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Success of Orotracheal Intubation with the Airtraq Optical Laryngoscope in Patients with Difficult Conventional Laryngoscopy

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Abstract

Objectives: This clinical review summarizes the success of orotracheal intubation using the Airtraq Optical Laryngoscope (AOL) in patients with difficult conventional laryngoscopy (CL). Two clinical studies (published in this journal) including altogether 312 patients with various conventional laryngoscopic views and further documented uses of the AOL in 20 patients with difficult CL (unpublished data) were evaluated.

Design of the Evaluated Studies: Patients with a previously experienced difficult airway, anatomic features predictive for difficult CL, and/or obesity were given preferential enrollment into these studies. The study design of all investigations provided conventional laryngoscopic view grading (CLV) before proceeding with further airway management (AM).

Setting: The studies were performed at a community hospital with a reference center for the management of thyroid diseases.

Patients: Adult patients undergoing elective thyroid surgery were investigated.

Operators: The operators (14 staff anesthetists, 2 anesthesia residents, 2 qualified anesthesia nurses, and 4 nonanesthesia residents) were first instructed in the use of the AOL on a suitable AM model and then during the first 10 applications on patients; residents and qualified anesthesia nurses were supervised during all performances on patients.

Interventions: CLV was performed with a standard Macintosh laryngoscope (using gentle lifting force without external laryngeal manipulation and the 5-grade modification of the original classification of laryngeal views by Cormack and Lehane). Laryngoscopy with the AOL was performed using the same technique as for CL. When the laryngeal aperture was in the center of the view finder, AOL-assisted tracheal intubation, with the tracheal tube (TT) placed in the tube-guide channel on the right side of the AOL blade, was attempted.

Measurements and Main Results: In the 332 investigated patients, grade 4 (visualization of only the epiglottis) and grade 5 (visualization of just the soft palate) at CL (judged as difficult CL) were obtained in 68 and 2 patients, respectively. In the 70 patients with difficult CL, the success rate of AOL-assisted tracheal intubation at the first attempt was 94 percent (66/70 patients); the causes of primary failures of tracheal intubation were failed identification of laryngeal structures (in one patient) and failed TT advancement during laryngeal passage (in 3 patients). The remaining 4 patients required a second attempt for successful tracheal intubation. Visualization of the entire laryngeal aperture was finally obtained in all patients; downsized TTs for atraumatic tracheal intubation were required in 2 patients. Minor problems and difficulties with impeded blade insertion (due to limited mouth opening and/or restricted pharyngeal space) and

impeded TT advancement during laryngeal passage at successful tracheal intubation were encountered in altogether 12 percent and in 9 percent, respectively; impeded TT advancement during tracheal passage was rarely a problem. There were no problems with poor visibility due to the presence of secretions and/or fogging of the optical system.

Conclusions: Performed by instructed operators (with various proficiency in airway management) or experienced users, AOL-assisted orotracheal intubation proved to be uniquely useful in patients with difficult CL with success after a maximum of two attempts.

Introduction

We performed clinical investigations with the Airtraq Optical Laryngoscope (AOL; manufactured by Prodol Medical, Vizcaya, Spain) in anesthetized patients requiring orotracheal intubation for elective thyroid surgical procedures. The study design of these investigations provided conventional laryngoscopic view grading (without external laryngeal manipulation) prior to AOL-assisted laryngoscopy and tracheal intubation attempts.

This clinical review summarizes the success of AOL-assisted orotracheal intubation performed by instructed operators (with variable proficiency in airway management) or experienced users in patients with difficult conventional laryngoscopy (CL), judged by visualization of only the epiglottis or just the soft palate. Two published clinical investigations (6, 7) in patients with various conventional laryngoscopic views and further documented uses of the AOL in patients with difficult CL (unpublished data) were evaluated.

Study Design of the Evaluated Clinical Investigations

Legal and Ethical Considerations. The studies with the Airtraq Optical Laryngoscope (AOL) were approved by the Institutional Review Board. Informed patient consent was obtained for the planned strategy of airway management (AM) and the anonymous use of patient data for scientific purposes.

