

The Airtraq™ Optical Laryngoscope: A Retrospective Audit Of Optimal Usage Characteristics In Clinical Practice

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Citation

A Joffe, H Olivar, A Dagal, R Raver, A Grabinsky. *The Airtraq™ Optical Laryngoscope: A Retrospective Audit Of Optimal Usage Characteristics In Clinical Practice*. The Internet Journal of Anesthesiology. 2010 Volume 29 Number 1.

Abstract

Purpose: To describe intubation success and the device manipulations needed to obtain adequate glottic views to facilitate successful first attempt tracheal tube passage with the Airtraq. **Methods:** Retrospective audit of anonymously collected prospective data from a departmental equipment purchasing committee sponsored device trial. Descriptive data is provided. The odds of successful passage of the tracheal tube on the first attempt without repositioning when the posterior arytenoids cleft was in the left lower quadrant of the view from the Airtraq was compared to its location in any of the other quadrants using a contingency table and presented as OR (95% CI). **Results:** All patients were successfully intubated with the Airtraq (median time 28 seconds). Device repositioning to attain adequate view of the glottis occurred in 30-48% of insertions depending on whether it was a back-up or rotational motion. The odds of successful intubation on first attempt was thirty times higher when the posterior interarytenoid cleft was in the lower left quadrant of the operators view (95% CI [4-300], $p < .0001$). **Conclusions:** Our results support the ease of use and attainment of skills of the Airtraq in inexperienced users. More importantly, our results suggest that maneuvering the device to obtain a view of the glottic structures in the lower left quadrant of operator's view leads to the highest likelihood of first attempt intubations success.

INTRODUCTION

The Airtraq™ optical laryngoscope (AT, ProMedic, Inc., Bonita Springs, FL, USA) is an indirect optical laryngoscope, which incorporates a guide channel into the blade of the device. Thus, it is classified as a “non-steering” device. That is to say that, in contrast to devices such as the Glidescope™ (Verathon, Inc., Bothell, WA, USA) where a laryngeal view is obtained with one hand and the tracheal tube is “steered” to the target with the other, the tracheal tube residing within a preformed guide channel will go where the tip of the device is aimed and cannot, itself, be “steered” without also

maneuvering the device. The AT has an anatomically shaped blade, which provides a view angle of approximately 260-270 degrees and a wide visual field at the tip of the blade of approximately 4-6 cm [1]. In its current form, the device consists of a two-piece molded plastic housing, a power source consisting of small batteries wired through the device to supply a light source at the distal end, which also acts as a heating/defogging mechanism. Inside the housing, images obtained at the viewing tip are transmitted to a hooded eyepiece at the proximal end via a series alignment of prism-mirror-prism-prism-mirror-prism-prism (figure 1).

Figure 1

Figure 1. An Airtraq optical laryngoscope (ProMedic, Inc., Bonita Springs, FL, USA) essentially in cross-section. Images are transmitted from the distal tip of the blade (bottom left of the picture) to a hooded eyepiece by a series alignment of a prism-mirror-prism-prism-mirror-prism-prism.



With the use of an optional wireless video system, which includes a video attachment for the device and a monitor that receives and displays the images from the camera by radiofrequency at 2.4 Ghz, the AT can be considered a video laryngoscope. Because there are no intrinsic costly video elements, the entire device is single-use, with a current per unit cost of \$80 (US). Similar to other video laryngoscopes, skills for its use can be rapidly developed even by inexperienced airway managers [2-6]. In addition, it has proven useful in the management of routine and difficult airways alike [7-10]. Since little information is available regarding the use of optimal technique and the outcome of intubations when using the AT in routine clinical practice outside of a controlled trial where only experienced operators are performing the intubations, our primary objectives were to describe intubation success and the device manipulations needed to obtain adequate glottic views to

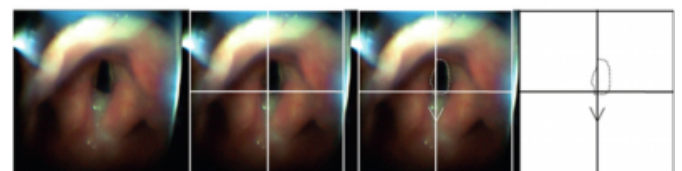
facilitate successful tracheal tube passage.

