Airtraq DL and AWS-200 for Double-lumen Endotracheal Tube Intubation: A Prospective Randomized Clinical Trial

Junko AJIMI[*1], Junichi NISHIYAMA[*2], Ritsuko MASUDA[*1], Takeo SHIBATA[*3] and Toshiyasu SUZUKI[*2]

[*1]*Department of Anesthesiology, Hachioji-hospital, Tokai University School of Medicine*
[*2]*Department of Anesthesiology, Tokai University School of Medicine*
[*3]*Department of Health Management, Tokai University*

(Received August 27, 2018; Accepted October 2, 2018)

Objective: This prospective randomized study aimed to assess the usefulness of two videolaryngoscopes with a side channel, the Airtraq DL™ and the AWS-200™, for intubation with a double-lumen tube (DLT).
Methods: In 60 patients with an American Society of Anesthesiologists physical status of 1–3 who were not expected to have difficult airway, the Airtraq DL™ and the AWS-200™ were randomly used for DLT intubation. The primary outcome was intubation time. The secondary outcomes included exposure time, the glottis view with the Macintosh and study videolaryngoscopes, the number of attempts before successful intubation, the intubation difficulty scale (IDS) score, and the subjectively rated ease of blade insertion and DLT advancement.
Results: No significant differences were observed in patient characteristics. In all patients, DLT intubation was successful at the first attempt. Intubation time was significantly shorter in the Airtraq DL™ group (17.2 ± 0.9 seconds, range = 9.6–29.4 seconds) than in the AWS-200™ group (21.6±1.1 seconds, range = 13.1–33.9 seconds) (P = 0.005). No significant differences were observed in any other outcomes.
Conclusion: In patients who were not expected to have difficult airway, DLT intubation with the Airtraq DL™ required significantly less time than with the AWS-200™.

Key words: Airtraq DL™, Airway Scope™, double-lumen tube, video laryngoscope, tracheal intubation

INTRODUCTION

The role of videolaryngoscopes is becoming increasingly important in airway management [1, 2]. They provide good visualization of the laryngeal structures without alignment of the oral, pharyngeal, and laryngeal axes. Furthermore, they are also useful for training novices in tracheal intubation [3, 4]. The American Society of Anesthesiologists Difficult Airway Algorithm was updated in 2013, and they recommended video-assisted laryngoscopy as an initial approach during intubation [1].

Generally, videolaryngoscopes can be classified into two categories [5]: those with a side channel that guides the endotracheal tube through the glottis, such as the Airtraq™ (Prodol Meditec S.A., Vizcaya, Spain) and the AWS-200™ (Nihon Kohden Corporation, Tokyo, Japan), and those for which the endotracheal tube must be preshaped with a stylet and steered by the operator, such as the Glidescope™ (Verathon Inc., Seattle, WA, USA) and the McGrath Series 5™ (Aircraft Medical, Edinburgh, UK). Videolaryngoscopes with a side channel enable the introduction of endotracheal tube into the trachea through the side channel once the vocal cord has been optimally exposed.

A double-lumen tube (DLT) is commonly used in thoracic surgery to achieve one-lung ventilation. Since it is larger and more complex than conventional endotracheal tubes, intubation is more difficult. To avoid trauma to the upper airway and to shorten intubation time, a complete view of the glottis is required [6, 7].

Recently, many different types of video devices have been reported for use in DLT intubation, including the Airtraq DL™, the Glidescope™, the McGrath Series 5™, and the Macintosh laryngoscope [8–11], and Airtraq DL™ was found to provide faster tracheal intubation and higher success rate than other devices. In addition, AWS Intlock (M-ITL-LL)™ (Nihon Kohden Corporation, Tokyo, Japan), which has a larger side channel was released in September 2016, allowing the use of DLT [12, 13].

To our knowledge, the efficacy of the Airtraq DL™ and the AWS-200™ with side channels for DLT intubation has not been studied previously in patients. Thus, we compared the DLT intubation time of these videolaryngoscopes. The Airtraq™ alone was found to take time in SLT intubation than other devices with a side channel [14]. The use of Airtraq™ in combination with the Universal Adapter for Smartphones™ (Prodol Meditec S.A., Vizcaya, Spain) allowed continuous observation on a monitor screen, which improved the impression of their use [15, 16]. Our hypothesis was that the DLT intubation time of patients would have no difference when using the Airtraq DL™ and the AWS-200™.

Junko AJIMI, Department of Anesthesiology, Hachioji-hospital, Tokai University School of Medicine, 1838 Ishikawamachi, Hachioji, Tokyo 192-0032, Japan
Tel: +81-42-639-1111 Fax: +81-42-639-1144 E-mail: ajimi@is.icc.u-tokai.ac.jp

MATERIALS AND METHODS

The study protocol was approved by the Institutional Review Board of Tokai University, School of Medicine (ref: 17R-071), on July 25, 2017 (chair-person Dr M Haida) and recorded on the UMIN Clinical Trials Registry (ref: NCT02329041). The investigation conforms with the principles outlined in the Declaration of Helsinki (*Cardiovascular Research* 1997; 35: 2–4). The study complies with the CONSORT 2010 statement for randomized studies.

