AIRWAY MANAGEMENT AT FLOOR LEVEL: A COMPARISON OF TRACHEAL INTUBATION USING THE MACINTOSH AND AIRTRAQ LARYNGOSCOPES

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Summary

Practitioners providing pre-hospital care during civilian practice and on military operations may be required to perform airway management and tracheal intubation at floor level. It has been shown that intubation using the Airtraq laryngoscope is easier to learn than standard Macintosh laryngoscopy. We hypothesised that the Airtraq would be easier to use and have shorter intubation times than Macintosh intubation. Sixty volunteers attending a medical conference with no prior Airtraq experience, who were skilled in pre-hospital Macintosh intubation, were recruited. Each was required to intubate an anatomically correct manikin at floor level using a Macintosh and Airtraq laryngoscope. The Airtraq was found to be superior in ease of use (VAS 30mm, P<0.001), had a shorter total intubation time (19.4seconds) and a higher intubation success rate (P=0.012) than the Macintosh laryngoscope (VAS 50mm, 20.4seconds). Rotating the tracheal tube 90° anticlockwise during loading into the guiding channel, made the Airtraq intubation easier (VAS 30mm, P=0.001) and faster (19.4seconds, P<0.001) than with standard orientation of the tube (VAS 40mm, 25.3seconds). Airtraq intubation may prove to be easier than Macintosh intubation, when utilised in the clinical pre-hospital setting, though randomised controlled clinical trials are required to confirm this.

Introduction

Expertise in airway management and tracheal intubation is a desirable competency for clinicians providing pre-hospital care in the civilian setting [1] and for those enhancing the military Medical Emergency Response Team [2]. In civilian pre-hospital care paramedics are the most frequent providers of advanced airway management: in the military this role is provided by clinicians predominantly from the specialities of anaesthesia and emergency medicine. Maintaining advanced airway management skills is crucial, and both patient and manikin based simulation training have an important role. Patient based airway management training occurs mostly within a hospital setting, where the patients are located on trolleys or beds that can be adjusted for height. This is a luxury rarely afforded to the pre-hospital practitioner, where skill in airway management and tracheal intubation at floor level may be required. Within the modern NHS framework, the opportunity for clinicians to train to intubate on the floor is limited to manikins, as this is rarely necessary or ethical on hospital patients.

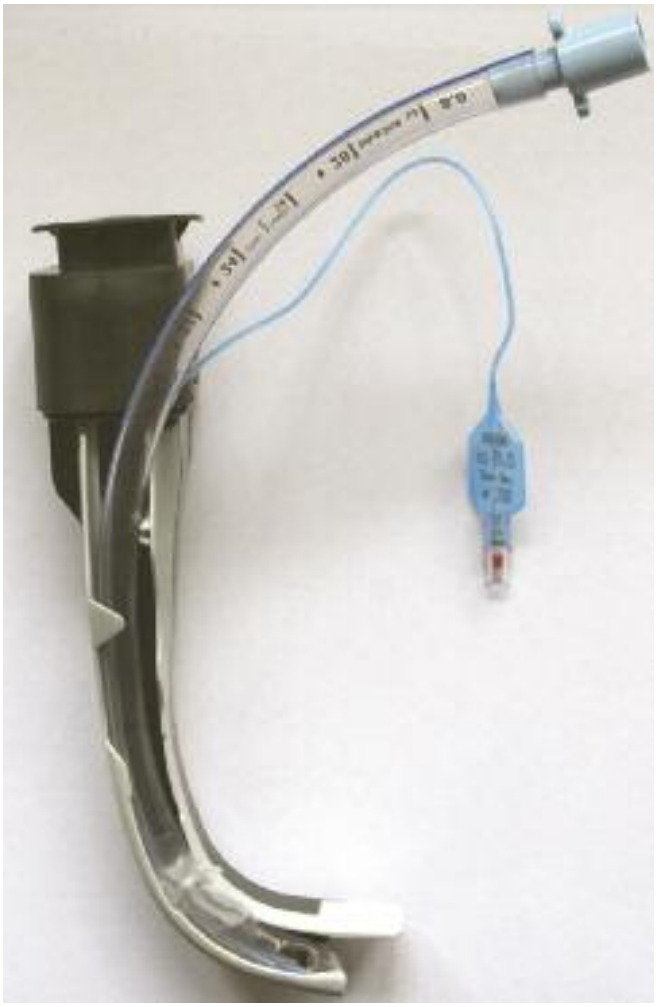

Figure 1. The Airtraq laryngoscope with tracheal tube loaded in guiding channel (lateral view).