METHODS

Between 1 July and 31 August 2010, anonymous data was collected during a device trial conducted by the equipment purchasing committee to evaluate the cost/benefit of purchasing the AT for use in our department. Prior to the planned device trial, an anonymous, structured data collection form was devised consisting of the patient's age, sex, height (cm), weight (kg), body mass index (kg/m^2), airway exam, as well as subjective assessments of the ease of insertion into the mouth, ability to obtain adequate glottic exposure, and the overall ease of intubation using the AT. Subjective assessments were graded as 1 (easy, no difficulties) to 6 (extremely difficult or impossible) using a modified Likert scale. Using the optional AT video camera and wireless monitor, internal recordings of orotracheal intubations were made whenever time and equipment availability allowed. No external recordings were made. Videos were then downloaded to a laptop computer and viewed using VLC media player for Mac (Open Source). Screenshots were taken of the video frame representing the view of the glottis just prior to actual intubation attempts. Screenshots were then imported into KeyNote '09 version 5.0.4 (Apple Computer, Inc., Cupertino, CA, USA) and superimposed upon a four-quadrant grid. The glottic opening and posterior arytenoid cleft were then traced and the photo deleted (figure 2).

Figure 2

Figure 2. From left to right: A screenshot of the view of the glottic opening just prior to attempted passage of the tracheal tube, a four-quadrant grid superimposed on the screenshot, a tracing of the glottic opening and the posterior arytenoids cleft is made, and then the screenshot deleted leaving behind the grid with relative location of the glottic opening and the posterior arytenoids cleft.



Subsequently, individual grids were superimposed upon each other to form a final graphic containing one grid with all intubation attempts and a figure similar to that of a previously published report [11]. The time required to complete the intubation was recorded from the intubations for which a video was available and was defined as the time

from the operator picking up the device to successful placement of the tracheal tube and removal of the AT from the patient's mouth. Major repositioning of the AT once positioned in the hypopharynx required to properly align the device and the glottic opening were also noted and recorded as a back/up maneuver or a rotation along a vertical axis to the left or right. The number of attempts required to position the AT in the mouth of the patient and the number of attempts required to successfully pass the tracheal tube through the vocal cords were also recorded. For the purposes of our description, a successful intubation attempt was defined as one where the tube passed through the cords after initial alignment of the AT with the glottic opening. If the tube had to be withdrawn back into the channel and the device repositioned by using a back/up or rotation along a vertical axis, another attempt was recorded. The University of Washington Minimal Risk-IRB (Seattle, WA, USA) approved this report and waived the need for informed consent.

Because decisions to purchase new anesthesia products are often made at the institutional or departmental levels chiefly based on cost considerations without adequate clinical data, a literature search was conducted regarding the learning curve of the AT to inform our decision upon the number of providers who would use the sample devices to allow adequate individual exposure to the AT. In a manikin study simulating a normal airway comparing three indirect laryngoscopes, inexperienced anesthesia providers had a favorable learning curve after five uses [12]. Another manikin-based study of normal and difficult airways involving medical students with no prior intubation experience included a 15 minute video presentation followed by five practice intubations on the manikin prior to testing the students on 5 different intubation scenarios including normal airway, head in lateral position, cervical spine immobilization, pharyngeal edema, and a final test again of the normal airway. All participants performed better in the last normal airway intubation than the first [13]. Thus, we believed that in order for each participant to have used the device enough to form a reasonable opinion regarding the usefulness of the device free of bias based solely on first impressions (good or bad), each participant would need to have used 5-10 devices. Based upon the number of sample devices supplied by the local distributor (Comedical, Inc., Seattle, WA, USA) to our department, the equipment committee selected five anesthesia providers (4 staff anesthesiologists and 1 nurse anesthetist) to provide

feedback that would ultimately be used to inform the purchasing committee on the utility of the AT within our department. One provider (AMJ) had prior experience with the AT, but none in the prior 12 months. The other participants had no prior real-life experience with this particular device. All intubations were performed by the five providers only for cases for which they were a primary anesthesia provider.