The study was conducted in Hachioji Hospital, Tokai University, School of Medicine, from August 2017 to April 2018. Written informed consent was obtained from all patients. Sixty patients aged 20 to 84 years with an American Society of Anesthesiologists (ASA) physical status of 1–3 and scheduled for thoracic surgery requiring DLT intubation were enrolled in this study. The exclusion criteria were ASA physical status ≥ 4, high risk of aspiration, and patients younger than 20 years. Furthermore, patients were also excluded from the study if they presented more than two of the following risks: mouth openings < 3 cm, thyromental distance < 6 cm, Mallampati class III or IV, neck flexion and extension < 30° [17]. Patients were assigned randomly to either the Airtraq DL™ group or the AWS-200™ group by opening a sealed envelope in the operation theatre. All envelopes were prepared and sealed before the beginning of the study. All intubations were performed by a single senior anesthesiologist (J.A.) with experience in more than 200 DLT intubation cases with the Macintosh laryngoscope.

In this study, the primary outcome was the time required for DLT intubation, which was compared between the Airtraq DL™ and the AWS-200™. The time required for intubation was defined as the time from insertion of the device into the oral cavity to its removal. An independent investigator who was not involved in this study measured the time based on videos recorded during intubation.

Secondary outcomes were evaluated in all patients, including exposure time (measured as the time from the insertion of the videolaryngoscope to observe a clear glottis view), the glottis view with the Machintosh and study videolaryngoscopes, the success of the first intubation attempt, the intubation difficulty scale (IDS) score, as described by Adnet *et al.* [18], and the ease of insertion of the laryngoscope and tube advancement, which were subjectively rated from 0 to 3 (0 = very easy, 1 = easy, 2 = difficult, 3 = very difficult) by the intubating anesthesiologist. Exposure time was defined as the time from the insertion of the videolaryngoscope to observe a clear glottis view. Some literatures have introduced the percentage of glottic opening as another measure of glottic view and showed that it has good intraobserver and interobserver reliability [19–21], and the glottic view was evaluated based on the Cormack-Lehane grade [22], which is usually used by anesthesiologists for assessing laryngeal view, in particular, with the Macintosh laryngoscope in the present study. We used the Macintosh laryngoscope to assess the initial view of the glottis for intragroup and intergroup comparisons.

Percutaneous oxygen saturation, electrocardiography, noninvasive blood pressure measurement, pulse oximetry, end-tidal carbon dioxide, and the Bispectal Index were monitored.

An attempt was considered successful if the DLT was correctly positioned in the main trachea and if there was no desaturation ($SpO_2 < 95\%$). If it was impossible to introduce the bronchial cuff through the vocal cords or if $SpO_2 < 95\%$ occurred, the attempt was considered a failure and mask ventilation was reestablished; once $SpO_2 > 98\%$, a new tracheal intubation, using the same device, was attempted. In the event of a second failure, the anesthesiologist switched to the other device. If DLT insertion failed using both videolaryngoscopes, tracheal intubation was performed using a single-lumen tube with the Phycon TCB Bronchial Blocker™ (Fuji Systems, Tokyo, Japan) (Fig. 1).

Before the start of this study, the participating anesthesiologist performed intubation with both devices on a mannequin 10 times or more and on patients 5 times or more and became familiarized with the use of the devices [4].

Generally, 35- and 37-Fr (for women and men, respectively) Shiley™ Endobronchial Tubes with Left Polyurethane Cuff (Medtronic, Minneapolis, MN, USA) were used in our institution based on the bronchial diameter [23]. For both Airtraq DL™ and AWS-200™ laryngoscope intubation, the original stylet inside the tube was removed, and the tube was preloaded into the conduit of the blade before intubation, as recommended by the manufacturer. Although a lubricant was applied, the AW-200™ caused friction in the advancement of a 37-Fr DLT from the side channel to the glottis. In the training sessions before the study, the use of a 35-Fr DLT for men did not cause any problems, such as elevated airway pressure. Thus, the authors decided to use a 35-Fr DLT for all patients when the AWS-200™ was used.

During induction of anesthesia, patients were in neutral supine position. After preoxygenation anesthesia was induced by intravenous injection of fentanyl 0.15 to 2 $\mu g kg^{-1}$ and propofol 2 to 3 mg kg^{-1}. When the patient lost consciousness, rocuronium 1.0mg kg^{-1} was injected. Mask ventilation with 100% oxygen was delivered to the patients during induction. When the BIS was less than 50, prior to intubation, glottis exposure was assessed according to the Cormack-Lehane grade [22], initially, with a Macintosh laryngoscope, and then, tracheal intubation was performed with the allocated device using a left-sided double-lumen tube.

The Airtraq DL™ is an indirect laryngoscope, and we used its specific, original, Universal Adapter for Smartphones™. An iPod Touch (Apple Inc., Cupertino, CA, USA) with the free Airtraq application (iOs: https://itunes.apple.com/es/app/airtraq-mobile/id860540544) was attached on the adapter for intraoral observation. To protect personal information, the iPod was entrusted to the hospital management. All tracheal intubations performed with the Airtraq DL™ were managed with visibility on the monitor on hand that was positioned at the same place as the monitor on the AWS-200™. These different designs could lead to different efficacies and levels of safety; thus, it is important to compare them. We managed to achieve the same visualization conditions for both devices, allowing similar eye and hand coordination (Fig. 2).

