

COMPARISON OF USE OF THE THE AIRTRAQ WITH DIRECT LARYNGOSCOPY BY PARAMEDICS IN THE SIMULATED AIRWAY

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ABSTRACT

Introduction. Paramedics often encounter patients with difficult airways requiring emergent airway management. **Objective.** The purpose of this study was to compare intubation utilizing the Airtraq with direct laryngoscopy (DL) in the manikin model. We evaluated the number of attempts, the time to successful intubation, and the Airtraq's learning curve. **Methods.** This was a randomized, crossover study involving paramedics. Each participant was given a standardized lecture and a demonstration of the Airtraq device. After a 5-minute practice session on a Laerdal Airway Management Trainer with the Airtraq and DL, participants managed the following four scenarios on a Laerdal SimMan manikin: 1) normal airway; 2) tongue edema; 3) cervical spine immobilization; and 4) repeated normal airway. Results were analyzed using the Wilcoxon signed rank test. **Results.** Thirty paramedics participated in this study. For scenario 1, there were no significant differences in either the number of attempts or the time to ventilation between the devices. For scenario 2, the mean time to ventilation was significantly faster, and fewer intubation attempts were observed with the Airtraq when compared with DL. For scenario 3, there were no significant differences in number of attempts and time to ventilation. Scenario 4 demonstrated significantly less time to ventilation and fewer intubation attempts with the Airtraq. A significant decrease in time to ventilation was observed with the Airtraq when comparing scenarios 1 and 4. **Conclusions.** The Airtraq was shown to be equal to or faster than DL. The Airtraq has a rapid learning curve demonstrated by a significantly decreased time to ventilation between scenarios 1 and 4. **Key words:** airway; Airtraq; simulation; paramedic; prehospital; out-of hospital; intubation.

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INTRODUCTION

Although paramedics have been practicing out-of-hospital endotracheal intubation for more than 25 years, several relatively recent studies suggest that frequent complications and adverse outcomes are associated with this procedure.¹⁻⁸ Compared with practitioners of other medical specialties, paramedics routinely intubate patients in challenging and uncontrolled settings. Therefore, any airway device that could make intubation easier and result in fewer complications may be useful in the out-of-hospital setting.

The Airtraq Optical Laryngoscope (Prodol, Spain) (Fig. 1) is a disposable, single-use device that provides views of laryngeal structures without requiring alignment of the oral, pharyngeal, and tracheal axes. The device is constructed with an anatomically shaped blade that contains two parallel channels. The first channel is the optical channel, and contains a series of lenses and prisms along with a battery-operated light source and a warming element at the tip to prevent fogging. The second channel is a guiding channel that houses and directs the endotracheal tube (ETT). The blade is inserted into the patient's mouth at midline, with the patient's neck in a neutral position. The tip of the Airtraq can be directed either into the vallecula or under the epiglottis. The operator looks through the optical channel, where he or she can indirectly view the glottis and tip of the ETT. After the glottis is centered into the operator's field of view, the ETT is advanced down the guiding track and through the vocal cords. A clear view of correct ETT placement is enabled through the entire procedure.

Prior studies have shown that the Airtraq is equal to or better than traditional methods of direct laryngoscopy (DL).⁹⁻¹⁹ Furthermore, studies evaluating its use on manikin models have shown a rapid learning curve when used by providers who are inexperienced with the device.^{9,11,13,16,20} To our knowledge, use of the Airtraq by out-of-hospital providers has not been thoroughly evaluated. A manikin-based study by Woollard et al.¹⁷ showed that the Airtraq was superior to DL when used by experienced prehospital practitioners. However, participants were granted only three attempts with one difficult airway scenario.