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In the UK, the gold standard device used to intubate the adult trachea is the Macintosh laryngoscope, which is used to align the oral, pharyngeal and laryngeal axes providing a direct line of sight from the upper incisors to the vocal cords. Visualising the vocal cords using the Macintosh laryngoscope, whilst the patient is on the floor, can be a challenge even for experienced practitioners, especially when the cervical spine is immobilised or when access to the head or floor space is limited [3]. The Airtraq laryngoscope (Prodol Meditec SA., Vizcaya, Spain) does not require a direct line of sight [4] to obtain an adequate view of the glottis and surrounding structures (Fig 1). It has been used successfully following failed direct laryngoscopy in patients with suspected difficult airways [5, 6] and as an alternative to fibreoptic endoscopy in both anaesthetised and awake patients [7, 8].

The purpose of this study was to evaluate the role of the Airtraq for use by practitioners experienced in pre-hospital intubation in anatomically correct manikins at floor level. We hypothesised that the Airtraq would be superior to the Macintosh laryngoscope in both ease of use and with shorter intubation times. We also evaluated the Airtraq with the tracheal tube loaded with different orientations of the tip. We hypothesised that during loading, if the tracheal tube was rotated anticlockwise so the tip was anterior, the intubation would be easier than the standard method of loading the tube, where the tip was on the right.

Figure 2. Laerdal airway training manikin at floor level.

Methods

Delegates attending the 2007 International Trauma Care Conference, with no prior Airtraq experience, who were skilled in pre-hospital tracheal intubation using the Macintosh laryngoscope, were invited to participate in the study. Following ethical approval and written informed consent, each participant was given a standardised two minute introduction to the Airtraq laryngoscope by one of the investigators. This included a demonstration of the intubation technique, which followed standardised insertion guidelines [9]. Each participant was allowed a maximum of three minutes to practice intubation on an airway training manikin, using both the Macintosh and Airtraq laryngoscopes.

All participants were then provided with standardised intubation equipment and an airway training manikin (Airway Management Trainer, Laerdal, Stavanger, Norway), which was located at floor level (Fig 2). They were informed that this part of the study had three phases. Each phase would start with mask ventilation of the manikin using a self-inflating bag, followed by tracheal intubation: once using a Macintosh laryngoscope, and twice with an Airtraq laryngoscope. A size 3 Macintosh laryngoscope and regular Airtraq laryngoscope was used during the study. The practitioners performed all the intubations unaided, using a lubricated 8.0-mm cuffed tracheal tube. They were instructed to intubate the manikin in a time efficient manner and that recommencing mask ventilation was not necessary between intubation attempts.

Figure 3. Standard orientation of the tracheal tube (tip of the tube and Murphy eye are to the right) within the guiding channel on an Airtraq laryngoscope.

The two Airtraq groups were known as Airtraq S (standard) and Airtraq A (anticlockwise). In Airtraq group S, the tracheal tube was pre-loaded so the tip of the tube and the Murphy eye was in the standard location on the right (Fig. 3). In Airtraq group A, the pre-loaded tracheal tube was rotated 90° anticlockwise, so the tip of the tube and the Murphy eye was anterior (Fig. 4). Prospective simple randomisation of the order in which the participants performed the three intubations was achieved using a random numbers table. Using a digital stopwatch, a time keeper recorded the time at two points during the intubation attempt in each of the three groups. The clock was started when the face mask was removed from the manikin. Using the 'lap' function, the intubation time (T1) was recorded when the tube was inserted through the vocal cords into the trachea. The participant was instructed to verbally inform the time keeper when this was

achieved. Once the self-inflating bag had been attached to the tube and inflation of the lungs confirmed, the watch was stopped and the total intubation time (TT) was recorded. Correct positioning of the tracheal tube was confirmed by the researchers. Inability to intubate the trachea or an attempt which required >30s to complete, was recorded as unsuccessful. The number of intubation attempts, optimisation manoeuvres (e.g. adjustment of head position, or use of a bougie) and oesophageal intubations were recorded. A feature of the airway training manikin used was that an audible click occurred when pressure was directed by the laryngoscope onto the incisor teeth. During each intubation attempt the severity of dental trauma was calculated based on the number of dental clicks recorded.

Immediately following the intubation, each participant scored the ease of laryngoscopy for each of the three groups (from 0 = extremely easy to 100 = extremely difficult) by marking a 100mm visual analogue scale (VAS).