Once the tip of the bronchial lumen passed through

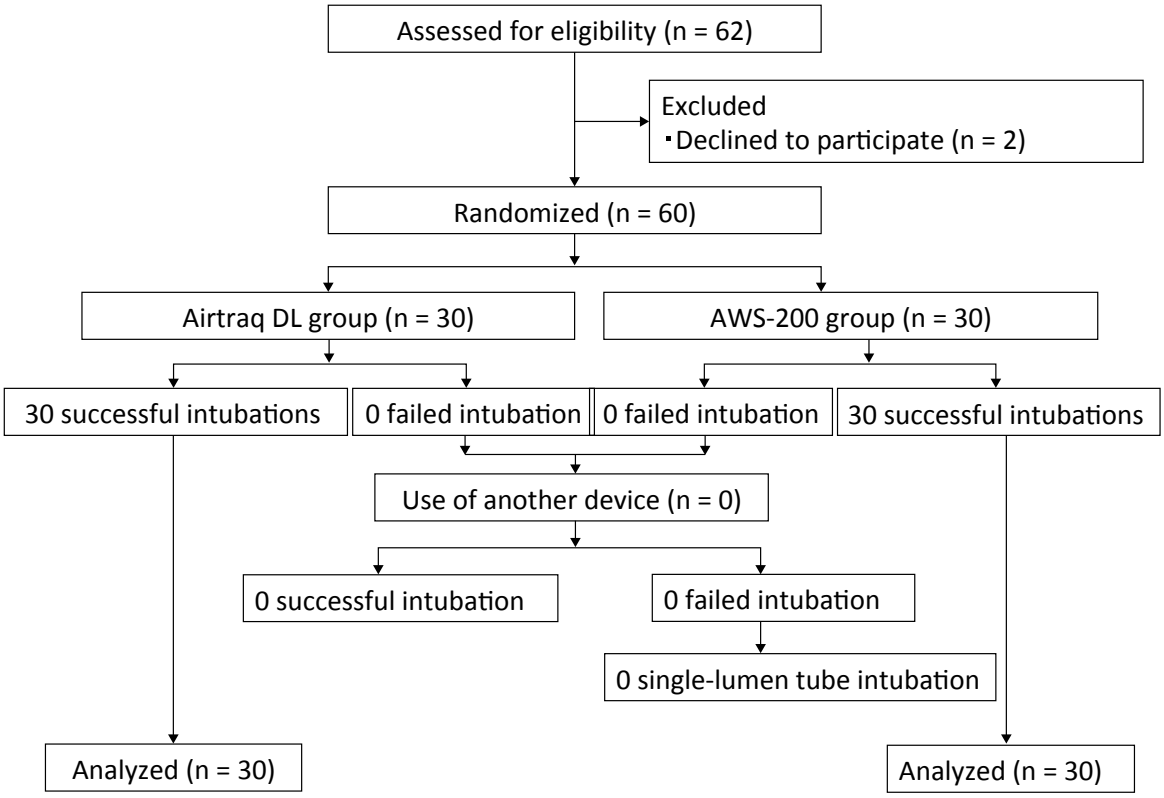

Fig. 1 CONSORT flow diagram of the study.