The purpose of this study was to compare use of the Airtraq Optical Laryngoscope with DL by paramedics in the manikin model given easy and difficult airway

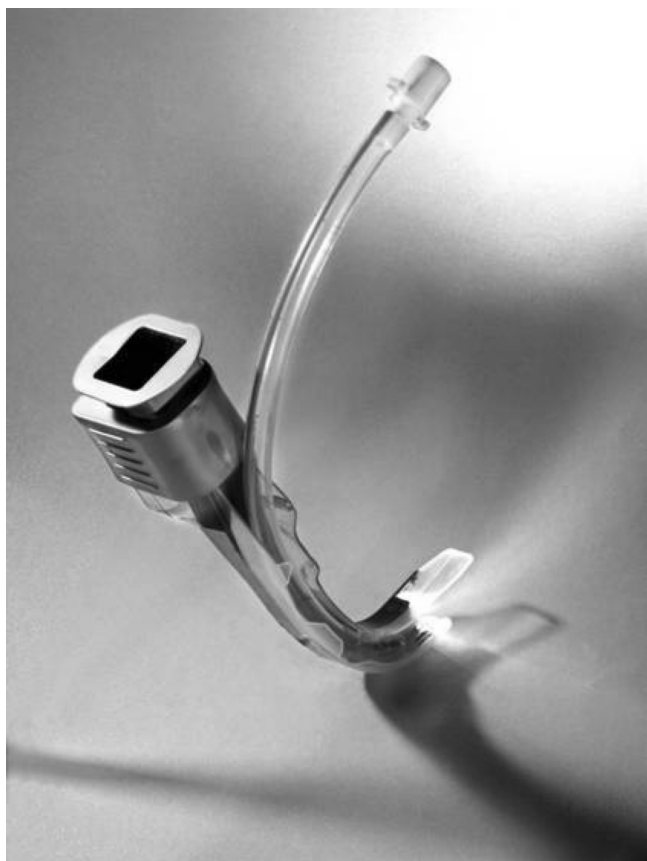


FIGURE 1. The Airtraq Optical Laryngoscope.

scenarios. In addition, we evaluated the learning curve associated with the device.

METHODS

Study Setting and Population

This study was approved by our institutional review board and was conducted in our institution's simulation center using three high-fidelity simulators. The study group comprised 30 paramedics with more than one year of experience.

Study Design and Protocol

This was a randomized, crossover study. Paramedics were told that a new airway device was being evaluated but were blinded to the study hypothesis. Participants were given a standardized 10-minute lecture followed by a demonstration of the Airtraq device and a set of instructions regarding its use. Each participant was then allowed a 5-minute practice session on a Laerdal Airway Management Trainer (Laerdal Medical Corporation, Wappingers Falls, NY) with the Airtraq and DL using a Macintosh 3 blade. All intubations were performed with a 7.5-mm cuffed ETT. A Macintosh 3 blade and malleable stylet were used

for all intubations performed using DL. The participants then managed the following four scenarios on a Laerdal SimMan manikin placed supine on the floor: 1) normal airway; 2) tongue edema; 3) cervical spine immobilization; and 4) repeated normal airway. Computer-generated randomization was used to establish the order of Airtraq versus DL used for each scenario. For scenario 3, the manikin was set to decreased cervical range of motion and a study investigator held manual in-line cervical immobilization at the direction of the participant for the duration of the scenario, to better replicate the more realistic environment.

The primary endpoint was time to ventilation via the ETT. This was defined as the time from passage of the tip of the blade past the teeth to successful ventilation of the manikin. Successful ventilation was confirmed using the airway pressure monitors on the manikin. A failed intubation was defined as inability of a participant to ventilate the manikin within 180 seconds through the ETT. Secondary endpoints included the number of intubation attempts, defined as removal and reinsertion of the blade, and the overall intubation success rate.

A power calculation was run for time to ventilation based on empirical data from a prior simulation study comparing use of the two devices by medical students new to airway management in several scenarios.¹¹ For a normal airway scenario (equivalent to two of the four scenarios in the current study), a sample size of 23 was required to achieve 80% power to detect the difference of 22 seconds (found for the data set of the prior simulation study) or more. The reference study reported t-test analyses for time to ventilation, but because the investigators were unable to be sure of a normal distribution a priori, sample size for that study was calculated based on a two-sided Wilcoxon signed rank test ($\alpha = 0.05$) with an assumption of a logistic distribution.²¹ For the current study, a larger sample goal was chosen because of the inclusion of a different study population and different scenarios.