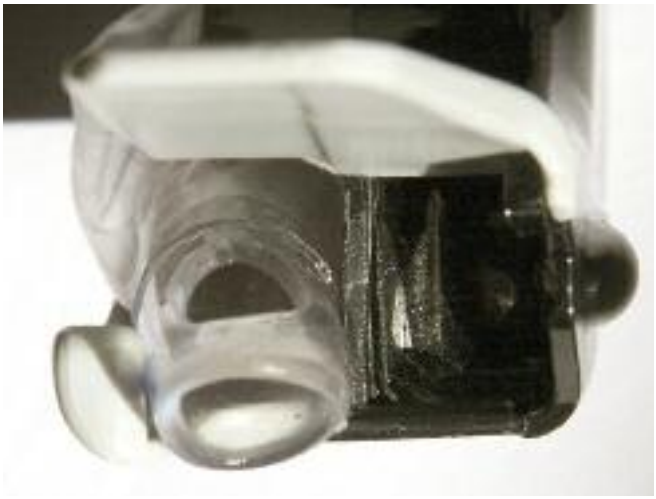

Figure 4. A tracheal tube rotated 90° anticlockwise (tip of the tube and Murphy eye are anterior) within the guiding channel on an Airtraq laryngoscope.

Statistics

During the process of designing this study, similar research studies had not been published or their data remained unreported, we were therefore unable to perform a prospective sample size calculation. Following the advice of our statistician we decided not to perform a retrospective power calculation. Consequently we opted for a convenience sample of all conference delegates prepared to be recruited into our study. The Friedman test (followed by post hoc multiple comparison tests) was used to compare the VAS score recorded following intubation and the two intubation timings between the three groups. The number of dental clicks was evaluated using the McNemar-Bowker test and the McNemar's test was used to evaluate the number of intubations attempts / manoeuvres. A P value of <0.05 was considered statistically significant. Statistical analysis was performed using SPSS 15.0 for Windows (SPSS Inc., Chicago, IL). Analysis was by intention to treat.

Results

Sixty practitioners were recruited into the study and the training experience of the participants is shown in Table 1. 65% of the clinicians were from anaesthesia and 35% were from emergency medicine.

Grade	Number of participants n = 60
Consultant	15 (25%)
Specialist Registrar	5 (8%)
Paramedic	40 (67%)

Table 1. Participant characteristics. Data are presented as number (percentage).

Data collected during tracheal intubation in each of the three groups is shown in Table 2. The median total intubation time (TT - from face mask removal to lung inflation) in Airtraq group A (19.4 seconds) was significantly lower than in Airtraq group S (25.3 seconds, P<0.001). The total intubation time (TT) in Airtraq group A was lower than the Macintosh group (20.4 seconds, P=0.09) which was lower than Airtraq group S (P=0.06), but neither of these differences was significant. The median intubation time (T1 - from face mask removal to tracheal tube insertion) in Airtraq group A (15.1 seconds) was significantly lower than in Airtraq group S (19.4 seconds, P<0.001). The T1 time in Airtraq group A was lower than the Macintosh group (16.5 seconds, P=0.11) which was lower than Airtraq group S (19.4 seconds, P=0.06), but neither of these differences was significant.

The ease of laryngoscopy VAS scores for each of the three groups is shown in Table 2. Intubation in Airtraq group A was significantly easier (VAS difference = 30mm) than in both Airtraq group S (40mm, P=0.001) and the Macintosh group (50mm, P<0.001). The intubation in Airtraq group S was also significantly easier than in the Macintosh group (P<0.001). When comparing individual VAS scores in the Macintosh group with Airtraq group A, 88% of the scores are greater, 8% are the same and 3% are lower.

No statistical difference was identified between the number of intubation attempts or manoeuvres required to aid tracheal intubation (Table 2). Similarly no statistical difference was identified for the number of dental clicks recorded for each group.

Table 3 shows the data on those participants who successfully completed the intubation within 30 seconds in all three groups. The proportion of successful intubations varies significantly between groups. The total intubation success rate was higher with Airtraq A versus Macintosh (difference = 15%, 95% CI 4 to 27%, P=0.012) and with Airtraq A versus Airtraq S (difference = 25%, 95% CI 13 to 37%, P=0.0003). There was no statistically significant difference in total intubation success rate between the Macintosh and Airtraq S groups (difference = 10%, 95% CI -4 to +25%, P=0.21). The clinicians appeared to have a higher intubation success rate than the paramedics although this only achieved statistical significance in the Airtraq S group (difference in success rate 38%, 95% CI 14 to 53%, P=0.003). All unsuccessful intubations were completed within 120 seconds. No oesophageal intubations were recorded.

Discussion

Pre-hospital tracheal intubation at floor level represents a greater challenge than intubation in a controlled, in-hospital environment, with the patient on a trolley or bed. Our study demonstrates that it is significantly easier to intubate manikins at floor level with the Airtraq laryngoscope (with both orientations of the tip of the tracheal tube) than with the Macintosh laryngoscope (P<0.001). When used by trained practitioners the Airtraq could improve and simplify tracheal intubation in the pre-hospital environment. The Airtraq has many favourable characteristics and its introduction may usefully supplement existing airway management equipment [3, 4, 10].

