Comparison of airway management associated hands-off time between Macintosh and Airtraq®: A randomized manikin trial

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**Keys words**: Hands-off time; cardiopulmonary resuscitation Airtraq; videolaryngoscopes; airway; management.

**INTRODUCTION**

Several studies have demonstrated that frequent or prolonged pauses of chest compressions during cardiopulmonary resuscitation (CPR) diminish the possibility of return of spontaneous circulation (ROSC), as coronary perfusion pressure is substantially decreased (1, 2). Taking that into consideration, the 2010 European Resuscitation Council (ERC) guidelines emphasized the importance of minimal interruptions of chest compressions (3). Advanced airway management during CPR is, therefore, desirable as ventilation and chest compressions can then be provided simultaneously, without having to interrupt chest compressions every few seconds in order to deliver 2 rescue breaths (3). This simultaneous delivery of ventilation and chest compressions is guaranteed with endotracheal intubation, whereas with supraglottic devices excessive gas leakage and inadequate ventilation may occasionally occur. In this case, rescuers have to stop chest compressions in order to successfully ventilate the patient (3). This is the reason why endotracheal intubation is considered the optimal way of airway management during CPR, provided that it is performed by a competent rescuer (3). Moreover, with endotracheal intubation the airway is secured and adequate ventilation is achieved even in the presence of poor lung compliance or high airway resistance. However, chest compressions should not be paused during laryngoscopy and intubation. Only if it is absolutely necessary the rescuer who intubates may ask for the interruption of chest compressions as the endotracheal tube (ETT) passes through the glottis. According to the 2010 ERC guidelines, this interruption should not exceed 10 seconds (3).

Nevertheless, endotracheal intubation is not always an easy task to accomplish, even among experienced rescuers. The reported incidence of difficult intubation is 1.15-3.8% in general population (4, 5). Moreover, as cardiac arrest is an emergency situation, intubation is not usually carried out under optimal conditions (i.e. head pillow, sniffing position), likewise in the operating theatre. The presence of chest compressions is another factor that may further increase the difficulty to intubate the cardiac arrest victim. Thus, even intubation of patients with “normal airways” (Cormack-Lehane < III) may be challenging during CPR.

In order to manage patients with difficult airways, a wide variety of alternative techniques and devices have been developed, such as bougies or stylets, the Intubating laryngeal mask Airway (ILMA), flexible fibreoptic intubation, blind oral or nasal intubation and retrograde intubation (6). However, many of these devices may not be readily available because of their high cost, or may have a very steep learning curve. Moreover, some of these techniques are “blind” and, therefore, not reliable (7-9). Optical laryngoscopes and videolaryngoscopes are new intubation devices, which permit the visualization of the glottis indirectly, without requiring the alignment of the three axes (oral, pharyngeal and tracheal), using lenses and miniature videocameras, respectively. Several studies have demonstrated that they offer a superior laryngeal image compared to classic direct laryngoscopes (10-24). The main advantage of these devices is that they resemble the Macintosh laryngoscope, thus anaesthetists are able to use them successfully with minimal training (8). Airtraq is an optical laryngoscope with an anatomically shaped blade, containing two parallel...
participants were divided into two groups. The first group initially attempted intubation with Macintosh, first without chest compressions and afterwards with chest compressions. The second group initially attempted intubation with Airtraq\textsuperscript{®}, first without chest compressions and then with chest compressions. In order for each participant to attempt intubation with both devices, groups crossed over. Therefore, we simulated two different scenarios; (a) normal airway without chest compressions and (b) normal airway with chest compressions.

All intubation attempts were performed using a standard 7.5 mm ETT (Mallinckrodt Medical, Atholone, Ireland) and adult Resusci Anne\textsuperscript{TM} manikin. The manikin was placed in sniffing position in a standard hospital bed. Both the ETT and the manikin were lubricated according to manufacturers’ instructions. Regarding the laryngoscopes, a size 3 Macintosh blade and a regular Airtraq\textsuperscript{®} (blue) were used (Fig. 1). Before using Airtraq\textsuperscript{®} an ETT was loaded on the guiding channel.

Our primary endpoint was the estimation and comparison of hands-off time, when chest compressions had to be interrupted, using either Macintosh or Airtraq\textsuperscript{®}. Our secondary endpoint was the estimation and comparison of intubation times between the two laryngoscopes.

