Comparison of the Macintosh and Airtraq Laryngoscopes in Endotracheal Intubation Success

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Objective: Endotracheal intubation of patients is an effective method for controlling airway and breathing. However, laryngoscopy and endotracheal intubation is not easy in every case. There is a recent abundance of equipment used for controlling ventilation and intubation. Airtraq is one of those equipments. In this study, our main objective is to compare the success rates of the Airtraq and Macintosh (direct and classic) laryngoscopes in endotracheal intubation.

Methods: In this single-center, prospective, randomized, clinical study was performed on 80 patients who were operated under general anesthesia, ASA I-II, 18-65 years old. Patients were intubated using two different endotracheal intubation tools. Group A was intubated using the Macintosh (direct and classic) laryngoscope, meanwhile Group B was intubated using the Airtraq laryngoscope. Patients' snoring complaints, modified Mallampati scores, sternomental distances, thyromental distances, interincisor distance measurements and Cormack-Lehane (C-L) laryngoscopic classification, upper lip bite test results, intubation time, number of intubation attempts, maneuvers and techniques used for facilitating intubation and complications arising from intubation were recorded.

Results: There was a statistically significant difference between the groups in terms of C-L scores ($p=0.041$). In all, 8 patients in the Macintosh group, and 2 patients in the Airtraq group were C-L grade III. In intubation of the Airtraq group, only 3 patients required facilitating techniques, meanwhile in intubation of the Macintosh group 15 patients we had to use one or more facilitating maneuver. The rate of Mallampati scoring "difficult" was 4/6 in the Macintosh and 2/11 in Airtraq laryngoscopy groups ($p=0.553$).

Conclusion: In cases with seemingly difficult intubations, we believe the Airtraq laryngoscope has an advantage over the Macintosh laryngoscope, owing to its better view of the oropharyngeal and glottic areas in addition to facilitating intubation in patients with limited head extension.

Keywords: Airtraq, laryngoscope, intubation success

Introduction

Airway management plays a key role in anaesthesia. Failed airway application is the most important cause of morbidity and mortality arising from anaesthesia (1). During anaesthesia applications, 30–40% of deaths are caused by the inability of performing or failure in airway management. In total, 17% of opened and closed insurance cases against anaesthesiologists (ASA Closed Claims) are related to the preoperative undocumented difficult/impossible intubation (2).

To control the airway and respiration, endotracheal intubation is the most effective method for patients undergoing anaesthesia. Laryngoscopy and endotracheal intubation cannot be easily performed in every case. In this case, difficult airway and difficult intubation are of concern. The term difficult airway is defined as when an anaesthesiologist who received classical anaesthesia training has problems in the ventilation of the upper airway via a face mask or has difficulties in tracheal intubation or a combination of both. Difficult intubation, on the other hand, is failure to perform endotrache-

al intubation via a conventional laryngoscope despite three or more attempts or these attempts taking longer than ten minutes. Apart from the difficult airway approach, when encountered with an unknown or unexpected airway, mastering difficult ventilation/intubation algorithms and airway devices that could be applied is particularly important in emergency situations (1-4).

Recently, the diversity in equipment used for ventilation and intubation has increased. Fiberoptic bronchoscope, rigid laryngoscope (Shikani, Bullard, Wu scope), video-laryngoscope (Mac scope, Airtraq) and intubation stylets are examples of this equipment. We have also used an Airtraq laryngoscope in this study. The Airtraq laryngoscope, which provides the screening of the glottis without changing the normal position of the mouth, pharynx and trachea axis, was recently developed for tracheal intubation. The blade of the Airtraq laryngoscope consists of two adjoining canals. While one canal provides the placement of the endotracheal tube, the other ends with a distal lens. The end of the blade has a battery-powered light source. The image is transmitted to the proximal region using combinations of lenses and prisms. Imaging lenses allow the screening of the glottis and surrounding structures along with the endotracheal tube end.

