J Anesth (2011) 25:93–97
DOI 10.1007/s00540-010-1038-7

ORIGINAL ARTICLE

Efficacy of the Airtraq® laryngoscope with a fiberoptic bronchoscope compared with that of Airtraq® alone for tracheal intubation: a manikin study

Kohki Nishikawa · Eiko Hukuoka · Toshiya Kawagishi · Yuki Shimodate · Michiaki Yamakage

Received: 18 March 2010 / Accepted: 4 October 2010 / Published online: 4 November 2010

Abstract
Purpose Successful intubation using the Airtraq® requires optimal positioning of the glottis in the middle of the viewfinder. If the glottic view cannot be optimized, some glottic manipulation is essential for the Airtraq-assisted successful intubation. We evaluated the efficacy of the combined use of the Airtraq and a fiberoptic bronchoscope (FOB) compared with that of the Airtraq alone for tracheal intubation in simulated airway scenarios.
Methods Eight anesthesia providers (four staff and four residents) were enrolled in this study. The participants intubated the trachea of the ALS Simulator manikin in five tongue edema scenarios simulating modified Cormack–Lehane grade 1, 2a, 2b, 3, and 4 views and one cervical immobilization scenario.
Results No significant difference in the rate of successful intubation was detected between the combined use and the use of Airtraq alone in all scenarios. However, the duration of intubation attempts with the combined use was significantly shorter in difficult laryngoscopy scenarios (Cormack–Lehane grade 2b–4) ($P < 0.01$) and were significantly longer in easy laryngoscopy scenarios (grade 1 and 2a) ($P < 0.05$) than those with Airtraq alone. The rate of successful intubation and duration of intubation attempts were similar between the anesthetists and residents in each intubation technique in all scenarios.
Conclusion The combined use of Airtraq® and a FOB enables rapid intubation in simulated difficult airway scenarios compared with intubation using Airtraq alone, and the speed of intubation performed by anesthetists and residents is similar in all airway scenarios.

Keywords Airtraq® · Fiberoptic bronchoscope · Combined use · Duration of intubation attempts · Residents

K. Nishikawa (✉) · E. Hukuoka · T. Kawagishi · Y. Shimodate
Department of Anesthesia, Muroran City General Hospital, 3-8-1 Yamate-chou, Muroran, Hokkaido 051-8512, Japan
e-mail: murohosp082@kujiran.jp

M. Yamakage
Department of Anesthesiology, Sapporo Medical University School of Medicine, Sapporo, Japan

Introduction

Airtraq® (Prodol Meditec S.A., Vizcaya, Spain) is a new battery-operated, anatomically shaped laryngoscope that has been developed for the management of normal and difficult airways. It is designed to provide a clear view of the glottis and allow intubation without alignment of the oral, pharyngeal, and tracheal axes using the viewfinder. Tracheal intubation using Airtraq, however, requires optimal positioning of the glottis in the middle of the viewfinder, as the tracheal tube is advanced toward the glottis under a predetermined angle, defined by the configuration of the airway channel and angulation of the tracheal tube [1]. Therefore, if the glottic view cannot be optimized for reasons of anatomic limitations, such as a large tongue, successful intubation will require some airway management in addition to the Airtraq device.

In the present study, we evaluated the efficacy and usability of Airtraq in combination with a fiberoptic bronchoscope (FOB) in comparison with Airtraq alone for tracheal intubation procedures in simulated difficult airway scenarios.

Materials and methods

After obtaining approval by our hospital's ethics committee and written informed consent, we recruited eight anesthesia

providers (four staff anesthetists and four residents). Before starting the study, each participant was given instructions for the correct use of Airtraq and a standardized demonstration of the intubation technique using Airtraq. Performance of tracheal intubation using the combination of Airtraq and the FOB required an assistant other than each participant. First, the Airtraq was maneuvered to the optimal position by each participant, and then held by an assistant. With the Airtraq in situ by an assistant, each participant advanced the FOB through the tracheal tube and inserted the FOB into the trachea under direct visualization, and then the tracheal tube was advanced under indirect visualization. All participants were allowed five practice intubation attempts using each intubation technique in the ALS Simulator manikin (Laerdal Medical Japan, Tokyo, Japan) with the normal airway setting. All intubations were performed using a 7.5-mm cuffed tracheal tube (Parker Flex-Tip; Kobayashi Medical, Japan).

