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Airway Scope: early clinical experience in 405 patients

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Abstract
The Airway Scope (Pentax, Tokyo, Japan) is a new device used for tracheal intubation. It allows visualization of the glottis through a non-line-of sight view. The aim of the present study was to evaluate the suitability of this device for the tracheal intubation of surgical patients. In this prospective study, the Airway Scope was used for the endotracheal intubation of 405 patients by 74 airway operators. The Airway Scope allowed visualization of the glottis in all 405 patients, including those with a Cormack-Lehane view of grade III ($n = 15$) or grade IV ($n = 1$) on Macintosh laryngoscopy. All tracheal intubations using the Airway Scope were successful. The mean time to complete tracheal intubation was 42.4 ± 19.7 s (±SD; range, 13–192 s). No dental damage was encountered, though minor mucosal injury caused by the blade was experienced in 2 patients. The Airway Scope consistently permitted a better intubation environment. With its potential advantages, the Airway Scope could be an effective aid to airway management in surgical patients.

Key words Laryngoscopy · Airway Scope · Intratracheal intubation

Introduction

The Airway Scope (AWS; Pentax, Tokyo, Japan) is a new rigid videolaryngoscope for tracheal intubation designed to provide a non-line-of sight view of the glottis [1]. It has a built-in charge-coupled device (CCD) camera and a light-emitting diode (LED) attached to the tip of the scope. The image is displayed on a 2.4-inch liquid crystal display (LCD) monitor built into the top of the handgrip (Fig. 1A,B). The portable imaging system is powered by two AA-size batteries. The single-use blade protects the video system from oral contamination and has two side channels parallel to the video system. The main channel acts as a conduit for the insertion and placement of the tracheal tube. It accepts tubes with an outside diameter between 8.5 and 11.0 mm. The subchannel, which accepts catheters with a diameter of 4.0 mm or less, acts as a route for suction or the application of topical anesthesia. Once the target signal shown on the monitor screen has been aligned with the glottis opening (Fig. 2A), pushing the tracheal tube along with the tube guide allows it to pass through the vocal cords (Fig. 2B). Not only the airway operator but also other individuals can view the depth of the tracheal tube at the level of the vocal cords (Fig. 2C).

Our preliminary study demonstrated that this new portable device provided better intubation conditions for novice personnel compared with the conventional Macintosh laryngoscope [2]. Increased evidence points to the many advantages of the device in airway management [3–6]. To properly evaluate the AWS in clinical settings, we assessed its performance in 405 tracheal intubations in the operating room.

Patients and methods

After obtaining Institutional Ethics Board approval and patients' written informed consent, the investigators recorded the clinical data of patients who required general anesthesia with tracheal intubation for surgery. AWS intubations between September 2006 and May 2007 were included in this study. Staff anesthesiologists, anesthesia residents, and non-anesthesia residents performed tracheal intubation for 405 patients using the AWS. The investigators offered suggestions about the AWS technique when the laryngoscopists had no prior experience with the AWS, and the laryngoscopist was allowed to practice intubation on a manikin prior to actual intubation. One investigator supervised the

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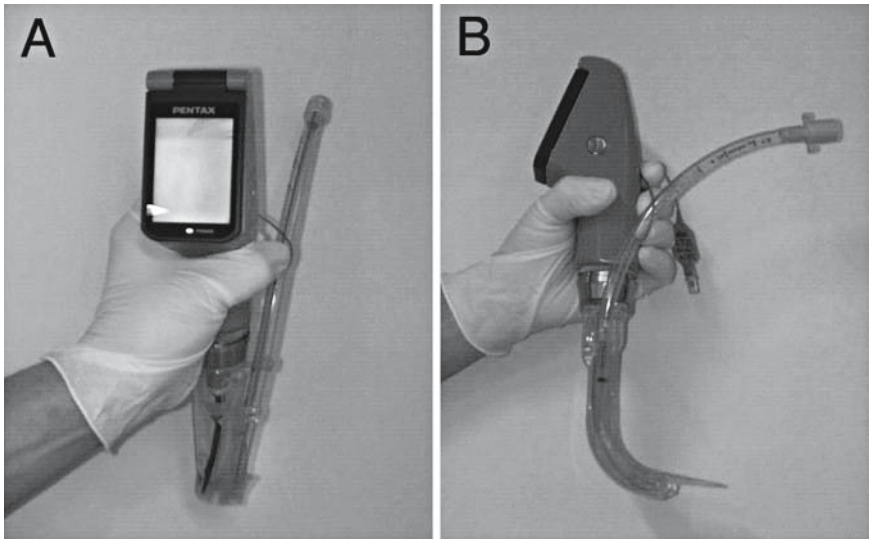