Data Analysis

Time to ventilation (primary endpoint) and number of attempts are reported as median and range. The differences for these two outcomes between the Airtraq and DL were compared using Wilcoxon signed rank tests to accommodate the lack of normality in the distributions. Wilcoxon rank sum tests were first used to compare paramedics completing the trials for the two instruments in opposite order for each scenario. No differences were found for order on any of the scenarios, and therefore order was not further used in the analysis. All analyses were performed with SPSS for Windows, version 14.0 (SPSS Inc., Chicago, IL).

TABLE 1. Paramedic Self-Reported Demographic Data*

Years of experience, median (range)	3 (1–16)
Blade preference	
Macintosh	20 (69%)
Miller	9 (21%)
Intubations per year	
0 to 5	5 (17%)
5 to 10	6 (21%)
10 to 15	9 (31%)
15 to 20	8 (28%)
20 to 25	1 (3%)
>25	0
Intubations per year with cervical spine immobilization	
0 to 5	22 (76%)
5 to 10	7 (24%)
>10	0

*Data from 29 of 30 participants.

RESULTS

Demographics

Thirty paramedics with more than one year of experience participated in the study. Prior out-of-hospital experience ranged from one to 16 years (median 3 years) (Table 1). Twenty paramedics (69%) reported preference for the Macintosh blade during intubation and seven (24%) reported prior training in rapid-sequence intubation.

Scenario 1 (Normal Airway 1)

There were no significant differences in time to ventilation, number of attempts, or overall intubation success rate for this scenario (Table 2). All paramedics successfully intubated the trachea with both methods. Median (minimum, maximum) time to ventilation was 22.5 seconds (11, 168) and 23.5 seconds (11, 65) for the Macintosh blade and the Airtraq, respectively ($p = 0.544$). The median number of intubation attempts was 1.0 and the range was 1 to 2 for both the Macintosh and the Airtraq ($p = 0.102$).

Scenario 2 (Tongue Edema)

There were significant differences in time to ventilation, number of attempts, and overall intubation suc-

TABLE 2. Comparison of Time to Ventilation, Number of Intubation Attempts, and Overall Intubation Success Rate for the Airtraq vs. the Macintosh Blade on the First Normal Airway Scenario (Scenario 1) ($N = 30$)

	Macintosh	Airtraq
Success rate	30 (100%)	30 (100%)
Time to ventilation, median (range)	22.5 sec (11, 168)	23.5 sec (11, 65)
Number of attempts		
1	25 (83%)	29 (97%)
2	5 (17%)	1 (3%)

TABLE 3. Comparison of Time to Ventilation, Number of Intubation Attempts, and Overall Intubation Success Rate for the Airtraq vs. the Macintosh Blade on the Tongue Edema Airway Scenario (Scenario 2) ($N = 30$)

	Macintosh	Airtraq
Success rate	2 (6.7%)	24 (80%)
Time to ventilation, median (range)	180 sec (35, 180)	56.5 sec (17, 180)
Number of attempts*		
1	1 (4%)	20 (69%)
2	6 (26%)	6 (21%)
3	8 (35%)	3 (13%)
4	1 (4%)	0
5	4 (17%)	0
6	2 (9%)	0
7	1 (4%)	0

*Missing data on seven failed intubation attempts with the Macintosh blade ($n = 23$) and one failed attempt with the Airtraq ($n = 29$).

cess rate for this scenario (Table 3). Only two participants (6.7%) successfully intubated the trachea with the Macintosh blade, compared with 24 (80%) using the Airtraq. Median time to ventilation for the Macintosh was 180 seconds (35, 180) compared with 56.5 seconds (17, 180) for the Airtraq; a difference of 123.5 seconds ($p < 0.00004$). Twenty-two paramedics were faster with the Airtraq, compared with only two who were faster with DL; there were six ties. The median number of intubation attempts was 3 (1, 7) for the Macintosh and 1 (1, 3) for the Airtraq ($p < 0.0001$).