PATIENT SELECTION

The AT was used in a convenience sample of patients presenting for elective or semi-elective surgeries requiring orotracheal intubation as part of a general anesthetic or for orotracheal intubation for the delivery of mechanical ventilation in patients in the intensive care unit. Any patient with mouth opening <2 cm was not considered a candidate for AT use.

ROUTINE ANESTHETIC CARE

All patients undergoing surgical procedures received a routine intravenous (IV) anaesthetic induction. This typically includes fentanyl 1 to 2 µg/kg followed by propofol 2 to 3 mg/kg two to three minutes followed by administration of a neuromuscular blocking drug. At our institution, this is most often accomplished by administration of 0.6-1.2 mg/kg. Succinylcholine and vecuronium are used much less often regardless of whether the induction is rapid sequence or the patient is outside the operating room. When intubating conditions were felt to be optimal, AT-guided intubation was attempted. No direct laryngoscopy was performed and thus no data regarding the Cormack-Lehane grade of the laryngeal view obtained during traditional laryngoscopy was recorded.

DEVICE USAGE

All participants were given a short manikin-based tutorial on proper use of the AT prior to using it in a clinical settings and were educated regarding proper insertion technique based on manufacturer recommendations. In addition, based upon previous reports [11,14], participants were told to 1) use the AT like a macintosh blade and not a miller blade and 2) optimize the laryngeal view by first performing a back/up maneuver as required to bring the glottic opening down within the visual field and then rotate the device along the vertical axis in order to align the posterior arytenoids cleft in the left lower quadrant of their view with the glottic opening in the middle or slightly to the left.

DATA COLLECTION

Data were analysed using Prism 5.0a (GraphPad Software, Inc., La Jolla, CA, USA) and presented as number (%), mean±SD, median (range), or median [IQR (range)] unless otherwise noted. The odds of successful passage of the tracheal tube on the first attempt without repositioning when the posterior arytenoids cleft was in the left lower quadrant of the view from the AT was compared to its location in any of the other quadrants using a contingency table and presented as OR (95% CI). A p-value <0.05 was considered significant.

RESULTS

Baseline patient demographics and particular airway exam features are shown in table 1.

Figure 3

Table 1. Baseline patient characteristics

Demographics	
Age, yrs	50±16
Male sex, n(%)	34 (68)
Ht, cm	170±18
Wt, kg	90±23
Body mass index, kg/m2	30±6.5
ASA class	2 (1-4)
Mallampati class	2 (1-3)
Mouth opening <3.5 cm, n(%)	8 (17)
Neck extension <35 degrees, n(%)	18 (38)
Upper lip bite test	2 (1-3)
Thyromental distance <6cm, n(%)	15 (31)
Sternomental distance <12cm, n(%)	15 (31)

Data is expressed as mean±SD or median (range) unless otherwise noted

Fifty devices were used and all 50 patients had successful tracheal intubations with the device. Forty-six intubations were carried out on elective surgical patients and 4 were performed on patients in the intensive care unit requiring intubation for respiratory failure. All devices were successfully inserted into the patient’s mouth on the first attempt except in one patient with limited mouth opening and a large tongue. All other instances of device reinsertion were due to secretions requiring suctioning (1 patient) or failure to turn on the lighting element of the device prior to inserting it into the patient’s mouth (3 patients). Internal recordings of the AT intubations were made in 40 of the 50 cases. Minor, clinically insignificant radio-interference was seen on 10 (25%) of the videos. Severe interference occurred once prior to any attempts (the patient underwent direct laryngoscopy and is not included in our results) and in another instance in which the operator removed the wireless camera and replaced it with the eyepiece. The intubation was carried out easily using the optical device alone.

Tracheal intubation characteristics are presented in table 2.

