

APPARATUS

A comparison of tracheal intubation using the Airtraq[®] or the Macintosh laryngoscope in routine airway management: a randomised, controlled clinical trial

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Summary

The Airtraq[®] laryngoscope is a novel single use tracheal intubation device. We compared the Airtraq[®] with the Macintosh laryngoscope in patients deemed at low risk for difficult intubation in a randomised, controlled clinical trial. Sixty consenting patients presenting for surgery requiring tracheal intubation were randomly allocated to undergo intubation using a Macintosh ($n = 30$) or Airtraq[®] ($n = 30$) laryngoscope. All patients were intubated by one of four anaesthetists experienced in the use of both laryngoscopes. No significant differences in demographic or airway variables were observed between the groups. All but one patient, in the Macintosh group, was successfully intubated on the first attempt. There was no difference between groups in the duration of intubation attempts. In comparison to the Macintosh laryngoscope, the Airtraq[®] resulted in modest improvements in the intubation difficulty score, and in ease of use. Tracheal intubation with the Airtraq[®] resulted in less alterations in heart rate. These findings demonstrate the utility of the Airtraq[®] laryngoscope for tracheal intubation in low risk patients.

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The failure to successfully intubate the trachea and secure the airway remains a leading cause of morbidity and mortality in anaesthetic [1–3] and emergency settings [4, 5]. The absence of any single factor that reliably predicts the existence of a difficult airway [6] means that many difficult intubations are not recognised until after induction of anaesthesia. Despite recent developments in airway device technologies, the curved laryngoscope blade described by Macintosh in 1943 remains the most popular device used to facilitate orotracheal intubation, both inside and outside the operating theatre, and constitutes the gold standard [7].

The Airtraq[®] (Prodol Meditec S.A., Vizcaya, Spain) is a new intubation device that has been developed to facilitate tracheal intubation in patients with normal or difficult airways (Fig. 1). As a result of the exaggerated curvature of the blade and an internal arrangement of optical compo-

nents, a view of the glottis is provided without alignment of the oral, pharyngeal and tracheal axes. The blade of the Airtraq[®] consists of two side by side channels. One channel acts as a conduit through which a tracheal tube (ETT) can be passed, whilst the other channel contains a series of lenses, prisms and mirrors that transfers the image from the illuminated tip to a proximal viewfinder, giving a high quality wide-angle view of the glottis and surrounding structures, and the tip of the tracheal tube. The Airtraq[®] is anatomically shaped and standard ETTs of all sizes can be used. A clip-on wireless video system is also available, which allows viewing on an external screen. This may be particularly useful for teaching purposes.

To use the Airtraq[®] device, the blade must be inserted into the mouth in the midline, over the centre of the tongue, the tip positioned in the vallecula (Fig. 2). Where necessary, the epiglottis can be lifted by elevating the



Figure 1 Photograph of the Airtraq® laryngoscope with an tracheal tube in place in the side channel.

blade into the vallecula. The ETT does not obstruct the endoscopic view of the vocal cords during intubation, unlike for example the Bullard laryngoscope [8] or the LMA Ctrach® [9]. Once the view of the glottis has been optimised, the tracheal tube is passed through the vocal cords, held in place, and the device is removed (Fig. 2).

We have previously demonstrated that the Airtraq® performs comparably to the Macintosh laryngoscope when used by experienced anaesthetists in easy intubation scenarios in the manikin [10]. Of interest, the Airtraq® appears to have advantages compared to the Macintosh laryngoscope in simulated difficult intubation scenarios in the manikin [10], and when used by both inexperienced [11] and novice [12] users in both easy and simulated difficult intubation scenarios. However, the utility of the Airtraq® in clinical practice remains to be determined.

The purpose of this study was to evaluate the usefulness of this new device for use by experienced anaesthetists, in patients deemed to be at low risk of difficult intubation. We hypothesised that, in the hands of experienced anaesthetists, the Airtraq® would perform comparably to the Macintosh laryngoscope in the normal airway. We further hypothesised that by reducing the requirement to manipulate the airway, the Airtraq® would result in less haemodynamic stimulation following intubation than would the Macintosh laryngoscope.