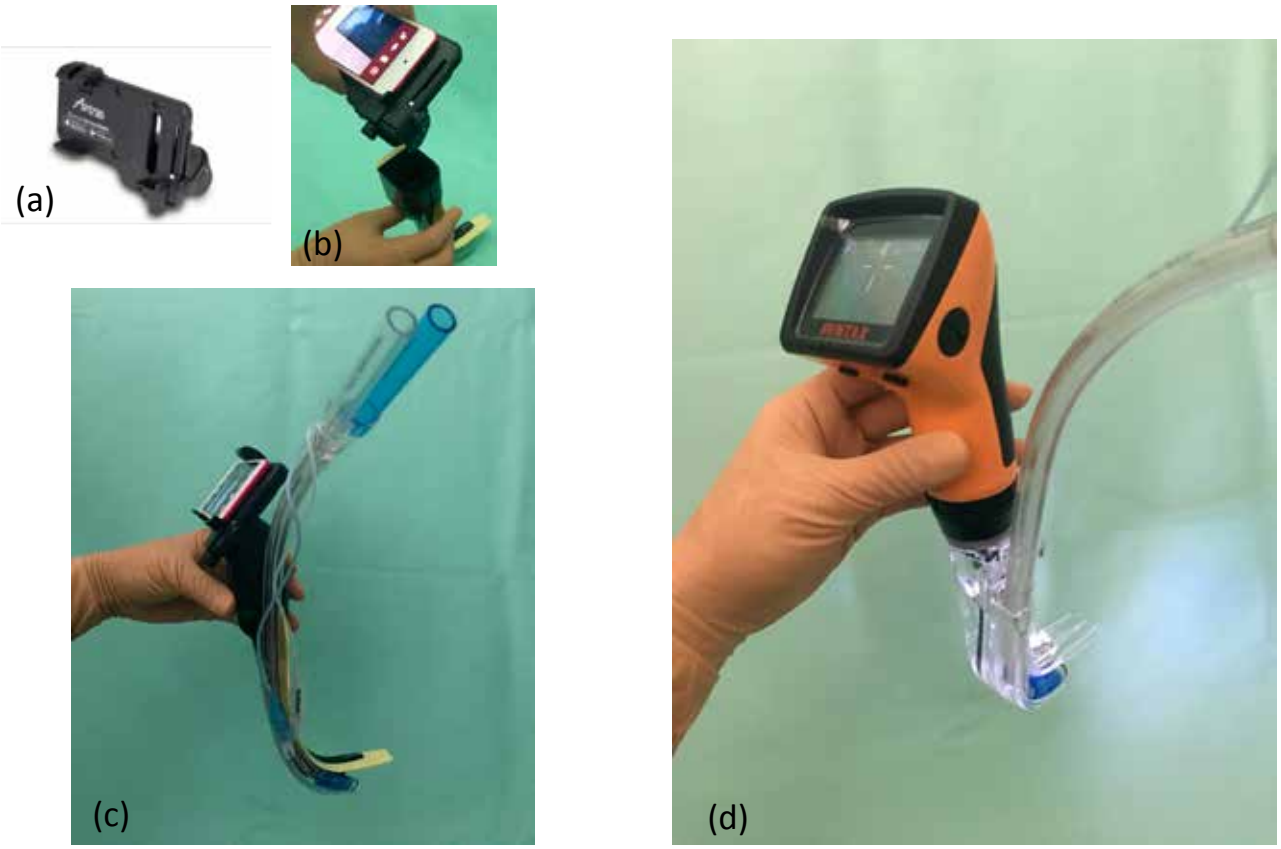

Fig. 2 (a) Universal Adapter for Smartphones. (b) Phone adapter attached to an iPod. (c) Airtraq DL™ with a double-lumen tube (DLT) inserted in the adjacent channel. (d) AWS-200™ with a DLT inserted in the adjacent channel.

Table 1 Demographic data and airway assessments

	Airtraq DL ™ (n = 30)	AWS-200™ (n = 30)	P-value
Age (years)	59 ± 3 (22–84)	61 ± 3 (24–78)	0.652
Sex (male/female)	23/7	20/10	0.390
Wight (kg)	59.1 ± 2.0 (38–94.9)	56.0 ± 1.7 (38.8–90.0)	0.217
Height (cm)	165 ± 2 (142–179)	162 ± 1 (148–173)	0.115
Body mass index (kg/m^2)	22 ± 1(16–37)	21 ± 1(16–32)	0.912
ASA physical status (1/2/3)	2/22/6	0/28/2	0.465
Mouth opening (cm)	4.3 ± 0.1 (3.5–6.5)	4.42 ± 0.1 (3.5–5.5)	0.166
Thyromental distance (cm)	7.5 ± 0.2 (5.5–10)	7.4 ± 0.2 (5–9.5)	0.721
Mallampati classification (I/II/III/IV)	11/19/0/0	22/8/0/0	0.014
A-OJM (> 30°)	29	28	0.500

Data are presented as means ± standard errors (range) or numbers of patients.
ASA = American Society of Anesthesiologists. A-OJM = atlanto-occipital joint movement.

the vocal cords, advancement was halted and the tube was tightly secured by the anesthesiologist before removal of the Airtraq DL™ or the AWS-200™ laryngoscope from the mouth. Using a fiber-optic bronchoscope to cannulate the bronchus and then railroad the DLT over the scope, the DLT was inserted to the correct position.

In terms of sample size, intubation was performed 30 times in each group, based on previous reports [11]. The analyses were conducted by Statistical Package for the Social Sciences (SPSS) Statistics software, version 25.0 (IBM Corporation, Armonk, NY, USA). Continuous and original data are presented as mean ± standard errors (SE), and the categorical data are presented as raw numbers and frequencies. The chi-squared test or Fisher's exact test was used to compare sex, Mallampati classification, and atlanto-occipital joint movement. Mann-Whitney's U test was used to compare other data. Data are presented as mean ± SE. $P < 0.05$ was considered statistically significant.

RESULTS

There were no significant differences between two groups in terms of demographic data or airway assessments (Table 1).

All the patients in the study were intubated successfully with the corresponding laryngoscope at the first attempt without any adverse effect. Intubation time was significantly shorter in the Airtraq DL™ group (17.2 ± 0.9 seconds, range = 9.6–29.4 seconds) compared with the AWS-200™ group (21.6 ± 1.1, range = 13.1–33.9 seconds) ($P = 0.005$) (Fig. 3). Exposure time was comparable between the groups (Airtraq DL™: 6.3 ± 0.3 seconds, range = 4.2–12.7 seconds; AWS-200™: 7.0 ± 0.4 seconds, range = 3.7–13.3 seconds) ($P = 0.132$) (Fig. 4).

With the Macintosh laryngoscope, the glottis view was Cormack-Lehane grade 3 in 4 and 5 patients in the Airtraq DL™ and AWS-200™ groups, respectively. However, with the videolaryngoscopes, the view improved to Cormack-Lehane grade 1 in both groups. The IDS scores were 0 in all patients in both groups. Insertion of the blade was rated as "very easy" or "easy" in all patients except in 4 and 1 in the Airtraq DL™ and AWS-200™ groups, respectively. No significant difference was observed. Furthermore, DLT advancement was rated as "difficult" in 5 patients each in the Airtraq DL™ and AWS-200™ groups and "very difficult" in 1 and 3 patients in the Airtraq DL™ and AWS-200™ groups, respectively. No significant difference was observed between the two groups (Table 2).

DISCUSSION

In this study, we compared two videolaryngoscopes with a guiding channel for DLT intubation by a senior anesthesiologist.

A videolaryngoscope, like the Airtraq DL™ and AWS-200™ laryngoscopes, has advantages of providing better glottis exposure and facilitation of intubation [3, 4]. However, the size and shape of DLT can make intubation difficult and attenuate the advantages of videolaryngoscopes [6, 7].