In this study, we aimed to compare the success of endotracheal intubation performed with Airtraq and Macintosh laryngoscopes (direct, classic).

Methods

This study was conducted in the Department of Anaesthesiology and Reanimation- GMMA between May 1 and 31, 2013 on taking the verbal and written consents of the patients after receiving approval from the ethics committee. This single-centre prospective, randomized, clinical study was conducted on consenting 80 patients aged between 18 and 65 years who were in American Anaesthesiologists Association (ASA) risk groups I-II and who underwent a surgery under general anaesthesia.

Pregnant women; patients with gastro-oesophageal reflux, delayed gastric emptying; severe respiratory and cardiovascular problems; those who had intraoral, neck, pre-planned emergency, neck dissection, larynx and thyroid surgeries; those who had failed intubation despite three successful attempts and those who refused to be a part of this study were excluded.

In preoperative evaluation, the patients were informed about the study, and their verbal and written consents were received, and prior to going to the operating theatre, the

patients' age, gender, preoperative diagnosis, surgery and height and weight measurements were recorded. The body mass index was calculated for each patient, and the ASA values were noted.

'Modified Mallampati' scores, which is an important test showing the tongue volume to the oral cavity volume ratio, were evaluated, and the scores were graded from 1 to 4. The grades are as follows:

Grade 1: Front and back piles, soft palate, tonsil bed and uvula are easily seen.

Grade 2: Uvula and soft palate are easily seen.

Grade 3: Soft palate and base of uvula are easily seen.

Grade 4: Uvula is completely hidden behind the tongue base, and pharynx wall cannot be seen.

As an indicator of the mouth opening of the patient, the 'inter-incisor' distance was measured and recorded while the patient's mouth was wide open. 'Upper lip bite test' was administered to test the size of the upper and lower jaws, micrognathia/retrognathia and mobility of temporomandibular joints and large upper teeth. The patient who could bite his upper lip over the vermilion line with his lower incisors (the demarcation line between the upper lip and facial skin) was placed in Grade 1; the one who could bite the upper lip with the lower incisor under the vermilion line was placed in Grade 2 and the one who could not bite the upper lip with the lower incisors was placed in Grade 3.

To evaluate the patency of the airway and conditions of intubation, the sternal notch-gonion and thyroid cartilage-gonion distances were measured and the 'sternomental' distance (SMM) and 'thyromental' distance (TMD) values were recorded. SMM and TMD are the parameters used in the prediction of difficult intubation; SMM<12.5 cm and TMM<6 cm suggest that a patient may have difficult intubation.

Considering the anatomical structures of the patients, the same brand of 7.0-, 7.5- numbered endotracheal tubes for women and 7.5-, 8.0- numbered endotracheal tubes for men were chosen.

After the patients were taken into operating theatres, required monitoring conditions were provided, and through a 20 G cannula intravenous (IV) aperture, 0.9% NaCl infusion was commenced from the dorsum of the non-dominant hand.

After all these evaluation and preparation procedures, patients were randomized by sealed tender and were divided into two groups. The patients in Group A received a Mac-

intosh (direct, classic) laryngoscope after the induction of anaesthesia, and those in Group B received an Airtraq laryngoscope for endotracheal intubation. According to the laryngoscopy results, the image of the larynx was graded from Grades 1 to 4. The grades are as follows:

Grade 1: Glottis is entirely seen.

Grade 2: Glottis is partially seen.

Grade 3: Only epiglottis is seen.

Grade 4: Epiglottis is also not seen.

The time from when the laryngoscope blade entered the mouth to passing through the vocal cords of the endotracheal tube was recorded as 'intubation time'. The number of intubation attempts was noted. The facilitating manoeuvres and techniques that were needed for intubation (positioning the head of the patient, administering external larynx compression, stylet using) were recorded. Intubation-related complications (teeth, lip, pharynx, larynx and nose injuries, oesophageal intubation, gastric content aspiration, subluxation on the temporomandibular joints, soft tissue injury, haemorrhage, oedema, bronchospasm, etc.) were recorded.