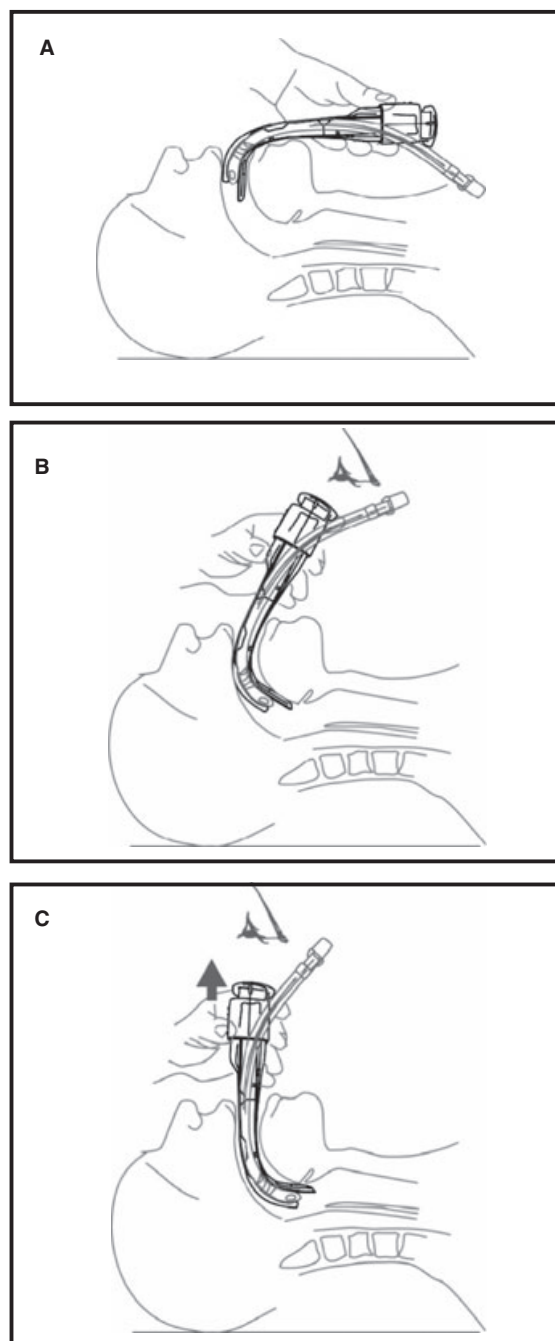


Figure 2 Technique of tracheal intubation with the Airtraq® laryngoscope. The device is held in the left hand and passed into the mouth over the tongue, in the midline (Panel A). Once the device has been passed over the back of the tongue, the view from the viewfinder is used to position the tip in the vallecula (Panel B). The view of the glottis can be optimised by lifting the epiglottis by elevating the blade into the vallecula (Panel C). Once the glottis is in the centre of the view seen from the viewfinder, the ETT is then passed from its position in the channel through the vocal cords. The ETT is then moved laterally to remove it from the channel, the device is withdrawn, and the ETT secured. Figure reproduced (with permission) from [8].

Methods

Following approval by the Hospital Ethics Committee, and written informed patient consent to participate in the study, we studied 60 ASA physical status I–III patients, aged 18 years of age or older, scheduled for surgical procedures requiring tracheal intubation, in a randomised, single blind, controlled clinical trial. Patients were not included if risk factors for gastric aspiration and/or risk factors for difficult intubation (Mallampatti class III or IV; thyromental distance less than 6 cm; interincisor distance less than 4.0 cm) were present or where there was a history of relevant drug allergy. All data was collected by an independent, unblinded observer.

Patients were randomised into two groups using sealed envelopes and the patient was blinded to their group assignment. All patients received a standardised general anaesthetic. Standard monitoring, including ECG, NIBP, S_aO_2 , end tidal carbon dioxide and volatile anaesthetic levels, was continuously performed. Prior to induction of anaesthesia, all patients were given fentanyl ($1\text{--}1.5\text{ }\mu\text{g.kg}^{-1}$) intravenously. A sleep dose of propofol ($2\text{--}3\text{ mg.kg}^{-1}$) was titrated to induce anaesthesia. Following induction of anaesthesia, all patients' lungs were manually ventilated with sevoflurane (2.0–2.5%) in oxygen, atracurium 0.35 mg.kg^{-1} was administered, and the trachea was intubated 3 min later, by one of four anaesthetists (CM, BH, JL, GC) experienced in the use of both laryngoscopes. Thereafter, the lungs were mechanically ventilated for the duration of the procedure and anaesthesia was maintained using sevoflurane (1.25–1.75%) in a mixture of nitrous oxide and oxygen in a 2 : 1 ratio. No other medications were administered, or procedures performed, during the 5-min data collection period following tracheal intubation. Further management was left to the discretion of the anaesthetist providing care for the patient.