Intubation time was evaluated as the primary outcome because it is considered to be a comprehensive end point for the evaluation of intubation techniques and performances [24, 25].

The time required for intubation was defined as the time from insertion of the device into the oral cavity to removal of the device from the oral cavity after the completion of the tube advancement into trachea. The intubation time has been defined as the time from blind insertion of a DLT to the appearance of a capnograph trace in some reports [10, 26] or to confirmed placement in the left mainstem bronchus in others [9, 11]. Misplacement of the left-sided DLT into the right mainstem bronchus occurred in 4.2% patients under blind advancement [27]. To avoid misplacement, insertion of the bronchial lumen in the bronchus was generally performed with flexible fiber-optic bronchoscopy by the senior anesthesiologist of the institution. Thus, in this study, intubation time was defined as the time from insertion of the device into the oral cavity until removal of the device from the oral cavity.

Small differences in intubation time, for example, a difference of 4 s between the Airtraq DL™ and the AWS-200™ observed in our study, might have no clinically significant impact. However, in patients with difficult intubation, in whom successful intubation often requires much time, intubation time may greatly differ.

According to some reports, DLT intubation with the Airtraq DL™ requires shorter time than that with

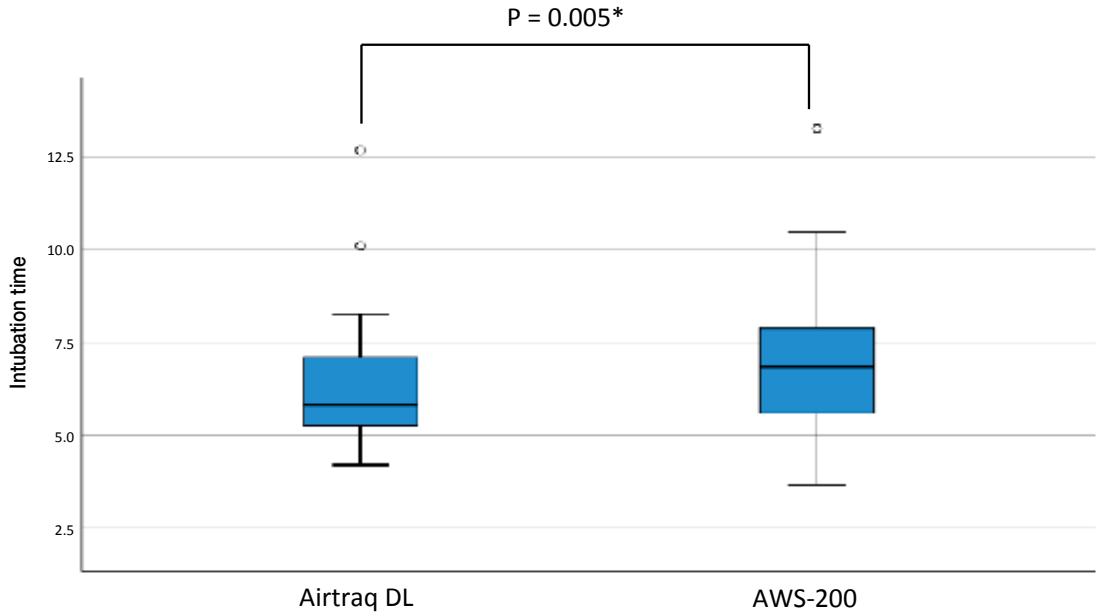

Fig. 3 Box-and-whisker plot (median, interquartile range, and range) of intubation time in the Airtraq DL and AWS-200 groups. *P < 0.05 was considered significant.

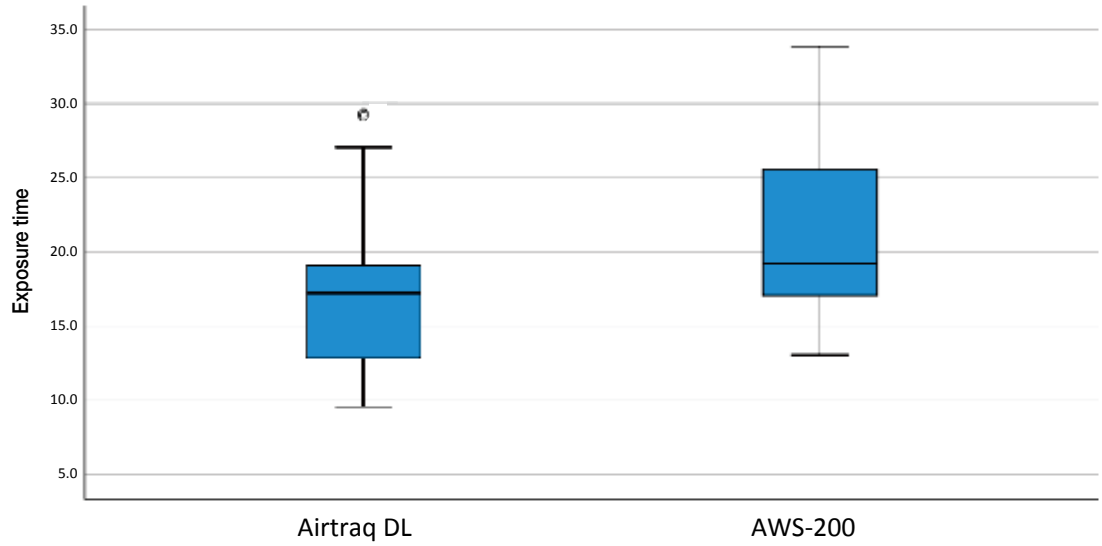

Fig. 4 Box-and-whisker plot (median, interquartile range, and range) of exposure time in the Airtraq DL and AWS-200 groups.