Patient Selection. The studies were performed at a community hospital with a reference center for the management of thyroid diseases; the institutional department of general surgery performs more than 1200 thyroid surgical procedures a year. Adult patients with American Society of Anesthesiologists physical status classification 1, 2, or 3 requiring orotracheal intubation for elective thyroid surgery were investigated. Patients with gastroesophageal reflux disease and those with difficult face-mask ventilation experienced during induction of general anesthesia were excluded from the studies. Patients with previously experienced difficult conventional tracheal intubation, anatomic features predictive for difficult conventional laryngoscopy (CL) and tracheal intubation [such as limited mouth opening (but not less than 20 mm), restrictions in forward movement of the jaw, reduced thyromental distance, and/or limitations in head and neck movement], and/or obesity were given preferential enrollment into the studies. Therefore, this clinical review represents data of prospective, but non-consecutive observational studies.

Participating Operators. Voluntary staff anesthesiologists, anesthesia residents, qualified anesthesia nurses, and nonanesthesia residents could participate in the studies. They first received formal hands-on training on a suitable AM model (AirSim Multi, TruCorp, Belfast, United Kingdom) for acquisition of sufficient skills in handling the AOL and passing the tracheal tube (TT) through the laryngeal aperture into the trachea, and were then instructed during the first 10 applications on patients (the number for obtaining acceptable clinical performance and competence estimated by the instructor). Residents and qualified anesthesia nurses were supervised during all performances on patients.

Anesthetic Technique. Patient monitoring and anesthetic care were provided by the S/5 Anesthesia Delivery Unit (Datex-Ohmeda, Instrumentarium Corporation, Helsinki, Finland). Glycopyrrolate 0.2 to 0.4 mg was given 3 min before induction of anesthesia. Following preoxygenation, general anesthesia was induced with 2.5 to 3.5 mg.kg⁻¹ propofol supplemented by 1.5 to 3.0 µg.kg⁻¹ fentanyl. After confirmation of effective face-mask ventilation with oxygen, muscle relaxation was achieved using 0.6 mg.kg⁻¹ rocuronium. During AM, intermittent boluses of propofol were occasionally given at the discretion of the operator when staff anesthetist, otherwise at the discretion of the instructor/supervisor for maintaining an adequate depth of anesthesia.

Conventional Laryngoscopy. After complete neuromuscular blockade [judged by neuromuscular transmission (S/5 Neuromuscular Transmission Module and Mechanosensor, with the electrodes placed over the ulnar nerve using the train-of-four mode)], conventional laryngoscopic view grading (CLV) was performed using direct laryngoscopy with a standard Macintosh laryngoscope for fiberoptic battery handles (Karl Storz Endoscopy, Tuttlingen, Germany; blade sizes 3 and 4 in small and large adults, respectively); gentle lifting force on the blade was applied and the laryngeal view was evaluated without external laryngeal manipulation. Positioning of the patient regarding elevation of the head and extension of the neck [particularly using the ramped head-elevated laryngoscopy position in obese patients (1)] was at the discretion of the operator when staff anesthetist, otherwise at the discretion of the instructor/supervisor.

Conventional Laryngoscopic View Grading. The 5-grade modification of the original classification of laryngoscopic views by Cormack and Lehane was used for CLV (9): grade 1, visualization of the entire laryngeal aperture; grade 2, visualization of just the posterior portion of the laryngeal aperture; grade 3, visualization of only the arytenoids; grade 4, visualization of only the epiglottis; and grade 5, visualization of just the soft palate. Difficult CL was given when views of grade 4 or 5 were obtained.

Optical Laryngoscopy. The AOL was inserted in the midline into the oral cavity. The blade was then slid around the tongue into the posterior pharynx; optimum depth of insertion was determined by the vallecula. Before the AOL main body reached the vertical plane, visualization of laryngeal structures was attempted. The blade was slightly elevated against the dorsal face of the tongue with minimum upward pressure for indirectly lifting the epiglottis.

Tracheal Intubation Technique. For AOL-assisted tracheal intubation, positioning of the patient (as selected for CLV) remained unchanged. Standard TTs (TTs; Lo-Contour Murphy, Mallinckrodt Medical, Athlone, Ireland) with inner diameters of 7.5 and 8.0 mm were used in small and large adults, respectively. When the laryngeal aperture was in the center of the view finder, the TT was gently advanced from the position in the tube-guide channel through the laryngeal aperture (under continued view). When the TT impinged on laryngeal structures (the arytenoids or the interarytenoid area), the blade was slightly withdrawn, elevated, and/or turned to the right or left side, and TT advancement was repeated; when further advancement of the TT was impeded (by impinging on the anterior wall of the thyroid cartilage or the anterior thyroid wall), the TT was slightly rotated to the right to facilitate passage into a midtracheal position. After visual confirmation of correct placement, the TT was secured at the proximal end and disengaged from the tube-guide channel, and the AOL was removed by rotating the unit forward back and gently lifting it out of the oral cavity.