The primary endpoints were the duration of the tracheal intubation procedure and the intubation difficulty scale (IDS) score [13]. The duration of the intubation attempt was defined as the time taken from insertion of the blade between the teeth until the ETT was placed through the vocal cords, as confirmed visually by the anaesthetist. If the ETT was not visualised passing through the vocal cords, the intubation attempt was not considered complete until the ETT was connected to the anaesthetic circuit and evidence obtained of the presence of carbon dioxide in the exhaled breath. The IDS score, developed by Adnet *et al.* [13], is a quantitative scale of intubation difficulty that can objectively compare the complexity of tracheal intubations (Appendix 1). The IDS score appears to be an excellent global measure of intubation difficulty [14].

A secondary endpoint was the rate of successful placement of the tracheal tube (ETT) in the trachea. A failed intubation attempt was defined as an attempt in which the trachea was not intubated, or which required > 120 s to perform. Additional endpoints included the number of intubation attempts, the number of optimisation manoeuvres required (readjustment of head position, use of a bougie, second assistant) to aid tracheal intubation and the severity of dental trauma. The severity of dental trauma was calculated based on the observer graded pressure on the teeth (none = 0, mild = 1, moderate/severe = 2). Once tracheal intubation was successfully accomplished, the anaesthetist scored the ease of use of each device using a visual analogue scale (from 0 = Extremely easy to 10 = Extremely difficult).

We based our sample size estimation on the IDS score. An IDS score of zero represents ideal intubating conditions, and increasing scores represent progressively more difficult intubating conditions. Based on initial pilot studies, we projected an IDS score of ≥ 1 in 50% of these low risk patients with the Macintosh laryngoscope. We considered that a clinically important reduction in the number of patients with an IDS score greater than zero in these low risk patients would be a 50% absolute reduction, i.e. an IDS score of ≥ 1 in 25% of patients. Based on these figures, using an $\alpha = 0.05$ and $\beta = 0.2$, for an experimental design incorporating two equal sized groups, we estimated that 29 patients would be required per group. We therefore aimed to enrol 30 patients per group.

Data for duration of intubation attempts and the instrument difficulty score were analysed using the *t*-test. Data for the success of tracheal intubation attempts were analysed using Fisher's exact test. Data for the IDS score, the number of intubation attempts, and the number of optimisation manoeuvres were analysed using the Mann–Whitney Rank sum test. The comparisons of haemodynamic data within groups were analysed using one-way repeated measures ANOVA, with *post hoc* testing using the Student–Newman–Keuls test. For these analyses, the pre-intubation data were chosen as baseline data, rather than the pre-induction values. Between-group comparisons were made using an unpaired *t*-test. Continuous data are presented as means (standard deviation (SD)), ordinal data are presented as medians (quartiles (interquartile range)), and categorical data are presented as number and frequencies. The α level for all analyses was set as $p < 0.05$.

Results

A total of 60 patients were entered into the study. Thirty patients were randomly allocated to undergo tracheal

Table 1 Demographic characteristics of patients enrolled in the study.

Parameter assessed	Macintosh	Airtraq
Male : Female ratio	11 : 19	11 : 19
Age; years	41.1 (16.9)	43.8 (16.8)
Weight; kg	73.8 (9.8)	71.7 (11.3)
Body mass index; kg.m ⁻²	27.7 (5.7)	27.1 (6.1)
ASA classification; Median (IQR)	1 (1, 2)	1 (1, 2)
Airway measurements		
Thyromental distance; cm	6.9 (0.7)	6.7 (0.7)
Inter-incisor distance; cm	4.5 (0.8)	4.3 (0.7)
Mallampatti classification		
1	17 (57)	13 (43)
2	13 (43)	17 (57)
> 2	0	0

Data are given as mean (SD) or number (%).

intubation using the Macintosh laryngoscope, and 30 to undergo tracheal intubation using the Airtraq[®] laryngoscope. There were no significant differences in demographic or baseline airway parameters between the groups (Table 1).

All patients were successfully intubated on the first attempt using the Airtraq[®] laryngoscope, whereas three attempts were required in one patient with the Macintosh laryngoscope (Table 2). The Airtraq[®] significantly reduced the mean intubation difficulty score, compared to the Macintosh group (Table 2). Sixteen patients in the

Table 2 Data for intubation attempts with each device.

Parameter assessed	Macintosh	Airtraq [®]
Overall success rate (%)	30 (100)	30 (100)
Intubation difficulty score	1.4 (2.2)	0.2 (0.5)*
Intubation difficulty score; %		
0	14 (46.7)	25 (83.4)*
1	8 (26.7)	4 (13.3)
= 2	8 (26.6)	1 (3.3)
Duration of intubation attempt; s	12.4 (9.2)	12.2 (8.5)
Lowest S _a O ₂ during intubation attempt; %	99.0 (1.4)	99.1 (1.5)
Number of intubation attempts; %		
1	29 (96.7)	30 (100)
2	0	0
3	1 (3.3)	0
Cormack and Lehane Glottic View (%)		
1	22 (70)	28 (95)
2	7 (25)	2 (5)
3	1 (5)	0
No. of optimisation manoeuvres; %		
0	23 (76.7)	30 (100)
1	5 (16.7)	0
= 2	2 (6.6)	0
Ease of use of instrument (VAS Score)	2.0 (1.5)	1.2 (1.4)*

Data are reported as mean (SD) or number (%).