Figure 4

Table 2. Tracheal intubation characteristics

Intubation characteristics	
Duration, sec	28 [21-39(11-118)]
Number insertion attempts, n (%)	1 45 (90)
	2 4 (8)
	3 1 (2)
Repositioning after insertion, n(%)	Back/up 12 (30)
	Rotation right 19 (48)
Number of intubation attempts, n (%)	1 27 (68)
	2 11 (23)
	3 2 (9)
Ease of insertion into mouth	2 [1-2(1-4)]
Ease of glottic view	1 [1-2(1-4)]
Overall ease of intubation	2 [1-2(1-4)]

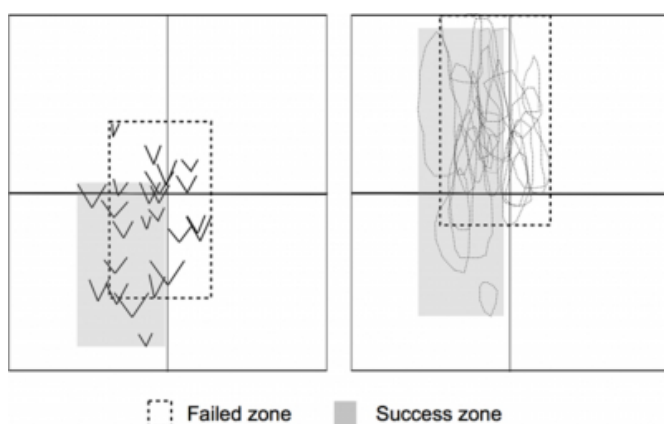
Data is expressed as mean±SD or median [IQR(range)] unless otherwise noted
Only includes the 40/50 intubations where video was available
Includes all 50 intubations

Fifty-five attempts to pass the tracheal tube were made during the 40 recorded intubations. The time required to intubate in seconds, the number of attempts to pass the tracheal tube beyond the vocal cords, and device repositioning after the AT was successfully inserted into the hypopharynx were calculated only from those intubations for which video was available. Among the 40 recorded intubations, first-pass success occurred in 27 (68%) patients. Among these 27 first-pass success intubations, prior to attempting passage of the tube, a back/up maneuver to bring the glottis down in the view alone was performed in 2 (7%), rotation of the device to the right to bring the glottis leftward in the view was performed in 8 (30%), and both a back/up maneuver and rotation to the right were performed in another 2 (7%) attempts. Fifteen (56%) successful intubations occurred without any repositioning. A second attempt at passing the tracheal tube after repositioning of the device was successful in another 11 (23%) patients while a third attempt after repositioning incorporating the use of a bougie was successful in the final 2 (9%) patients. Among those requiring a second attempt, a back/up maneuver alone was performed in 3 (27%), rotation of the device to the right was performed in 6 (55%), and both a back/up maneuver and rotation to the right were performed in another 2 (18%) attempts. In the final 2 patients who required a third attempt, both a back/up manoeuvre and rotation to the right were performed multiple times prior to a bougie being used. Despite the need for repositioning, successful placement of the tube occurred rather quickly, with a median time of 28 seconds. Compared with unsuccessful attempts, successful

attempts were ones where in general the glottic opening was down in the view and the posterior arytenoids cleft was down and to the left. The relative locations of these same structures mapped only for unsuccessful first attempts and the final repositioning of the device, which facilitated successful passage of the tracheal tube is shown in figure 3.

Figure 5

Figure 3. The location of the glottic opening (right) and the interarytenoid cleft (left) for all intubations where passage of the tracheal tube was not successful on the first attempt (○) compared with the location of these structures during successful passage of the tube (?).



Based upon the graphic representations in figure 3, the odds of first-pass success for when the posterior arytenoids cleft was in the left lower quadrant of the view from the AT compared to the other three quadrants was calculated and was 30 (95% CI [4-300], $p < 0.0001$).

Overall, subjective opinion of the AT was favorable with operators noting only minor difficulties in inserting the device into the patient's mouth or the overall intubations based upon the need for device repositioning.