Table 2 Intubation data of the two laryngoscopes

	Airtraq DL™ (n = 30)	AWS-200™ (n = 30)	P-value
Initial glottic view with Machintosh (1/2/3)	15/11/4	11/14/5	0.338
Glottic view with study videolaryngoscope (1/2/3)	30/0/0	30/0/0	NA
Exposure time (s)	6.3 ± 0.3 (4.2–12.7)	7.0 ± 0.4 (3.7–13.3)	0.132
Intubation time (s)	17.2 ± 0.9 (9.6–29.4)	21.6 ± 1.1 (13.1–33.9)	0.005*
Success rate of first intubation attempt (n, %)	30 (100%)	30 (100%)	NA
IDS (0/1/2/3/4)	30/0/0/0/0	30/0/0/0/0	NA
Ease of laryngoscope insertion (0/1/2/3)	18/8/4/0	18/11/1/0	0.759
Ease of tube advancement (0/1/2/3)	10/14/5/1	11/11/5/3	0.838
DLT size (37 Fr/35 Fr)	22/8	0/30	NA

Data are presented as means ± standard errors (range) or numbers of patients.
Ease of laryngoscope insertion and tube advancement: 0 = very easy, 1 = easy, 2 = difficult, 3 = very difficult.
*Statistically significant difference between the two groups.
DLT = double-lumen tube; IDS = intubation difficulty scale; NA = not analyzed.

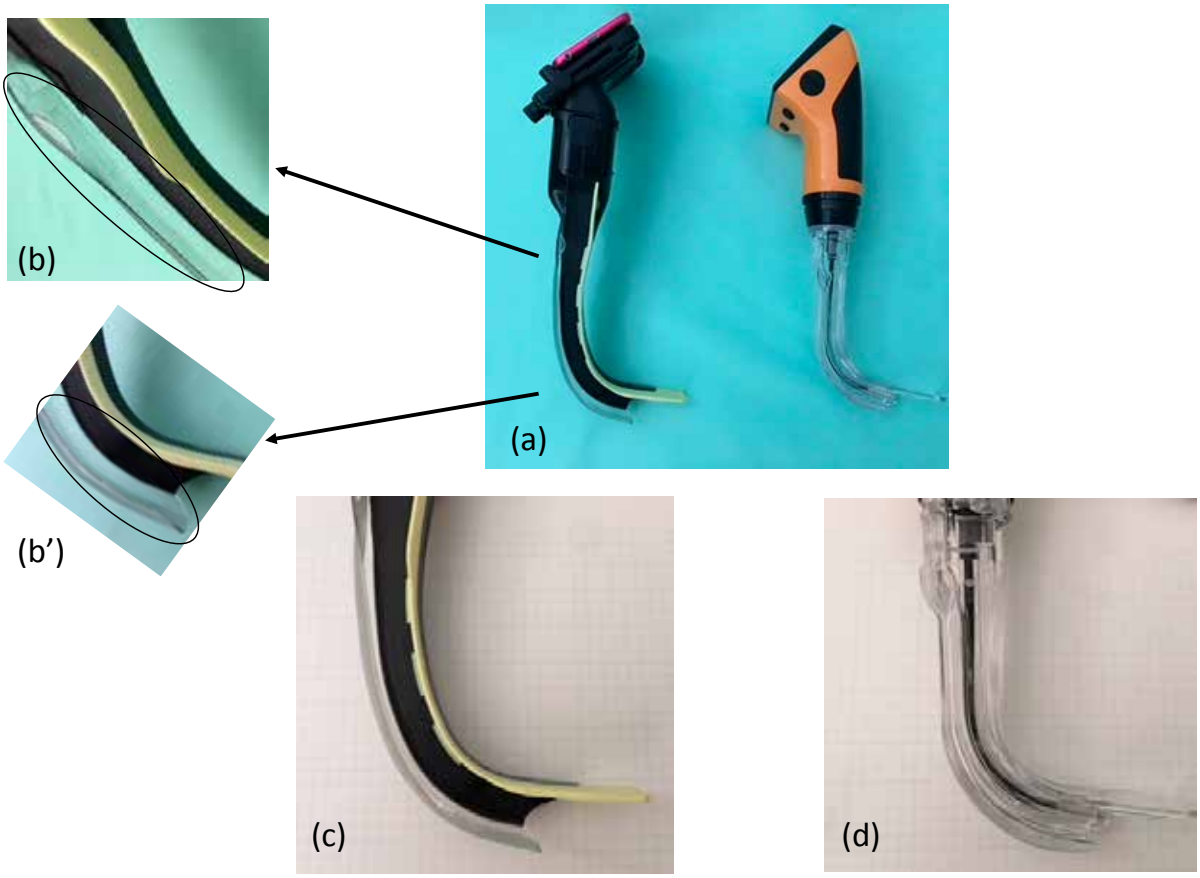

Fig. 5 (a) Lateral view of the Airtraq DL and AWS-200. (b and b′) Concavo-convex special treatment applied to the transparent part to reduce friction. Blade tip of the Airtraq DL (c) and the AWS-200 (d).

the Glidescope™ and the McGrath Series 5™, but the IDS scores are comparable among them [8, 9]. As for the reasons for comparable IDS scores despite different intubation times, the authors attribute the longer intubation time to the removal of the stylet. Because no stylet is required for the Airtraq DL™ or the AWS-200™, which has a side channel, the authors assumed that the intubation time was comparable between these devices.