*Significantly ($p < 0.05$) different compared to the Macintosh laryngoscope.

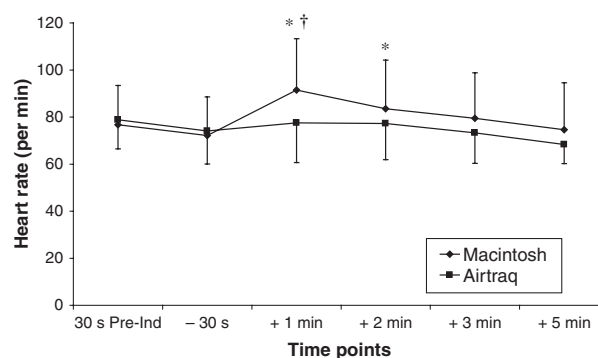


Figure 3 Graph representing the changes in heart rate following tracheal intubation with each device. The data are given as mean (SD). *Significantly different compared to baseline (i.e. pre-intubation) value. †Significantly different compared to the Airtraq laryngoscope. 30 s Pre-Ind, 30 s prior to induction of anaesthesia; -30 s, 30 s prior to tracheal intubation, +1min, one minute post tracheal intubation etc.

Macintosh group had an IDS score of ≥ 1 , compared to five in the Airtraq[®] group ($p < 0.05$). There was no difference between groups in the duration of intubation attempts, or in the lowest oxygen saturation during these intubation attempts (Table 2). Twenty-eight patients intubated with the Airtraq[®] had a grade I Cormack and Lehane glottic view, compared to 22 patients in the Macintosh group. No manoeuvres were required in any patient to improve the glottic exposure in patients in the Airtraq[®] group compared to six in the Macintosh group (Table 2). There was no incidence of dental or other airway trauma with either laryngoscope.

The anaesthetists found the Airtraq[®] to be easier to use than the Macintosh laryngoscope (Table 2). Tracheal intubation with the Macintosh resulted in a modest but significant increase in heart rate and mean arterial blood pressure, compared to pre-intubation values, in contrast to the Airtraq[®] (Figs 3 and 4). There was a significant between-group difference in heart rate at 60 and 120 s post intubation (Fig. 3). In contrast, there was no between group difference in mean arterial blood pressure following tracheal intubation (Fig. 4).

Discussion

It has been recommended that, after initial manikin assessment and pilot studies, all new airway devices be compared in a randomised controlled trial against the current gold standard [15]. We have already assessed the performance of the Airtraq[®] in manikins when used by anaesthetists [10], relatively inexperienced medical personnel [11], and novice users [12], and demonstrated potential advantages in both easy and simulated difficult laryngoscopy scenarios. The curved laryngoscope blade

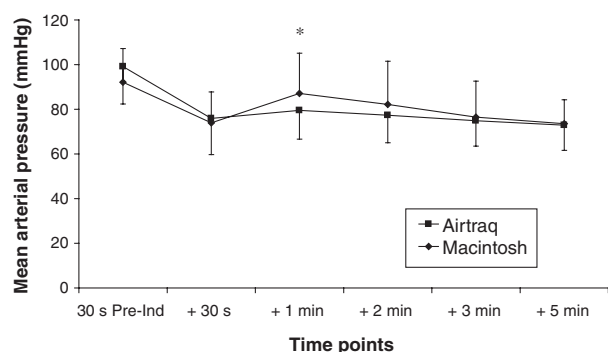


Figure 4 Graph representing the changes in mean arterial blood pressure following tracheal intubation with each device. The data are given as mean (SD). *Significantly different compared to baseline (i.e. pre-intubation) value. 30 s Pre-Ind, 30 s prior to induction of anaesthesia; – 30 s, 30 s prior to tracheal intubation, + 1 min, 1 min post tracheal intubation etc.

described by Macintosh in 1943 remains the most popular device used to facilitate orotracheal intubation, notwithstanding recent developments in airway device technologies, and therefore constitutes the gold standard [7]. We therefore wished to compare the utility of the Airtraq® to the Macintosh laryngoscope in this randomised controlled clinical trial.