The design of the study was a randomized crossover trial. Before this study, four tongue edema scenarios and one neck immobilization scenario were prepared. The tongue edema scenarios were simulated modified Cormack–Lehane grade 2a, 2b, 3, and 4 laryngeal views by Yentis and Lee [2], which were made by inflating the tongue of the manikin with air using the Macintosh laryngoscope by two experienced anesthetists. The neck immobilization scenario was made by using a hard cervical collar. After completing the training session, each participant performed tracheal intubation using two intubation techniques in the manikin in the above five difficult airway scenarios.

The primary endpoints were rate of successful intubation and time required for successful intubation. A failed intubation was defined as an attempt in which the trachea was not intubated or that required more than 180 s to perform. The duration of successful intubation was defined as the time taken from insertion of the blade of Airtraq between the teeth until the tracheal tube was placed through the vocal cords and connected to a manual self-inflating resuscitation bag and the lungs were ventilated.

Secondary endpoints were the number of intubation attempts and number of optimization maneuvers (readjustment of head position, external laryngeal manipulation, and second assistant) required to aid tracheal intubation.

Data other than number of intubation attempts and number of optimization maneuvers are presented as mean ± standard deviations (SD), and the numbers of intubation attempts and optimization maneuvers are expressed as medians and ranges. Intergroup comparisons of the rate of successful intubation and the duration of intubation attempts were performed by using McNemar's chi-square test and paired *t* test, respectively. The numbers of intubation attempts and optimization maneuvers were analyzed using the Wilcoxon signed-ranks test. A probability value <0.05 was considered statistically significant.

Results

Four experienced anesthetists and four residents participated in this study. All anesthetists had performed a minimum of 100 and 20 tracheal intubations using Airtraq and the FOB, respectively. No resident had experience of more than 10 tracheal intubations.

Success rate

In the manikin-simulated modified Cormack–Lehane grade 1, 2a, and 2b, all participants successfully intubated the trachea using both intubation techniques. Although all participants with the use of the combination of Airtraq and FOB also successfully intubated in the last two tongue edema scenarios simulating grade 3 and 4, three and two participants failed to intubate the trachea with the Airtraq in these scenarios, respectively. However, these differences in the rate of successful intubation were not statistically significant. In the cervical immobilization scenarios, two and one participants failed with the Airtraq and the combined use, respectively (Fig. 1).

Intubation time

The time required for successful intubation was significantly shorter with the Airtraq than with the combined techniques in the easy laryngoscopy scenarios simulating grade 1 and 2a ($P < 0.01$), whereas it was significantly shorter with the combined technique than with the Airtraq alone in the difficult airway scenarios simulating grade 2b, 3, and 4 ($P < 0.05$). The cervical immobilization scenario did not produce a significant difference in the duration of

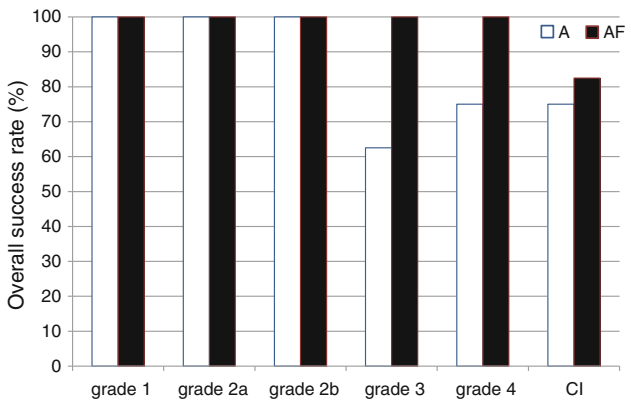

Fig. 1 Success rate in tracheal intubation using each intubation technique in the several difficult airway scenarios. *A*, Airtraq®; *AF*, combination of Airtraq® and fiberoptic bronchoscope; *grade 1, 2a, 2b, 3, 4*, modified Cormack–Lehane grade 1, 2a, 2b, 3, 4 laryngeal views; *CI*, cervical immobilization. There was no significant difference between the two intubation techniques in all scenarios