The IDS score is typically used to indicate the difficulties of intubations with different laryngoscopes [15, 28], but it remains controversial whether the IDS score is suitable for the evaluation of indirect laryngoscopes [29, 30]. In the present study, the distributions of the IDS scores were same between the two groups (all patients had IDS scores of 0). These findings might indicate that DLT intubation using either of these two laryngoscopes is not difficult. Additionally, the distributions of the ease of laryngoscope insertion and tube advancement, as subjectively assessed by the intubator, were comparable between the two groups. Twenty-eight patients in the Airtraq DL™ and 26 patients in the AWS-200™ were given intubation manipulation ratings of very easy or easy. These findings in the study might suggest that the Airtraq DL™ and the AWS-200™, limited to 35 Fr, have equivalent manipulation difficulties in DLT intubations despite the acknowledged limitations of the subjective end points.

Tracheal intubation is performed in two steps, glottis exposure and tube advancement into the trachea. No significant difference in the exposure time was observed between the Airtraq DL™ and AWS-200™ groups. The required time differed in the step of tube advancement into the trachea. This step was significantly shorter in the Airtraq DL™ group than in the AWS-200™ group. The AWS Intlock (M-ITL-LL)™ can accommodate a tube with an external diameter of up to 13.5 mm. Although the 37-Fr Shiley™ Endobronchial Tube with Left Polyurethane Cuff with an external diameter of 12.3 mm, which was used in the present study, could be placed in the side channel, the advancement of the tube in the side channel caused great friction. Thus, a 35-Fr tube was used for intubation with the AWS-200™ in all patients in the present study.

For the Airtraq DL™, the tip of its blade is placed at the epiglottic vallecula to expose the larynx. In contrast, for the AWS-200™, the epiglottis is lifted with the tip of its blade to expose the larynx. Comparison of the lateral views of the side channels revealed that the side channel of the Airtraq DL™ curves more gently than that of the AWS-200™ (Fig. 5a, c, d). In addition, the side channel of the Airtraq DL™ can accommodate a tube with an external diameter of up to 19 mm, and the inner surface of the transparent part of the side channel is specially treated with a concavo-convex pattern to reduce friction (Fig. 5b and Fig. 5b'). The shape and special treatment of the side channel might have contributed to the shorter intubation time in the Airtraq DL™ group.

Our study has several limitations. First, the operator, the educational instructor for difficult airway management of The Japan Society for Clinical Anesthesia and the fellow of the Japanese Society of Anesthesiologists

with more than 20 years' clinical experience, was highly experienced in the use of videolaryngoscopes. The personal characteristics and skills of the senior anesthesiologist may influence the result. However, this conclusion cannot be extrapolated for novices. Second, the study used only one type of DLT. Double-lumen endotracheal tubes with various stiffness and shapes exist, and the evaluation may be differed. Finally, the present study compared the time required for DLT intubation with the Airtraq DL™ and the AWS-200™ in patients without difficult airway. However, we found there were about 15% patients with a Cormack-Lehane grade 3 by Macintosh examination in both groups. Their glottic views were improved and they were successfully intubated under videolaryngoscopes. Further studies on whether the intubation time in patients with difficult airway differs between these devices may provide clinically more useful information.

In conclusion, DLT intubation with the Airtraq DL™ required significantly shorter time than with the AWS-200™. However, no significant differences were observed in the IDS scores or in the ease of blade insertion or DLT advancement. With these two types of videolaryngoscopes with side channel, the Airtraq DL™ and the AWS-200™, DLT intubation was performed safely and effectively. Both the Airtraq DL™ and the AWS-200™ appear to be useful devices for patients who are not expected to have difficult airway. Because the Airtraq DL™ can also accommodate larger tube sizes, it seems to have more advantages than the AWS-200™.

Clinical trial registration: UMIN Clinical Trials Registry (ref: NCT02329041)