DISCUSSION

Our main findings are that the AT performed well in the hands of providers experienced in traditional laryngoscopy, but had no prior or no recent experience with the AT. This includes the emergent intubation of 4 patients in the intensive care unit for respiratory failure. Ninety percent (90%) of devices were successfully inserted into position on the first attempt and successful passage of the tracheal tube was completed in ≤ 2 tries in 91% in a median (IQR) time of 28 (21-39) seconds. This compares favorably with a recent report examining the learning curve of the AT in novice laryngoscopists [2]. In a prospective randomized trial of 108

consecutive ASA physical status I to III patients, aged 18 years or older, scheduled for urological surgical procedures requiring general anesthesia and tracheal intubation, first year anesthesia trainees were able to successfully achieve tracheal intubation in a mean \pm SD time of 40 ± 23 seconds. Skills were acquired for the use of the AT in < 6 intubations each and supports our findings in providers who performed > 8 intubations each. While the study of Di Marco and colleagues excluded patients with a history of difficult intubations and included a population with reassuring airway exams, approximately one-third of our group had one or more non-reassuring findings on preoperative airway exam and a mean body mass index of 30 ± 6.5 kg/m², which itself has been reported to make insertion of the AT into the patient's mouth more difficult [15]. Learning curves obtained in the controlled setting of the operating room in patients with anticipated or documented easy airways should be interpreted with caution, however, when attempting to organize sufficient training for providers to be competent in its use in difficult airways inside or outside the operating room. Currently, a single case series including 7 patients has documented the success of the AT after failed direct laryngoscopy in the hands of experienced users, but the number of AT intubations that qualified them as experienced was not reported [16]. This is underscored by a recent study reporting on operator and patient-related factors associated with success or failure of 742 Glidescope™ (GS, Verathon, Bothell, WA) intubations [17]. Using a benchmark of > 29 prior GS intubations to define those who were experienced with the device, only an 83% first attempt success was documented in patients with difficult airways. The type of adjunct training (eg web-based modules), the number of intubations to acquire skills in the setting of difficult airways, and more importantly, the ongoing experience necessary to retain those skills remains elusive and warrants further study. We acknowledge that ours was not a prospective trial evaluating the use of the AT in the very patients for whom such devices were originally intended—those with difficult airways. Thus, our report only further supports prior literature documenting the ease of use and a short learning curve of the AT.

More importantly, our video analysis adds to the current knowledge regarding optimal use of the device regardless of experience. Thus, the manner in which the providers who participated our trial were told to acquire glottic exposure deserves mention. First, providers were told to use the device as a macintosh blade and not a miller blade [14].

Next, based upon a prior study, which examined the influence of the position of the glottic opening and interarytenoids cleft on subsequent success rate of tracheal intubation, providers were told to use a back and up maneuver if needed to lower the position of the glottic opening and interarytenoid cleft below the horizontal midline in their view [11]. Lastly, based upon knowledge of the preferred direction of the tracheal tube when exiting the tube channel of the AT, providers were encouraged to rotate the device to the right in order to bring the view of all structures to left of the midline. Our video analysis, which employed similar methodology to that previously used by Dhonneur and colleagues [11] supports their findings suggesting that optimal positioning of the glottic opening and interarytenoid cleft be positioned below the horizontal midline. However, our analysis also supports the use of an additional rightward rotation with the device in order to bring these structures not only below the horizontal midline, but also to the left of the vertical midline of the operator's view. This is underscored by the at least 4-fold increased odds of first attempt success when the interarytenoid cleft was down and to the left of the midline compared with its position in any other position.

Another limitation of our report is that we did not make any external recordings of the intubations with which to correlate the internal video. Thus, the device manipulations were inferred from the internal recording only and may have confounded our conclusions. While the appearance of the glottic opening to the left of the vertical midline in the view of the operator appeared to be a result of device rotation to the right along a vertical axis as we report, it is possible that another movement might have resulted in the same view such as a side-to-side movement of the device. This does not alter our assertion that optimal positioning of the posterior arytenoids cleft lies down and to the left, however, no matter how the view was obtained. This, we believe, makes our report not only supportive, but additive to the current knowledge base.

In summary, the AT was found to be a useful device by our group of experienced anesthesia providers. Intubations were generally rapid with the operators encountering minimal difficulty. In addition, we suggest that the operator use back-up and rotational movements to move the view of the glottis and posterior interarytenoid cleft down and to the left of the view prior to advancing the tube from the device channel to maximize the chances of first pass intubation success. As

with any airway management tool, adequate exposure to the technology is needed to first acquire the skill and then to maintain competence in it. With respect to the AT, further study is needed before a recommendation can be made.

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