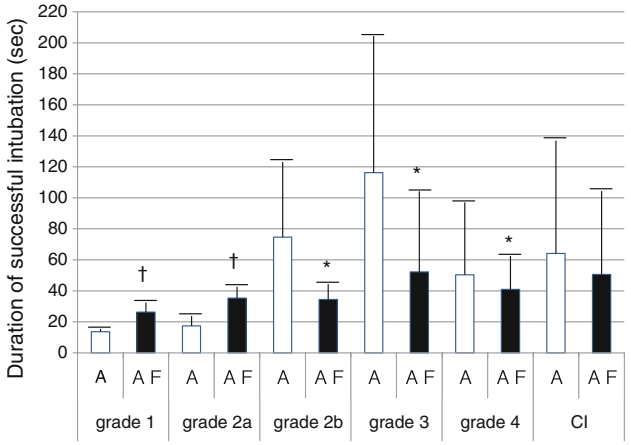

Fig. 2 Duration of successful intubation attempts using each intubation technique in the several difficult airway scenarios. Values are presented as mean ± SD. *$P < 0.05$ compared with Airtraq® alone; † $P < 0.01$ compared with Airtraq® alone. *A*, Airtraq®; *AF*, combination of Airtraq® and fiberoptic bronchoscope; *grade 1, 2a, 2b, 3, 4*, modified Cormack–Lehane grade 1, 2a, 2b, 3, 4 laryngeal views; *CI*, cervical immobilization

intubation attempts between the two intubation techniques (Fig. 2).

Number of intubation attempts

Only one intubation attempt with each intubation technique was necessary in the easy airway scenarios simulating grade 1 and 2a. Although the number of intubation attempts in the difficult airway scenarios simulating grade 2b, 3, and 4 was larger than that in the easy airway scenarios in both intubation techniques, the successful intubation with Airtraq required more intubation attempts than was needed with the combined techniques in the grade 2b, 3, and 4 simulated scenarios (Fig. 3).

Number of optimization maneuvers

To successfully intubate the trachea with the Airtraq, the need for optimization maneuvers increased with the level of difficulty of the tongue edema scenario, whereas the combined technique did not require optimization maneuvers for successful intubation in almost all intubation attempts (Fig. 4).

Comparison of anesthetists and residents

The rate of successful intubation, duration of intubation attempts, and the number of intubation attempts and optimization maneuvers by the anesthetists and residents were similar for each intubation technique in each level of difficulty of the tongue edema and cervical immobilization scenarios.

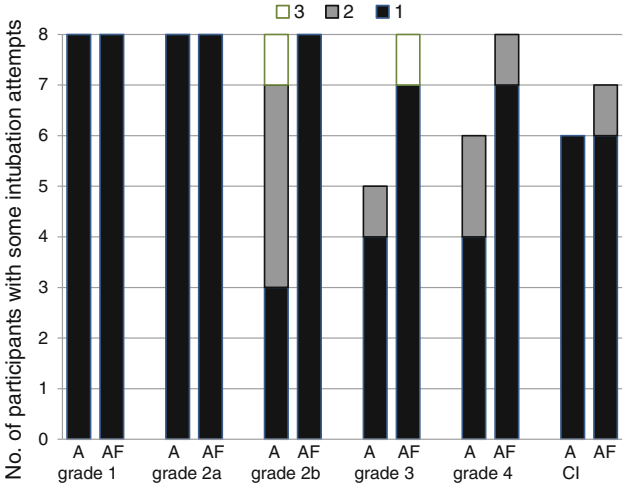

Fig. 3 Number of the participants requiring some intubation attempts for successful intubation using each intubation technique in the several difficult airway scenarios. *A*, Airtraq®; *AF*, combination of Airtraq® and fiberoptic bronchoscope; *grade 1, 2a, 2b, 3, 4*, modified Cormack–Lehane grade 1, 2a, 2b, 3, 4 laryngeal views; *CI*, cervical immobilization. Total numbers of participants were different between groups because of failed tracheal intubation