Fig. 1A,B. Photographs of the Airway Scope. **A** Front view. **B** Side view. The tracheal tube is equipped with a side channel. Figure reproduced (with permission) from reference [2]

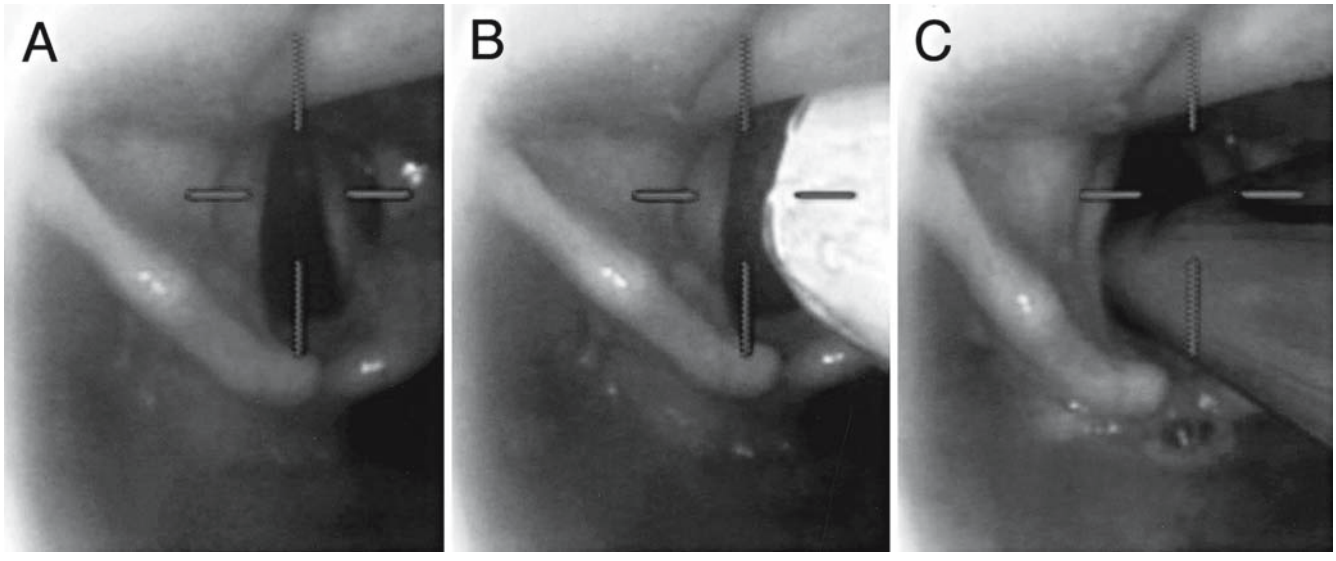

Fig. 2A–C. Video images taken during laryngoscopy and intubation using the Airway Scope. **A** The target signal is aligned with the glottis opening. **B** Cuffed tube is advanced into the trachea. **C** Confirmation of the insertion of the endotracheal tube through the vocal cords. Figure reproduced (with permission) from reference [2]

laryngoscopy and tracheal intubation at the beginning of the investigation period and subsequently other staff anesthesiologists similarly supervised the residents when they performed laryngoscopy. The time to secure the airway was defined as the time from interruption of intermittent positive-pressure ventilation to connection of the endotracheal tube to an anesthesia circuit. If the first intubation attempt failed, the duration of the subsequent attempt was added to the time of the first attempt to secure the airway. The patient received mask and bag ventilation with oxygen between the tracheal intubation attempts, to ensure adequate oxygenation. Correct placement of the tracheal tube was confirmed by the appearance of the end-tidal CO_2 trace on the monitor screen. The video image was recorded on a camcorder throughout the procedure. The number of attempts required to achieve successful tracheal intubation and the number of optimization maneuvers required were also recorded for each intubation for each patient.