Scenario 3 (Cervical Spine Immobilization)

There were no significant differences in time to ventilation, number of attempts, or overall intubation success rates (Table 4). Twenty-nine paramedics (96.7%) successfully intubated the trachea with the Macintosh blade, compared with 30 (100%) with the Airtraq. The median time to ventilation was 32 seconds (13, 180) with the Macintosh and 29 seconds (14, 156) for the Airtraq ($p = 0.361$). The median number of attempts was 1 for both the the Airtraq and the Macintosh for this scenario; six participants had fewer attempts with the Airtraq

TABLE 4. Comparison of Time to Ventilation, Number of Intubation Attempts, and Overall Intubation Success Rate for the Airtraq vs. the Macintosh Blade on the Cervical Spine Immobilization Scenario (Scenario 3) ($N = 30$)

	Macintosh	Airtraq
Success rate	29 (96.7%)	30 (100%)
Time to ventilation, median (range)	32 sec (13, 180)	29 sec (14, 156)
Number of attempts		
1	23 (78%)	27 (90%)
2	4 (13%)	2 (7%)
3	2 (7%)	1 (3%)
4	1 (4%)	0

TABLE 5. Comparison of Time to Ventilation, Number of Intubation Attempts, and Overall Intubation Success Rate for the Airtraq vs. the Macintosh Blade on the Second Normal Airway Scenario (Scenario 4) ($N = 30$)

	Macintosh	Airtraq
Success rate	30 (100%)	30 (100%)
Time to ventilation, median (range)	20.5 sec (10, 168)	17.5 sec (10, 29)
Number of attempts		
1	25 (83%)	30 (100%)
2	5 (17%)	0

and only one with the Macintosh (23 ties), resulting in a slight statistical trend ($p = 0.053$).

Scenario 4 (Normal Airway 2)

All participants successfully intubated the trachea with both devices (Table 5). However, significant differences between the methods in time to ventilation and number of attempts were observed. Median time to ventilation was 20.5 seconds (10, 168) for the Macintosh and 17.5 seconds (10, 29) for the Airtraq ($p = 0.002$). Twenty-three participants were faster using the Airtraq and six were faster using the Macintosh. The median number of intubation attempts was 1 for both the Macintosh and the Airtraq. However, all participants successfully intubated the trachea with the Airtraq on the first attempt, compared with two attempts by five participants with the Macintosh, resulting in a significant difference in signed ranks ($p = 0.025$).

Comparison of Normal Airway Scenarios

There were no significant differences between number of attempts or time to ventilation for the Macintosh blade between the two normal airway scenarios (scenarios 1 and 4). The median time to ventilation using the Macintosh was 22.5 seconds (11, 168) for scenario 1 and 20.5 seconds (10, 168) for scenario 4 ($p = 0.611$). For the Airtraq, the median time to ventilation for scenario 4 was 17.5 seconds (10, 29) versus 23.5 seconds (11, 65) for scenario 1 ($p = 0.001$), a difference of 6 seconds (Fig. 2). The median number of intubation attempts with both instruments for both scenarios was 1 ($p = 0.317$); using the Airtraq for scenario 4, all participants succeeded on the first attempt.

DISCUSSION

This study demonstrates that in the hands of experienced paramedics with minimal training, the Airtraq Optical Laryngoscope is faster than or equal to traditional methods of DL with a Macintosh blade in a manikin model for both easy and difficult intubations. Our findings are consistent with those of prior stud-

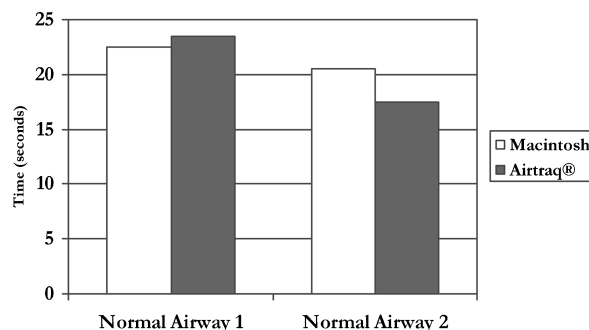


FIGURE 2. The Airtraq learning curve. The median time to ventilation with the Airtraq improved between scenarios 1 and 4: $\Delta T = 8.4$ sec ($p = 0.001$).