Procedure after Failed Tracheal Intubation. When tracheal intubation failed after two separate attempts (duration more than 120 seconds and/or desaturation with oxygen saturations of less than 95 percent), further AM (and the tracheal intubation technique applied) was at the discretion of the operator when staff anesthetist, otherwise at the discretion of the

instructor/supervisor. Between the tracheal intubation attempts, the patients received face-mask ventilation with oxygen to ensure adequate oxygenation.

Severe Complaints and Injuries Associated with Airway Management. Severe complaints and injuries (to oropharyngeal, laryngeal, and/or tracheal structures) associated with AM were evaluated at the postanesthesia care unit and during the postanesthesia visit on the first postoperative day at the normal ward.

Instructor/Supervisor and Independent Observer. The corresponding author of this clinical review was instructor/supervisor and independent observer during both studies. He documented the laryngeal views obtained with CL and the AOL (rated by the operator); furthermore, he documented minor problems and difficulties and failures during AM, the procedure(s) applied after failed tracheal intubation, and severe complaints and injuries associated with AM.

Results

Data Evaluation. Two clinical investigations (6, 7) were evaluated for this clinical review; the study design of both investigations provided conventional laryngoscopic view grading before proceeding with further airway management (AM). The use of the Airtraq Optical Laryngoscope (AOL) was investigated in altogether 312 patients requiring orotracheal intubation for elective thyroid surgical procedures with various conventional laryngoscopic views. Further 20 patients with difficult conventional laryngoscopy (CL) also requiring orotracheal intubation for elective thyroid surgery (during July and December 2008, unpublished data) attempted by using the AOL were additionally included in this clinical review. None of these patients was excluded from the study because of difficult face-mask ventilation experienced during induction of general anesthesia.

Participating Operators. Fourteen staff anesthesiologists, 2 anesthesia residents, 2 qualified anesthesia nurses, and 4 nonanesthesia residents (with various proficiency in AM) volunteered and participated in these studies and evaluations. The operators were instructed (and supervised when not staff anesthetist) or experienced users of the AOL.

Overall Success of Tracheal Intubation. In the 332 patients evaluated, grade 1 to 5 at CL was obtained in 111, 90, 61, 68, and 2 patients, respectively. The overall success rate of AOL-assisted tracheal intubation at the first attempt was 98 percent (325/332 patients); in all patients, tracheal intubation was successful after a maximum of two attempts.

Difficult Conventional Laryngoscopy and Success of Tracheal Intubation. In the 70 patients with difficult CL (grade 4 or 5), the success rate of AOL-assisted tracheal intubation at the first attempt was 94 percent (66/70 patients). The causes of primary failures of tracheal intubation were failed identification of anatomical structures (in one patient) and failed tracheal tube (TT) advancement during laryngeal passage (in 3 patients). Visualization of the entire laryngeal aperture was finally obtained in all patients; downsized TTs for atraumatic tracheal intubation were required in 2 patients.

Minor Problems and Difficulties at Successful Tracheal Intubation. In patients with difficult CL, impeded blade insertion (due to limited mouth opening and/or restricted pharyngeal space) and impeded TT advancement during laryngeal passage passage at successful tracheal intubation were encountered in altogether 12 percent and in 9 percent, respectively; impeded TT advancement during tracheal passage was rarely a problem. There were no problems with poor visibility due to the presence of secretions and/or fogging of the optical system.

Severe Complaints and Injuries Associated with Airway Management. In all evaluated patients, severe complaints and injuries (to oropharyngeal, laryngeal, and/or tracheal structures)

associated with AM were not observed at the postanesthesia care unit and during the postanesthesia visit on the first postoperative day at the normal ward.

Discussion

In this clinical review (including altogether 332 patients with various conventional laryngoscopic views requiring orotracheal intubation for elective thyroid surgical procedures), the overall success rate of tracheal intubation at the first attempt with the Airtraq Optical Laryngoscope (AOL) performed by instructed operators or experienced users (staff anesthetists, anesthesia residents, qualified anesthesia nurses, and nonanesthesia residents) was 98 percent, with definitive success of tracheal intubation after a maximum of two attempts in all patients. We specifically evaluated the 70 patients with difficult conventional laryngoscopy (CL), defined as visualization of only the epiglottis or just the soft palate; the first-attempt success of tracheal intubation in these patients was 94 percent. These favorable results may not be obtained with CL techniques and limited tracheal intubation attempts.