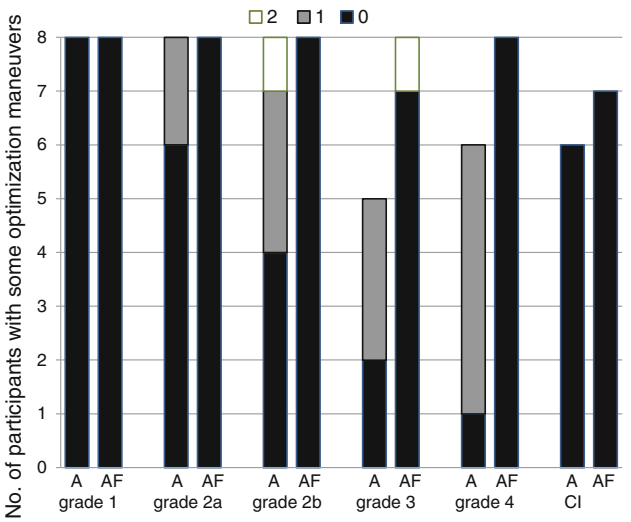

Fig. 4 Number of the participants requiring some optimization maneuvers for successful intubation with each technique in the several difficult airway scenarios. *A*, Airtraq®; *AF*, combination of Airtraq® and fiberoptic bronchoscope; *grade 1, 2a, 2b, 3, 4*, modified Cormack–Lehane grade 1, 2a, 2b, 3, 4 laryngeal views; *CI*, cervical immobilization. Total numbers of participants were different between groups because of failed tracheal intubation

Discussion

Our study demonstrates that, in comparison with Airtraq alone, the combined use of Airtraq and the FOB provides more rapid tracheal intubation in difficult airway scenarios simulating modified Cormack–Lehane grade 2b–4 and results in particularly high percentages of successful

intubation in simulated modified Cormack–Lehane grade 3 and 4 scenarios, in which any optimization maneuvers could not have compensated for suboptimal laryngeal exposure. Additionally, the durations of intubation attempts using the two techniques by anesthetists and residents were similar in all laryngoscopy scenarios.

Airtraq is a disposable optical laryngoscope, and the viewfinder allows indirect visualization of the glottis, the surrounding structures, and the tip of the tracheal tube with minimal airway manipulation [3]. Airtraq-assisted intubation has, however, possible anatomic limitations, such as a small sternomental distance (obesity, flexed neck, etc.) and a large tongue [1]. Application of Airtraq for patients with these complications tends to cause a partial or total glottic view, which is off-center of the viewfinder, and consequently may result in failure to intubate. Therefore, in cases in which positioning of the glottis in the middle of the viewfinder is not possible, internal or external glottic manipulation is essential for successful intubation using Airtraq. Therefore, in this study, we employed the FOB-guided intubation technique combined with the Airtraq laryngoscope with the aim of adjusting the route of the tracheal tube determined by a suboptimal glottic view.

In the tongue edema scenario, a suboptimal laryngeal view that required manipulation for the successful Airtraq intubation had already occurred in the manikin-simulated modified Cormack–Lehane grade 2a scenario. As for success rate of tracheal intubation, although the difficulties in Airtraq-guided tracheal intubation associated with modified Cormack–Lehane grade 2a and 2b could be completely overcome by repositioning the glottis in the viewfinder using optimization maneuvers, application of optimization maneuvers to the simulated grade 3 and 4 scenarios was not sufficient to enable successful intubations in all cases using Airtraq alone. However, the use of the FOB-guided technique combined with Airtraq led to successful intubations in all cases with fewer airway optimization maneuvers in this study. Although the duration of successful intubation was significantly shorter with the combined technique than with Airtraq alone in the manikin-simulated modified Cormack–Lehane grade 2b–4, it was longer with the combined technique in modified Cormack–Lehane grade 1 and 2a. Airtraq is an easy-to-use intuitive device in both experienced and inexperienced hands [3]. On the other hand, FOB procedures require a high level of skill in manipulation [4]. The combined use of Airtraq and the FOB would therefore have required a longer time for tracheal intubation than that in the case of using Airtraq alone because of difficulties in FOB procedures in the first two scenarios simulating relatively easy laryngoscopy.

In the cervical immobilization scenario, although successful intubation was not achieved in all cases by either technique, the overall success rates using the two techniques were not significantly different. Additionally, not only the combined use of Airtraq and FOB but also the use of Airtraq alone required few optimization maneuvers and intubation attempts, as also reported previously [3, 5, 6]. The only factor for failed tracheal intubation was difficulty in insertion of the blade into the mouth because of limited mouth opening accompanied by using a hard cervical collar in both intubation techniques. These findings suggested that cervical immobilization was of little consequence for Airtraq-assisted successful intubation if the blade could be inserted into the mouth.