ies suggesting that the Airtraq is easy to use and has a rapid learning curve when used by providers who are inexperienced with this device. Furthermore, our study shows that these findings also apply when the Airtraq is used by paramedics performing endotracheal intubation on the ground, which better replicates their intubation environment. The Airtraq was found to be equal to DL in the participants' first normal airway scenario, but not faster. In the participants' final normal airway scenario, however, the time to ventilation was significantly shorter with the Airtraq compared with the Macintosh blade. Participants in this study received only a brief lecture and introduction period, followed by four airway scenarios. Although this amount of training should not be interpreted as being enough to become proficient to use the Airtraq in the clinical setting, it does suggest that the Airtraq has a rapid learning curve and that after just a few uses the operator becomes more proficient with the device. The maximum time allowed was 180 seconds, and therefore the actual time differences between the devices may be more profound for the tongue edema scenario and the second normal airway scenario. Ventilation can be initiated with the Airtraq still in position, unlike ventilation during DL, and this may contribute to the faster times seen, particularly in the normal airway, where experienced laryngoscopists are already very quick.

Successful intubation was achieved on the first attempt with the Airtraq by all paramedics during the final scenario, compared with 83% in the DL group. A significantly fewer number of attempts was also demonstrated in the tongue edema scenario. The complication rate during airway management is known to rise as the number of intubation attempts increases.²² Fewer attempts seen with use of the Airtraq in these scenarios may lead to decreased complication rates associated with multiple attempts at DL.

The overall intubation success rate was significantly higher in the tongue edema scenario when using the Airtraq. This suggests that there may be cases in which the Airtraq would allow intubation when DL would

have failed. This benefit might therefore be more noticeable in difficult airway cases. Physical examination can often help predict a difficult airway; however, the unexpected difficult airway is often more challenging. Paramedics routinely intubate patients in difficult and uncontrolled settings. Furthermore, several studies within the last decade suggest that frequent complications and adverse outcomes are associated with out-of-hospital intubation.^{1–8} Direct laryngoscopy is a complex intervention, and skills are difficult to acquire^{23,24} and maintain²⁵ if not performed frequently. The current national paramedic curriculum requires only five endotracheal intubations for one to graduate,²⁶ compared with emergency medicine, anesthesiology, and nurse anesthetist training program requirements of 35 to 200 intubations.^{27–30} In addition, Wang et al. evaluated 2003 statewide data from Pennsylvania and found that out-of-hospital intubation is an infrequently performed procedure. Thirty-nine percent of providers in their population performed no out-of-hospital intubations and 67% performed two or fewer intubations a year.³¹

This new airway device may be useful as a primary or backup device for out-of-hospital intubations. Many advanced airway devices require a significant amount of training and time invested in skill acquisition as well as skill maintenance. The ease of use and potential for decreased complications would be important for paramedics who perform limited numbers of out-of-hospital intubations using traditional methods of DL.

Limitations

There are a number of limitations to this study. Paramedic participation was voluntary and, therefore, may result in a sampling bias of enthusiastic practitioners who are interested in education and research. Furthermore, this study design evaluated only laryngoscopy and did not seek to replicate an entire intubation scenario. Participants were allowed as many attempts as possible, no backup airway devices were offered, and ventilation between attempts was not required. Therefore, it is unknown how the Airtraq would compare with DL if other steps in the intubation process were included. In addition, the use of manikins does not fully replicate the intubation environment of live humans.

CONCLUSION

We found the Airtraq Optical Laryngoscope to be equal to or faster than DL in simulated easy and difficult airway scenarios. This device appears to have a rapid learning curve after minimal training and may be useful as a primary or backup device for out-of-hospital endotracheal intubation. Although the Airtraq shows promise, it is not known how the device will perform

in the clinical out-of-hospital environment. Our findings will need to be verified with prospective clinical trials.

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