Rotating the tracheal tube 90° anticlockwise (so the tip of the tracheal tube and the Murphy eye is anterior) during loading into the guiding channel, has the effect of making the Airtraq intubation easier and faster than both Macintosh intubation and Airtraq (standard orientation) intubation. Loading the tracheal tube in the standard position may cause the tip of the tracheal tube to hook on the right arytenoid cartilage as it passes from the guiding channel towards the vocal cords, which could explain why the Macintosh group had lower median intubation

	Macintosh n = 60	Airtraq (S) n = 60	Airtraq (A) n = 60
Two attempts / manoeuvres	4 (7%)	9 (15%)	3 (5%)
Use of bougie	3 (5%)	NIL	NIL
Dental clicks	0 [0 – 0] (0 – 4)	0 [0 – 1] (0 – 6)	0 [0 – 0] (0 – 5)
VAS (mm)	50 [40 – 65] (20 – 100)	40* [20 – 50] (0 – 100)	30* [20 – 30] (0 – 60)
T1 - Intubation time (sec) (Mask removal to tube insertion)	16.5 [11.8 – 24.2] (8.5 – 79.1)	19.4 [14.4 – 27.4] (6.9 –116.4)	15.1* [11.5 – 19.1] (7.5 –49.1)
TT - Total intubation time (sec) (Mask removal to lung inflation)	20.4 [16 – 28.4] (10.1 – 85.0)	25.3 [19.8 – 32.5] (9.2 –119.2)	19.4* [16 – 24.6] (11.2 – 52.8)

*Table 2. Data from tracheal intubation in all three groups. Data are presented as number (%) or median [inter-quartile range] (range). * P < 0.001*

	Macintosh	Airtraq (S)	Airtraq (A)
Total successful intubations	48/60 (80%)	42/60 (70%)	57/60 (95%)
Successful Paramedics	30/40 (75%)	23/40 (58%)	37/40 (93%)
Successful Clinicians	18/20 (90%)	19/20 (95%)*	20/20 (100%)

Table 3. Data from successful intubations (total intubation time <30 seconds) in all three groups. Data are presented as number (%). P = 0.003*

times (T1 and TT) and lower VAS scores than Airtraq group S. The same problem of hooking on the arytenoid occurs when railroading a tracheal tube over a fibrescope or a bougie [11], and a simple solution to this problem is to rotate the tube in an anticlockwise direction as it is advanced. Trying to rotate a well lubricated tracheal tube away from the right arytenoid cartilage whilst it is within the Airtraq guiding channel is a difficult manoeuvre, and may risk damaging the cuff. Although the evidence supporting the anticlockwise rotation of the tube during loading into the Airtraq is statistically significant for intubation time, ease of use (P<0.001 for both) and intubation success rate (P=0.0003), we acknowledge that the data is based on manikins. Prior to proposing a change to the Airtraq intubation guidelines [12], patient based studies are required to confirm our results and to evaluate the clinical significance of our findings.

Whilst Airtraq intubation is quick to learn [10], it also provides a full indirect view of the glottis, which could reduce the incidence of pre-hospital oesophageal intubation [13], although further studies would be required to confirm this hypothesis.

In certain circumstances, the threshold for performing a surgical airway [14] is thought to be inversely proportional to expertise with managing difficult airways and laryngoscopy. Following appropriate training, the Airtraq could provide military practitioners, who are inexperienced using the Macintosh laryngoscope, with the skills to easily intubate the trachea from above the vocal cords.

Recruiting delegates from a focused clinical conference may potentially introduce sampling bias and we acknowledge that this is a limitation of our study. The study population arguably have a greater commitment to their education and professional development and they are potentially more knowledgeable in airway management and may have achieved greater or lesser success than those who did not attend the conference.

During laryngoscopy, when the pharynx is contaminated with blood, the use of suction is essential to ensure an adequate view of the glottis. If blood obscured the distal optical channel of the Airtraq laryngoscope then this view would be compromised. However, regular suctioning of the pharynx during Airtraq intubation has been reported to effectively remove blood and airway secretions, without obscuring the view of the glottis [5]. To date, there is limited data evaluating the use of the Airtraq laryngoscope during the application of cricoid pressure [15].

Floor based simulation training in airway management and intubation would provide valuable experience to clinicians working in civilian pre-hospital settings and to Defence Medical Services personnel providing medical support to military operations.

Given its potential ease of use and advantages over direct laryngoscopy [4], patient-based randomised controlled trials evaluating the Airtraq laryngoscope should be conducted in both military and civilian pre-hospital environments.

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Potential conflict of interest

The Airtraq laryngoscopes and airway training manikin used in this study were provided by Fannin UK Ltd, who are the UK distributors of the Airtraq (Fannin UK Ltd, Reading). However, the study sponsors did not provide financial support and were not involved in the study design, analysis of the data, preparation of the manuscript or the decision to submit it for publication.

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