Data values were expressed as means ± SD (ranges). The number of optimizing maneuvers was examined using the χ^2 test. A P value of less than 0.05 was assigned as statistically significant.

Results

Participating operators

Of the 405 tracheal intubations for the 405 patients, 52 were performed by 21 staff anesthesiologists, 102 by 15 anesthesia residents, and 251 by 38 non-anesthesia residents. In all, each of the 74 operators performed 1 to 23 tracheal intubations (median, 4 intubations). With regard to experience, 60 (81%) operators had performed tracheal intubation less than ten times, and 14 (19%) operators had performed it more than ten times.

Patients

The patients consisted of 158 men and 247 women, aged 54 ± 17 years (range, 17–92 years), with body weight of 59 ± 12 kg (range, 37–114 kg), height 159 ± 9 cm (range, 137–182 cm), and body mass index 23.3 ± 3.9 $kg \cdot m^{-2}$ (range, 15.2–44.2 $kg \cdot m^{-2}$). Of the 405 patients, tracheal intubation with the AWS was attempted as the first choice in 392 patients, including 4 patients with a history of difficult airway and 14 patients with anticipated difficult airway. The AWS was utilized as a rescue device in the remaining 13 patients, in whom the use of the Macintosh laryngoscope had resulted in unsuccessful intubations.

Performance

The AWS provided a view of the glottis and tracheal intubation was successfully performed in all 405 patients. The AWS secured a view of the glottis even in those patients in whom the Macintosh laryngoscope showed a Cormack-Lehane view [7] of grade III ($n = 15$) or grade IV ($n = 1$). In all, 323 polyvinyl chloride tracheal tubes (Portex, SIMS Portex, Hythe, Kent, UK), 65 reinforced tracheal tubes (Cliny, Create Medic, Yokohama, Japan), and 17 preformed polyvinyl chloride tracheal tubes (RAE; Mallinckrodt, Athlone, Ireland) were correctly placed in the trachea. Tracheal intubation was performed after induction of general anesthesia in 390 patients, and in 15 awake or lightly sedated patients.

Time to secure the airway could be measured in 375 of 390 patients whose tracheas were intubated after the induction of general anesthesia. The mean time to complete tracheal intubation was 42.4 ± 19.7 s (range, 13–192 s). In general, instrumentation of the airway was completed within 1 min in 344 (92%) of the 375 patients. With respect to the 14 operators who had experienced tracheal intubation more than ten times, the mean shortest time was 24.7 ± 4.6 s (range, 17–34 s).

Attempts required to achieve intubation and optimization maneuvers

Tracheal tubes were placed easily in the correct position at the first attempt in 95% (383/405) of the patients. Multiple attempts (median, 2 times; range, 2–4 times) were needed for successful intubation in 5% (22/405) of the patients. Although the AWS provided a good view of the glottis, the tip of the tracheal tube collided with the arytenoids and could not be advanced into the trachea in 9% (38/405) of the patients. In these patients, manual displacement of the larynx by backward pressure on the thyroid cartilage was applied to lead the tube tip into the tracheal orifice. Reinforced tracheal tubes frequently required this maneuver, compared with polyvinyl chloride tracheal tubes (38% [25/65] vs 4% [13/340]; $P < 0.001$). In a patient in whom the Macintosh laryngoscope was unsuccessful, an inexperienced operator, without knowledge of such a maneuver, intended to intubate with a reinforced tube, but could not advance it into the trachea. In this patient, a normal polyvinyl chloride tube resulted in successful performance, and subsequently the operator exchanged it for a reinforced tube, with the aid of a tracheal tube exchanger. The tip of the tracheal tube collided with either the anterior commissure of the glottis or the anterior wall of the cricoid cartilage in 1% (4/405) of patients, preventing the advance of the tube into the trachea. On these occasions, relaxing the elevation of the AWS allowed the tube to advance into the trachea.

Complications

No erroneous esophageal intubation was experienced. No dental damage was experienced. A small trauma to the upper lip occurred in one patient with a small mouth. Another patient suffered mucosal injury of the pharynx during intubation; the tip of the blade scratched the posterior pharyngeal wall during placement of the blade tip onto the laryngeal surface of the epiglottis. The mucosal injury did not require suturing or electrocauterization.

