with uninterrupted chest compression. Conducting chest compressions significantly reduced the effectiveness of direct laryngoscopy using the Macintosh laryngoscope, and increased the statistical significance of the intubation process from 27 (IQR, 25–33) s without CC scenario to 38 (IQR, 31–46) s for ETI during uninterrupted chest compression. This relationship is confirmed by studies by Maruyama.[16] Gaszynska and Gaszynski reported in their study that the success ratio on the first attempt of ETI using MAC during uninterrupted chest compressions was 73.3%[17] when performed by third-year paramedic students. Kohama et al in their study concerning the effectiveness of intubation using MAC during resuscitation by 18 novice doctors from an anesthesia department reported shorter time of intubation (18.9 ± 4.0 s); however, overall effectiveness of intubation during CC was similar to our study and amounted to 66.7%.[3] Overall effectiveness of MAC intubation in different studies varied and amounted to 81.3% (Han et al[8]) to 89.4% (Kim et al[18]).

As shown in our study, people who previously had no contact with the ETView are able – with a little training to effectively perform intubation using this device. The high efficiency of ETView during simultaneous chest compressions means there is no need to interrupt the CC for the duration of intubation. This is particularly important in view of the fact that survival of cardiac arrest victims is directly related to the quality of CPR. Among factors that determine this quality, minimizing interruptions of CC seems to be of great significance.[19] An undoubted downside for routine use of the ETView may be the cost. The standard endotracheal tube costs about $2, whereas the ETView tube is 15 times more expensive, not including the additional cost of the monitor. However, at many Emergency Medical Services and emergency departments displays are now available which can be connected to an ETView via a special cable, and thus can display the image captured by the ETView. The cost of the ETView is not high compared with other videolaryngoscopy or intubation fiberoscopy devices. Also, it should be borne in mind that the life and health of the patient are paramount.

This study has some limitations. This is a manikin-based rather than a clinical study. The manikin model may not precisely reproduce the intubation conditions of real patients. However, according to the International Liaison Committee on Resuscitation (ILCOR), randomized clinical trial for cases of cardiac arrest is highly unethical;[20] therefore, CPR mannequins are an important and established tool for training medical professionals in these crucial and life-saving procedures.[21,22] Some studies have been published with airway simulators,[23,24] and many concepts for managing the airway were developed and practised on manikins and subsequently transferred to clinical scenarios. The strengths of this study include the fact that it was a randomized crossover trial that used a highly advanced patient simulator for performing intubation during resuscitation, and the Lucas-2 chest compression system was used to standardize chest compressions.

CONCLUSIONS

CPR employing continuous chest compression makes intubation with the Macintosh laryngoscope difficult. The ETView provides a promising device for the management of intubations during resuscitation by novice physicians. Use of this device seems to offer advantages over the MAC during CPR, as rates of successful intubation are increased and number of intubation attempts are reduced, thereby improving the Cormack & Lehane grading and diminishing potential damage.

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