The time required for the first successful intubation attempt was defined as the time from insertion of the blade between the teeth until ETT placement in the trachea and cuff inflation by each participant. A pause of chest compressions exceeding 1.5 seconds during airway management was considered to be the beginning of hands-off time (27). Chest-compressions were continued during airway management attempts and the participants were asked to avoid stopping chest compressions, and therefore minimize hands-off time. In case the ETT insertion was not possible during ongoing chest compressions, the participant was advised to state “stop compressions”, complete the insertion process and, then, state “continue compressions” as soon as possible. When hands-off time exceeded 10 s, participants were instructed to interpose bag-mask ventilation for at least 30 s (30:2 ratio of compressions to breaths). As many as three attempts were allowed with each device. The ability to ventilate the manikin with a self-inflating bag designated a successful attempt. The time elapsed was recorded by a single observer, using always the same stopwatch. The same observer confirmed correct ETT placement. A failed intubation attempt was defined as an attempt in which the trachea was not intubated or an insertion attempt last-

**Fig. 1. — Airtraq (regular) and Macintosh (size 3).**

channels; the optical channel and the guiding channel (Fig. 1). The optical channel has a combination of lenses and prisms, which transmit the image to a proximal viewfinder. The guiding channel accommodates the ETT. Through the viewfinder, visualization of the glottis and the ETT tip is feasible. Standard ETTs up to 8.5 mm ID can be used with Airtraq. The ETT is loaded on the guiding channel before the laryngoscope’s insertion. Airtraq\textsuperscript{®} blade is then inserted into the mouth in the midline, over the tongue, and advanced slowly until the epiglottis comes into view. Then the laryngoscope is lifted up in such a way that the glottis comes in the centre of the image. Finally, the ETT is advanced through the vocal cords. In many instances several manoeuvres may be necessary in order to intubate the trachea, such as twisting or corkscrewing the ETT (25, 26).

In our trial, the hypothesis was that time of interruption of chest compressions (hands-off time) and intubation time can both be reduced with Airtraq\textsuperscript{®}, compared with the classic Macintosh laryngoscope.

**MATERIALS AND METHODS**

Thirty participants from five General Hospitals in Athens, Greece, were recruited in sessions organized from December 2014 to November 2015. The study population included anaesthetists, both consultants and residents, regardless of their gender, age, years of working experience and previous training or experience with Airtraq\textsuperscript{®} optical laryngoscope. The equipment was demonstrated by the same investigator in detail and participants were then allowed to familiarize themselves with it for about 5 min. Each participant was allowed to perform practice attempts until two successful endotracheal intubations were achieved, both with Macintosh and Airtraq\textsuperscript{®}. Then, they were randomly allocated to the order of intubation with each instrument, using sealed numbered envelopes. Thus, participants were divided into two groups. The first group initially attempted intubation with Macintosh, first without chest compressions and afterwards with chest compressions. The second group initially attempted intubation with Airtraq\textsuperscript{®}, first without chest compressions and then with chest compressions. In order for each participant to attempt intubation with both devices, groups crossed over. Therefore, we simulated two different scenarios; (a) normal airway without chest compressions and (b) normal airway with chest compressions.

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After comparing parametrically hands-off time between Macintosh and Airtraq®, using paired samples t-test, statistically significant difference was not noted (p = 0.326), as demonstrated in Table 2 and Figure 2.

Two way repeated measures ANOVA was used to analyze two factors: a) device and b) chest compressions, related to the average intubation time. Our conclusion was that participants were able to intubate the manikin more rapidly using Macintosh (18.68s with and 18.58s without chest compressions, respectively) than using Airtraq® (22.62s with and 22.03s without chest compressions, respectively) (Table 3, Fig. 3). On the contrary, there was not statistically significant difference of average intubation time between the two scenarios (without and with chest compressions), neither for Macintosh, nor for Airtraq® (Table 4, Fig. 3).