In the present study, no significant difference between the anesthetists and residents in duration of successful intubation using Airtraq was observed in both easy and difficult airway scenarios. The times required for tracheal intubation using the combined technique were also, in contrast to our expectation, similar between the anesthetists and residents. Difficulty in advancing the tracheal tube into the trachea over the FOB has been observed in several studies [7, 8]. In this study, the FOB was advanced toward the glottis by viewing though the viewfinder of Airtraq, not by viewing through the viewfinder of the FOB, and this might have facilitated manipulation of the FOB even by relatively inexperienced residents without significant prolongation of the time required for tracheal intubation compared to the time required for intubation by experienced anesthetists.

We had several limitations to our study. First, as operating the combination of Airtraq and the FOB required two people, the holding of the Airtraq device by an assistant might have influenced the success rate and intubation time. Second, the current study was performed in the manikin-simulated difficult airway to elucidate the efficacy of combined technique compared with that of Airtraq alone for difficult intubations, which are rarely encountered in the clinical situation. Although this manikin setting does limit our conclusions, to our knowledge, there is no published study of comparing the combined technique with Airtraq alone in surgical and/or critically ill patients. Therefore, further clinical studies are required to confirm these positive findings.

Finally, as for the costs, both intubation techniques using the Airtraq require relatively high costs because it is a single-use device. However, this also removes concerns regarding the potential for reusable devices to facilitate transmission of infections [9, 10].

In conclusion, the duration required for intubation attempts using the combination of the fiberoptic-guided technique and the Airtraq-assisted procedure was, in comparison with that using Airtraq alone, reduced significantly in difficult manikin scenarios but was prolonged significantly in easy laryngoscopy scenarios. The rate of successful intubation with the two techniques did not differ

in all scenarios. The speed of tracheal intubation by both techniques was similar between the anesthetists and residents in all manikin scenarios.

References

1. Matioc AA. Use of the Airtraq® with a fibreoptic bronchoscope in a difficult intubation outside the operating room. Can J Anesth. 2008;55:561–2.
2. Yentis SM, Lee DJ. Evaluation of an improved scoring system for the grading of direct laryngoscopy. Anaesthesia. 1998;53:1041–4.
3. Maharaj CH, Costello JF, Higgins BD, Harte BH, Laffey JG. Learning and performance of tracheal intubation by novice personnel: a comparison of the Airtraq and Macintosh laryngoscope. Anaesthesia. 2006;61:671–7.
4. Ovassapian A. Fiberoptic tracheal intubation in adults. In: Ovassapian A, editor. Fiberoptic endoscopy and the difficult airway. Philadelphia: Lippincott-Raven; 1996. p. 71–103.
5. Maharaj CH, Higgins BD, Harte BH, Laffey JG. Evaluation of intubation using the Airtraq® or Macintosh laryngoscope by anaesthetists in easy and simulated difficult laryngoscopy: a manikin study. Anaesthesia. 2006;61:469–77.
6. Maharaj CH, Ni Chonghaile M, Higgins BD, Higgins BD, Harte BH, Laffey JG. Tracheal intubation by inexperienced medical residents using the Airtraq and Macintosh laryngoscopes: a manikin study. Am J Emerg Med. 2006;24:769–74.
7. Asai T, Shingu K. Difficulty in advancing a tracheal tube over a fiberoptic bronchoscope: incidence, causes, and solutions. Br J Anaesth. 2004;92:870–81.
8. Johnson DM, From AM, Smith RB, From RP, Maktabi MA. Endoscopic study of mechanisms of failure of endotracheal tube advancement into the trachea during awake fiberoptic orotracheal intubation. Anesthesiology. 2005;102:910–4.
9. Will RG, Ironside JW, Zeidler M. A new variant of Creutzfeldt-Jakob disease in the UK. Lancet. 1996;347:921–5.
10. Lowe PR, Engelhardt T. Prion-related diseases and anaesthesia. Anaesthesia. 2001;56:485.