Discussion

The AWS provided visibility of the vocal cords in all 405 patients. The vocal cords were also visible with the aid of the AWS in the 16 patients with a Cormack-Lehane view of grade III or grade IV with the Macintosh laryngoscope. Tracheal intubation using the AWS was successful in each patient. During the early stages of the evaluation, none of the users had any experience with this new device. Nevertheless, every laryngoscopy procedure and tracheal intubation was performed success-

fully. This indicates that the AWS requires less operator skill. The AWS provided an excellent intubation environment even when used by novice operators. Shortly after the device became available on the market, the AWS was often requested for the management of patients in whom it was expected that intubatation with a Macintosh laryngoscope would be difficult or very difficult.

In the present study, we collected data on the time required for instrumentation in 375 patients. Of these, 344 (92%) tracheal intubations were completed within 1 min. The overall time needed to secure the airway was 42.4 ± 19.7 s. This duration, however, seems longer than that reported in the literature when the Macintosh laryngoscope was used for tracheal intubation [8,9]. In the current series, we collected data on intubation from the first experience to the 405th experience at our institution; 60 of the 74 operators had performed tracheal intubations less than ten times. Insufficient experience with the AWS might explain the difference between our results and those of previous studies [8,9]. With respect to the 14 residents who had experienced intubation more than ten times, the shortest mean time was 24.7 ± 4.6 s. This duration may be similar to that required for anesthesia residents performing tracheal intubation with a Macintosh laryngoscope.

Recently, three videolaryngoscopes that provide a non-line-of sight view of the glottis have become available commercially; the GlideScope (Verathon, Bothell, WA, USA), the Airtraq (Prodol, Vizcaya, Spain), and the McGrath (Aircraft Medical, Edinburgh, UK). The GlideScope seems to be a widely used videolaryngoscope [10–17], and it yields a relatively more superior view of the glottis on a separate monitor screen. This device, however, must be resterilized after use, typically via the Sterrad (Advanced sterilization products, Irvine, CA, USA) system. The Airtraq [18–22] is a single-use portable device that consists of two channels. One channel houses the optic viewing system, composed of lenses and prisms, and the other acts as a conduit through which a tracheal tube can be passed. The built-in passageway of the tracheal tube provides an easy means to advance the tube when the larynx comes into view. The McGrath videolaryngoscope is portable, and consists of a handle, a camera stick, and a single-use blade. The monitor screen is mounted on the top of the handle. One case series showed useful initial clinical information related to this device [23].

With respect to the AWS, in addition to a non-line-of sight view of the glottis, it has several other potential advantages. First, the scope has a built-in monitor at the top of the handgrip. This means that the eyes of the laryngoscopist are focused on the monitor screen, laryngoscope, and the patient's face simultaneously, making the manipulation of the device easy. Some difficulties have been reported during the manipulation of a laryngoscope while viewing the events on a separate monitor screen placed on the side of the patient [17]. Second, the target signal shown on the monitor screen is helpful for operators. Third, the AWS is portable, as it is powered by AA batteries. This is convenient for clinical use, both in the operating room and in emergencies outside the operating room. Finally, the blade of the AWS is disposable, thus eliminating the potential risk of contamination and infection.

There are several limitations to the use of the AWS. First, the thickness of the root of the blade is 18 mm. This makes it unsuitable for patients with an inter-incisor gap of less than 18 mm. Based on our experience, an inter-incisor gap of at least 25 mm is required for a smooth manipulation of the blade. Second, the blade of the AWS accepts tracheal tubes with an outside diameter of 8.5–11.5 mm; thus, small-size tracheal tubes for children or infants cannot be used. The device cannot be used with large-size tubes, including double-lumen bronchial tubes. Finally, we sometimes experienced instances in which the tip of the reinforced tracheal tube swerved from the target and collided with the arytenoids. Even in such situations, manual displacement of the larynx, obtained by applying external pressure on the thyroid cartilage, enhanced the slide of the tube tip into the glottis. The reinforced tracheal tube is flexible and can be easily bent, though it resists kinking. When the tip of the reinforced tube leaves the tube guide of the blade, it can drop down by gravity. This could potentially hinder the advance of the tube into the glottis. In this regard, the use of a reinforced tube could have disadvantages compared with the use of a polyvinyl chloride tube.

In conclusion, the AWS allowed successful tracheal intubation in 405 surgical patients. It consistently permitted a comparative or better intubation environment.

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