Discussion

Securing the airway in cardiac arrest victims should be considered early during CPR, for the reasons mentioned above. However, intubation should not interfere with chest compressions. This suggests that intubation should only be attempted by clinicians competent with the technique (3). Otherwise, the risk of failed intubation, misplaced tubes and prolonged intubation time may outweigh the benefits (28-38). However, direct laryngoscopy and endotracheal intubation during CPR may be a challenge even among experienced rescuers due to the presence of chest compressions and the suboptimal positioning of the patient, often observed in such emergency situations. If the cardiac arrest victim has a difficult airway, the challenge is even greater.
Video laryngoscopes and optical laryngoscopes are new intubation devices, which are considered valuable tools for difficult airway management. Several studies have proved that they offer better visualization of the glottis compared to standard direct laryngoscopes (10-24). Thus, video laryngoscopes may be useful when difficulty is encountered in intubating a cardiac arrest victim. Moreover, several studies have demonstrated that only a few intubations are needed for naive users to become proficient with video laryngoscopes (15, 39-44). Airtraq, more specifically, enables novices to perform successful intubations after minimal training (25, 45, 46). On the contrary, intubation with direct laryngoscopes has a steep learning curve, as 47-56 patients are required to reach an intubation success rate of 90% (47). That is why inexperienced users are dissuaded of attempting endotracheal intubation during CPR by the ERC. The 2010 ERC guidelines suggest that inexperienced users should attempt the insertion of a supraglottic device instead, despite the fact that endotracheal intubation is the gold standard method of securing the cardiac arrest victim’s airway (3). The introduction of video laryngoscopes in daily practice may be the answer, as novices may become competent with their use after a very short training period.

Numerous studies, both clinical and manikin, have compared the performance (intubation success rate, intubation time, complications etc.) of Airtraq optical laryngoscope and Macintosh standard laryngoscope. Some of these studies included only experienced anaesthetists, while others used unqualified medical staff. Moreover, some studies compared the performance of the two laryngoscopes in normal airways, while others in several difficult airway scenarios. Regarding intubation time, it seems that Macintosh performs better or, at least, the same with Airtraq among experienced anaesthetists, in patients with normal or in manikins with simulated normal airways (48-50). Only one manikin study demonstrated better intubation time with Airtraq among anaesthetists, both in easy and difficult airway scenarios (51). On the other hand, in several difficult airway scenarios, such as cervical immobility, morbid obesity, limited mouth opening, airway oedema etc., Airtraq offers better intubation times compared to Macintosh (52-57). When novices are the study population, things are different; Airtraq performs better than Macintosh, providing better intubation times (25, 45, 46, 58-62). In 2011 a systematic review and meta-analysis regarding the comparison of the two laryngoscopes (63) was published. It included 12 randomized controlled trials (manikin studies were excluded). In some of these trials experienced anaesthetists were the study population, while in others only novices participated. Lu et al. (63) note an important heterogeneity between results from individual trials, which constituted a limitation to the generalization of an overall result. The conclusion of the meta-analysis was that Airtraq reduced intubation time significantly in both experienced and novice intubators by 14 and 16 s, respectively. However, a subgroup analysis showed that Airtraq significantly improved intubation time in difficult airways (by 23 s), but not in normal airways.

There is scarce bibliography regarding hands-off time during airway management in cardiac arrest victims. Ruetzler et al. (27) estimated the hands-off time during airway management in cardiac arrest victims. Ruetzler et al. (27) estimated the hands-off time during airway management in cardiac arrest victims. Ruetzler et al. (27) estimated the hands-off time during airway management in cardiac arrest victims. Ruetzler et al. (27) estimated the hands-off time during airway management in cardiac arrest victims.

### Table 2
Comparison of mean hands-off time between the 2 devices

<table>
<thead>
<tr>
<th>Device</th>
<th>Mean</th>
<th>SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macintosh</td>
<td>0.103</td>
<td>0.40</td>
<td>0.326</td>
</tr>
<tr>
<td>Airtraq</td>
<td>0.110</td>
<td>0.42</td>
<td></td>
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</tbody>
</table>

Fig. 2. — Comparison of mean hands-off time between the 2 devices.
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Comparison of the two devices in each scenario

<table>
<thead>
<tr>
<th></th>
<th>Mean (s)</th>
<th>SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Without chest compressions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macintosh</td>
<td>18.68</td>
<td>5.39</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Airtraq®</td>
<td>22.62</td>
<td>5.87</td>
<td></td>
</tr>
<tr>
<td><strong>With chest compressions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macintosh</td>
<td>18.58</td>
<td>5.56</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Airtraq®</td>
<td>22.03</td>
<td>5.74</td>
<td></td>
</tr>
</tbody>
</table>

Table 3

Comparison of the two scenarios with each device

<table>
<thead>
<tr>
<th></th>
<th>Mean (s)</th>
<th>SD</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td><strong>Macintosh</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without chest compressions</td>
<td>18.68</td>
<td>5.39</td>
<td>0.893</td>
</tr>
<tr>
<td>With chest compressions</td>
<td>18.58</td>
<td>5.56</td>
<td></td>
</tr>
<tr>
<td><strong>Airtraq®</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without chest compressions</td>
<td>22.62</td>
<td>5.87</td>
<td>0.470</td>
</tr>
<tr>
<td>With chest compressions</td>
<td>22.03</td>
<td>5.74</td>
<td></td>
</tr>
</tbody>
</table>