The AOL allows for the transmission of a color image with adequate quality to the view finder at the proximal end of the laryngoscope handle (by internal arrangements of optical components), usually providing the operator a panoramic view of the laryngeal aperture when properly inserted. However, the tube-guide channel at the right side of the AOL blade, for guidance of the tracheal tube (TT) into the correct position, may incorporate some problems with deflection and impingement of the TT on surrounding laryngeal structures. The handling of the AOL is similar to CL with the Macintosh laryngoscope (indirect lifting of the epiglottis); therefore we anticipated easy adoption by novice users. Because of expected problems of viewing the intubation process through the view finder and difficulties in manipulating the TT through the laryngeal aperture into a midtracheal position, novice users first received formal hands-on training on a suitable airway management (AM) model and were then instructed during the early series of performance on patients.

The results of this clinical review strongly support formal instruction of operators inexperienced with the use of a new device for AM; this approach was obviously the key factor for success. When the novice users of the AOL performed the first series of laryngoscopy and tracheal intubation attempts with the AOL on patients, they were already familiar and confident with the technique.

The relatively bulky AOL blade (a limitation of this device) may impede blade insertion, particularly in patients with limited mouth opening and/or restricted pharyngeal space (encountered in altogether 12 percent). There were no problems with poor visibility due to fogging of the optical system (by warming-up the system slightly above body temperature within a short period of time); also secretions did not appear to interfere with the laryngeal view because the optical system is protected and remote from the tip of the blade (both special features of this device).

Visualization of the entire laryngeal aperture (failed in one patient at the first attempt), a prerequisite of successful AOL-assisted tracheal intubation, was finally obtained in all patients. The curvature of the tube-guide channel and the orientation of the optical system of the AOL were usually well aligned with the laryngeal aperture; when the laryngeal aperture was in the center of the view finder, advancement of the TT into a midtracheal position was generally successful at the first attempt (except in 3 patients). The AOL blade favorably incorporates the TT already in the tube-guide channel, eliminating the need for additional space passing the TT through the oral cavity, a problem which may be encountered when using GlideScope video laryngoscopes for orotracheal intubation ([10](#)). Nevertheless, there were minor problems and difficulties with impeded TT passage through the laryngeal aperture in 9 percent (partly attributable to distortion of the larynx, frequently observed in patients undergoing thyroid surgery). When the TT impinged on laryngeal structures (usually on the arytenoid cartilages or

the interarytenoid area), a backward, upward, and to the left or right movement of the AOL blade regularly solved this problem. Interestingly, impeded TT advancement during tracheal passage (despite tracheal deviations and/or compressions by enlarged thyroid glands and using standard TTs) was rarely a problem.

Severe complaints and injuries associated with AM were not observed; this may be due to visualization of the entire laryngeal aperture during successful laryngoscopy and controlled TT advancement into a midtracheal position. In patients with difficult CL, conventional tracheal intubation (particularly after multiple attempts) may not provide comparable results. It should be noted, that the insertion of the AOL blade into the oral cavity was performed with special caution because this maneuver is usually blind; pharyngeal injuries (for example, laceration of the posterior pharyngeal wall) by uncontrolled blade insertion cannot be excluded (2).

Performed by instructed operators (with various proficiency in AM) or experienced users, AOL-assisted orotracheal intubation proved to be uniquely useful in patients with difficult CL with success after a maximum of two attempts. The efficacy of the AOL in difficult CL situations is now supported also by other studies and case series: in 20 patients with normal airways but with manual cervical spine immobilization (3), in 24 patients with anticipated difficult CL (4), in 59 patients with morbid obesity (8), and in 7 patients with visualization of just the soft palate at CL and multiple conventional tracheal intubation attempts (5).

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Implications for Clinical Practice

Notice: Implications for Clinical Practice are the personal views of the authors.

The Airtraq Optical Laryngoscope (AOL) may be a valuable supplement to the flexible bronchoscope for orotracheal intubation in patients with difficult conventional laryngoscopy (CL). The preliminary favourable results obtained with the AOL (successful tracheal intubation in patients with difficult CL when performed by instructed operators or experienced users) should be taken into consideration when planning future equipment availability and updating formulated strategies for difficult airway management.

Economic Considerations

Notice: Economic Considerations are the personal views of the authors.

The costs of the disposable Airtraq Optical Laryngoscope (exclusive value-added taxes, according to the offer of the Austrian distributor, queried in December 2008) are about 48 Euro and allows for this device to be provided at multiple locations within the hospital (including normal wards).