REFERENCES

1) Apfellbaum JL, Hagberg CA, Caplan RA, Blitt CD, Connis RT, Nickinovich DG. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology 2013; 118: 251–70.
2) Niforopoulou P, Pantazopoulos I, Demestiha T, *et al*. Videolaryngoscopes in the adult airway management: a topical review of the literature. Acta Anaesthesiol Scand 2010; 54: 1050–61.
3) Ray DC, Billington C, Kearns PK, *et al*. A comparison of McGrath and Macintosh laryngoscopes in novice users: a manikin study. Anaesthesia 2009; 64: 1207–10.
4) Savoldelli GL, Schiffer E, Abegg C, Baeriswyl V, Dlergue F, Waeber JL. Learning curves of the Glidescope, the McGrath and the Airtraq laryngoscopes: a manikin study. Eur J Anaesthesiol 2009; 26: 554–8.
5) Savoldelli GL, Schiffer E. Videolaryngoscopy for tracheal intubation: the guide channel or steering techniques for endotracheal tube placement? Can J Anaesth 2008; 55: 59–60.
6) Cohen E. Methods of lung separation. Curr Opin Anaesthesiol 2002; 15: 69–78.
7) Cohen E. Recommendation for airway control and difficult airway management in thoracic anesthesia and lung separation procedures. are we ready for the challenge? Minerva Anesthesiol. 2009; 75: 3–5.
8) Wan L, Lias M, Li L, *et al*. McGrath Series 5 videolaryngoscope vs Airtraq DL videolaryngoscope for double-lumen tube intubation: A randomized trial. Medicine (United States) Volume 95, Issue 51, 2016, Page e5739.
9) Yi J, Gong Y, Quan X, Huaang Y.: Comparison of the Airtraq laryngoscope and the GlideScope for double-lumen tube intubation in patients with predicted normal airways: a prospective randomized trial. BMC Anesthesiology. 2015; 15: 58. Doi: 10.1186/s12871-015-0037-5.
10) Belze O, Lepage E, Bazin Y, Kerourin P, Fusciardi J, Remerand F, Espitalier F.: Glidescope versus Airtraq DL for double-lumen tracheal tube insertion in patients with a predicted or known difficult airway: A randomised study. Eur J Aeaesthesiol. 2017 Jul; 34(7): 456–463. doi: 10.1097/EJA.0000000000000655.
11) Wasem S, Lazarus M, Hain J, Festl J, Kranke P, Roewer N, Lange M, Smul TM.: Comparison of the Airtraq and the Macintosh laryngoscope for double-lumen tube intubation: a randomized clinical trial. Eur J Anaesthesiol 2013; 30(4): 180–186.
12) Kurahashi N, Komasawa N, Hattori K. *et al*. Rapid-sequence intubation of a patient with difficult airway using a double-lumen endotracheal tube with the Pentax-AWS Airwayscope and a soft-tipped tube exchanger. J Clin Anesth 2017; 36: 14–5.
13) Sano H, Komasawa N, Minami T. Efficacy of the Pentax-AWS AirwayscopeTM with a newly developed Intlock for a double lumen tracheal tube. J Clin Anesth 2016; 34: 373–4.
14) Marui T, Kuwasako Y, Shinoda T, Omri N, Otake H. Comparison of the usability of Airtraq®, Kingvision® and airwayscope® for oral intubation in normal airway patients. Journal of the Showa Medical Association. 2014; 74: 183–9.
15) Lee DW, Thampi S, Yap EPH, Liu EHC. Evaluation of a smartphne camera system to enable visualization and image transmission to aid tracheal intubation with the Airtraq® laryngoscope. J Anesth. 2016; 30: 514–7.
16) Gome-Rios MA, Freire-Vila E, Criado-Alonso MJ, Fernandez-Goti MC. Airtraq laryngoscope: Embracing video laryngoscopy. Saudi J Anaesth. 2016; 10: 246–7.
17) Shiga T, Wajima Z, Inoue T, Sakamoto A. Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. Anesthesiology. 2005; 103: 429–37.
18) Adnet F, Borron SW, Racine SX, Clemessy JL, Fournier JL, Plaisance P. The intubation difficulty scale (IDS): proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. Anesthesiology.1997; 87: 1290–7.
19) Suman H, Huma S, Neerja B. A comparison of truview EVO2 laryngoscope with Macintosh laryngoscope in routine airway management: a randomized crossover clinical trial. Saudi J Anaesth. 2013; 7: 244–8.
20) Lili X, Zhiyong H, Jianjun S. A comparison of the glidescope with the Macintosh laryngoscope for nasotracheal intubation in patients with ankylosing spondylitis. J Neurosurg Anesthesiol. 2014; 26: 27–31.
21) Ochroch EA, Hollander JE, Kush S, Shofer FS, Levitan RM. Assessment of laryngeal view: percentage of glottic opening score vs Cormack and lehane grading. Can J Anaesth. 1999; 46: 987–90.
22) Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia. 1984; 39: 1105–11.
23) Brodsky JB, Fitzmaurice BG, Macario A. Selecting Double-Lumen Tubes for Small Patients. Anesth Analg. 1999; 88: 466–7.
24) Kaki AM, Almarakbi WA, Fawzi HM, Boker AM. Use of airtraq, C-Mac, and glidescope laryngoscope is better than Macintosh in novice medical students' hands: a manikin study. Saudi J Anaesth. 2011; 5: 376–81.
25) Kleine-Brueggeney M, Greif R, Schoettker P, *et al*. Evaluation of six videolaryngoscopes in 720 patients with a simulated difficult airway: a mulicentre randomized controlled traial. Br J Anaesth 2016; 116: 670–679.
26) Kido H, Komasawa N, Matsunami S, Kusaka Y, Minami T. Comparison of McGRATH MAC and Macintosh laryngoscopes for double-lumen endotracheal tube intubation by anesthesia residents: a prospective randomized clinical trial. Journal of Clinical Anesthesia (2015) 27, 476–480.
27) Seo JH, Bae JY, Kim HJ, Hong DM, Jeon Y, Bahk JH. Misplacement of left-sided double-lumen tubes into the right mainstem bronchus: incidence, risk factors and blind repositioning techniques. BMC Anesthesiol. 2015; 15: 157.
28) Benumof JL. Intubation difficulty scale: anticipated best use. Anesthesiology. 1997; 87: 1273–4.
29) Puchner W, Drabauer L, Kern K, Mayer C, Bierbaumer J, Rehak PH. Indirect versus direct laryngoscopy for routine nasotracheal intubation. J Clin Anesth. 2011; 23: 280–5.
30) Combes X, Dhonneur G. Difficult tracheal intubation. Br J Anaesth. 2010; 104: 260–1.