Following the surgery, the patients were awakened and were taken to the recovery room. The patients whose modified Aldrete scores were 9 and above were transferred to appropriate clinics.

Statistical analysis

Before the study, power analysis was performed with a subgroup of 10 patients. According to the power analysis, the number of patients to be enrolled with 80% power and an α error of 0.05 was found to be 80. After the data were transferred to the computer, analysis was conducted with the Statistical Package for the Social Sciences 15.0 (SPSS Inc., Chicago, IL, USA). Conformance with normal data distribution was viewed via the Kolmogorov–Smirnov test. In descriptive statistics, mean, standard deviation, number and percentage were used. For the comparison of between-group discrete variants, chi-square and Fisher's exact test were used. For the comparison of between-group continuous variables, Student's t-test was used. For statistical significance, $p < 0.05$ was adopted.

Results

In terms of demographic data, no significant difference was detected between the groups (Table 1). In the patients' airway assessment data, TMD and mouth opening (MO) values showed statistically significant differences (for TMD, $p = 0.039$; for MO, $p = 0.018$). TMD of three patients in the Macintosh laryngoscope group and of five patients in

Table 1. The demographic data of patients (Mean $\pm$ SD)

	Group A Macintosh laryngoscope (n=40)	Group B Airtraq laryngoscope (n=40)	p*
Age (years)	40.4 $\pm$ 13.7	38.5 $\pm$ 15.0	0.546
BMI (kg m ⁻²)	Normal weight 17 (42.5%)	Normal weight 21 (52.5%)	0.954
	Overweight 17 (42.5%)	Overweight 13 (32.5%)	
	Obese 6 (15%)	Obese 6 (15%)	
Gender (M/F) (%)	26/14 (65/35)	25 / 15 (62.5/37.5)	0.816
ASA (I/II) (%)	31/9 (77.5/22.5)	33 / 7 (82.5/17.5)	0.576

BMI: body mass index; SD: standard deviation; M: male; F: female. *Chi-square test

Table 2. Patients' airway assessment data

	Group A Macintosh laryngoscope (n=40) (min–max)	Group B Airtraq laryngoscope (n=40) (min–max)	p*
TMD (cm)	9 (6–11)	8 (6–11)	0.039
MO (cm)	5.5 (4–7)	5 (4–7)	0.018
Mallampati Score (I/II/III/IV)	19/15/5/1	16/13/8/3	0.553
Snoring History (E/H)	17/23	15/25	0.648
U.L.B.T (I/II/III)	17/23/0	21/18/1	0.362
SMD (cm)	16.5 (12–21)	16 (13–20)	0.953

TMD: thyromental distance; MO: mouth opening; U.L.B.T: upper lip bite test; SMD: sternomental distance. *Student's t-test

the Airtraq laryngoscope group was measured to be 6 cm, which is the cut-off value used in the anticipation of difficult intubation. Other airway assessment data did not show any statistically significant difference (Table 2).

The distribution of the Cormack–Lehane (C-L) score of the patients according to the groups is shown in detail in Table 3. In terms of the C-L scores, a statistically significant difference was observed between the groups ($p = 0.041$). Eight patients in the Macintosh laryngoscope group and two in the Airtraq laryngoscope group were identified as C-L grade III.