All intubations in this study were performed by four experienced anaesthetists in patients deemed on clinical grounds to be at low risk for difficult tracheal intubation. Each anaesthetist had performed > 500 intubations using the Macintosh laryngoscope, and at least 50 intubations with the Airtraq® in manikins and 20 intubations with the Airtraq in patients prior to this study.

Our study demonstrates that, in comparison with the Macintosh laryngoscope, the Airtraq® provides comparable or superior intubating conditions in the normal airway. There was no difference between groups in the degree of success of intubation attempts, or in the duration of time required to perform tracheal intubation. However, the Airtraq® device did reduce intubation difficulty. Whilst overall intubation difficulty scale scores [13] were low in both groups, as would be expected in this population, both the mean IDS scores and the number of patients with an IDS score of ≥ 1 were significantly lower in patients intubated using the Airtraq®. The Cormack and Lehane grading system, although originally designed to compare glottic views at direct laryngoscopy [16], provided a useful comparison of the direct and indirect laryngoscopic views achieved in this study. Twenty-eight patients intubated with the Airtraq® had a grade I Cormack and Lehane glottic view, compared to 22 patients in the Macintosh group. Fewer patients required additional manoeuvres to improve glottic exposure with the Airtraq® device. Furthermore,

the investigating anaesthetists also subjectively rated the Airtraq® as easier to use, in comparison with the more familiar Macintosh laryngoscope. However, the limitations of this latter measurement should be acknowledged.

The Airtraq® resulted in less stimulation of heart rate following tracheal intubation in comparison with the Macintosh laryngoscope. This finding probably reflects the fact that the Airtraq® provides a view of the glottis without the need to align the oral, pharyngeal and tracheal axes, and therefore requires less force to be applied during laryngoscopy. The haemodynamic findings for direct laryngoscopy in our study were similar to those described previously [17–19]. The potential of the Airtraq® to produce less stimulation of heart rate may be particularly advantageous in clinical situations such as coronary artery disease or arrhythmias.

Direct trauma to the oral tissues has been reported in 6.9% of patients undergoing conventional laryngoscopy and tracheal intubation [20]. Previous manikin studies of normal and simulated difficult intubation demonstrated less potential for trauma to the teeth and upper airway with the Airtraq®. Dental trauma scores, as measured by the number of dental clicks and/or the severity of dental compression, were lower with the Airtraq® laryngoscope, particularly in the difficult airway scenarios [20]. However, as might be expected in this study of patients at low risk for difficult laryngoscopy, there was no incidence of dental or other airway trauma with either laryngoscope.

An important potential advantage of the Airtraq® is that it is a single-use device. This removes concerns regarding the potential for multi-use intubation devices to facilitate transmission of prions, which are thought to be responsible for causing variant CJD [21, 22]. These concerns arise from the difficulties in ensuring that all proteinaceous material has been removed from reusable laryngoscope blades during cleaning and sterilisation [23, 24]. In recognition of these concerns, the guidelines of the Association of Anaesthetists of Great Britain and Ireland state that 'single use intubation aids' should be used wherever possible [25]. However, studies have reported that certain single use laryngoscope blades provide inferior intubating conditions compared to reusable blades such as the Macintosh [26, 27]. These findings raise concern regarding the safety of single use conventional laryngoscope blades. Our study demonstrates that the Airtraq® is at least as effective as the reusable Macintosh bladed laryngoscope, attesting to its safety in this regard.

In conclusion, the Airtraq® laryngoscope offers a new approach for the management of the normal airway. The Airtraq® reduced the difficulty of tracheal intubation and the degree of haemodynamic stimulation compared to the Macintosh laryngoscope in patients at low risk for difficult laryngoscopy and intubation, in this first randomised

clinical trial with this device. Further studies, in the clinical context, particularly in predicted difficult intubation scenarios, are necessary to confirm and extend these initial positive findings.

Acknowledgement

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Conflict of interest

The authors have no conflict of interest with regard to the Airtraq® device.

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Appendix 1: Intubation Difficulty Scale score

The IDS score is the sum of the following seven variables:

N1: Number of intubation attempts > 1

N2: The number of operators > 1

N3: The number of alternative intubation techniques used

N4: Glottic exposure (Cormack and Lehane grade minus 1)

N5: Lifting force required during laryngoscopy (0 = normal; 1 = increased)

N6: Necessity for external laryngeal pressure (0 = not applied; 1 = applied)

N7: Position of the vocal cords at intubation (0 = Abduction/not visualised; 1 = Adduction)

Note: Intubation Difficulty Scale Score reproduced from Adnet *et al.* [13].