Table 4

Fig. 3. — Comparison of mean intubation time curves between the two devices, in each scenario.

off time period during the insertion of six airway devices (endotracheal tube, Combitube, Easy tube, Laryngeal tube, LMA, and I-Gel) by emergency medical technicians. According to this study, supraglottic devices have a significant advantage over endotracheal intubation, as they reduce the interruption of chest compressions. Another manikin study by GRUBER et al. (64) compared the same airway devices and reached to the same conclusions.

In our study, there was not a statistically significant difference in hands-off time period during intubation with Macintosh and Airtraq® laryngoscopes by anaesthetists (Table 2). Regarding intubation time, it was not affected by chest compressions, as statistically significant difference was not observed comparing the two scenarios (with and without chest compressions) (Table 4). On the other hand, we observed a statistically significant difference in intubation time with the two laryngoscopes, regardless of the chest compressions’ presence (Table 3). Intubation with Macintosh was faster than intubation with Airtraq in both scenarios. This can be attributed to the lack of familiarity of the participants with Airtraq, as 56.7% of them had no previous experience with the optical laryngoscope. On the other hand, all the anaesthetists were competent with the standard Macintosh blade, as they all use it in their everyday practice. But there may also be another reason for these results. Although video and optical laryngoscopes offer a superior visualization of the glottis compared to standard laryngoscopes, this is not always matched with higher intubation success rates or faster intubation. And the reason for this lies to the working principle of these laryngoscopes; as stated above, optical and video laryngoscopes offer an indirect image of the glottis, without the alignment of the three axes. But the lack of alignment of the three axes makes it more difficult for the ETT to be introduced through the vocal cords. Several manoeuvres or preshaping of the ETT with a special stylet may be needed to achieve that, so the operators are advised to follow each manufacturer’s instructions in order to intubate the trachea successfully (65). All these manoeuvres may be time consuming and, this, may be the reason why many studies, including ours, demonstrated that intubation with Macintosh is faster, at least as far as normal airways are concerned (48-50). In difficult airways things are different, as standard laryngoscopes offer a poor laryngoscopic view and,
therefore, intubation is difficult and lengthy or, even, impossible. Optical and video laryngoscopes, on the other hand, convert these “blind” intubations into intubations under visual control and, therefore, intubation success rates and intubation times are better in these cases (52-57). Finally, when the study population consists of inexperienced users and not anesthesiologists, optical and video laryngoscopes perform better than the standard Macintosh blade, simply because they have a smaller learning curve (25, 45, 46, 58-62).

This study has a number of significant limitations. Firstly, it is a manikin study and results of manikin-based studies are limited in interpretation compared with clinical studies. Our manikins were placed in sniffing position, which is the preferred head position for intubation, despite the fact that in real life conditions cardiac arrest victims cannot always be placed optimally for airway management (i.e. head down, sniffing position). Another significant limitation is that the participants in our study were anaesthetists with a mean working experience of four years. However, rescuers of cardiac arrest victims in Europe are usually inexperienced intubators and, as explained above, the results in such a population would probably be different. Moreover, our volunteers did not have the same previous experience with Airtraq; some of the participants were familiar with the optical laryngoscope, while others had never used it before. On the contrary, all of them were competent with Macintosh. In addition to that, the study population was a convenience sample, as no power analysis was performed. Finally, the scenario without chest compressions always preceded the scenario with continuous chest compressions.

In conclusion, despite its proven role in difficult airway management, Airtraq does not seem to reduce hands-off time and intubation time during airway management in cardiac arrest victims with normal airways by experienced anaesthetists, compared with Macintosh laryngoscope. When Macintosh was used, less anaesthetists needed a second attempt to successfully intubate the manikin, while intubation time was shorter, regardless of the presence of chest compressions. Therefore, Macintosh seems to be the laryngoscope of choice when anaesthetists attempt intubation of cardiac arrest patients with normal airways.

References


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Evaluation of intubation using the Airtraq or Macintosh laryngoscope by anaesthetists in easy and simulated difficult laryngoscopy — a manikin study, Anaesthesia, 61, 469-477, 2005.