No statistically significant difference between the intubation time of the patients and the number of intubation attempts was observed. When the groups were compared in terms of facilitating manoeuvres, in the Macintosh laryngoscope group, a statistically significant difference was observed be-

Table 3. Distribution of Cormack–Lehane score by groups

	Group A Macintosh laryngoscope (n=40)	Group B Airtraq laryngoscope (n=40)	p*
I	20	30	0.041
II	12	8	
III	8	2	
IV	0	0	
*Chi-square test			

Table 4. Distribution of intubation parameters by groups

	Group A Macintosh laryngoscope (n=40) (min–max)	Group B Airtraq laryngoscope (n=40) (min–max)	p*
Intubation time (s)	15 (7–60)	19 (8–80)	0.76
Number of intubation attempts (1/2/3)	33/7/0	37/3/0	0.179
Facilitating manoeuvres (E/H)	15/25	3/37	0.01
*Chi-square test			

tween the groups ($p=0.01$) (Table 4) particularly because of the positioning the patient's head and the frequently used external larynx compression manoeuvres.

In terms of intubation-induced postoperative sore throat, no statistically significant difference was observed between the groups. With the help of the airway assessment data, the incidence rates of C-L III and IV scores in patients with anticipated difficult intubation were shown in Table 5. The incidence rate of difficult intubation in patients having anticipated difficult intubation according to the Mallampati score was 4/6 in the Macintosh laryngoscope group, whereas in the Airtraq laryngoscope group, it was 2/11. In the Macintosh laryngoscope group, 6 of 8 patients were intubated on the first attempt and the intubation of two patients was accomplished on the second attempt. The longest intubation took 50 s. In the Airtraq laryngoscope group, on the other hand, 1 out of 2 with anticipated difficult intubation was intubated on the first attempt, and the other one was intubated on the second attempt. The longest intubation took 48 s.

In the Macintosh laryngoscope group, for 7 out of the 8 patients who had been assessed as having difficult airway, fa-

cilitating manoeuvres were required during intubation, and head positioning was mostly applied (7/7). This manoeuvre was followed by external larynx compression (5/7) and use of a stylet (2/7). In the Airtraq laryngoscope group, 1 of the 2 patients regarded as having difficult airway required external larynx compression.

When the frequency of intubation-induced complications in patients with difficult airway was compared, there was no significant difference between the groups. Whereas 4 of the 8 patients with C-L score III in the Macintosh laryngoscope group suffered from lip and mouth injuries, in the Airtraq laryngoscope group, 1 of the 2 patients having C-L score III suffered from mucosal bleeding. No other complication was observed.

Discussion

In our study, in terms of the C-L score, we found statistically significant differences in favour of the Airtraq laryngoscope group. Whereas eight patients with C-L score III were observed in Macintosh laryngoscope group, this number was 2 in the Airtraq laryngoscope group. In both groups, no patient with C-L score IV was observed.

Laryngoscopic imaging and intubation success are different concepts. In almost all studies in literature, including our study, intubation success was based on laryngoscopic imaging classification (1-8). However, it must be remembered that the improvement of laryngoscopic imaging conditions does not always result in a higher intubation success (3).

Although the larynx and glottis are clearly imaged, the placement and progression of endotracheal tube via imaging devices may sometimes fail. Practitioners, to ensure a successful intubation, must comply with the instructions of the device and apply appropriate manoeuvres (1-3). While conducting our study, we also had difficulties in inserting the endotracheal tube in some patients, including those with C-L score I in both the Macintosh and Airtraq laryngoscope groups. This situation not only extended the intubation time but also required the use of facilitating manoeuvres.

In a randomized controlled clinical study conducted by Maharaj et al. (4) which the Macintosh laryngoscope was compared with the Airtraq laryngoscope in patients with low risk of difficult intubation, four experienced anaesthesiologists participated, and it was concluded that performing 20 intubations with the Airtraq laryngoscope to gain experience was enough. Therefore, the same experienced anaesthesiologist who had also used the Macintosh laryngoscope before our study performed 20 intubations with the Airtraq

Table 5. Cormack–Lehane scores of patients with anticipated difficult intubation via airway assessment tests (I, II, III and IV)

	Group A Macintosh laryngoscope (C-L I/II/III/IV)	Group B Airtraq laryngoscope (C-L I/II/III/IV)	Difficult intubation incidence rates C-LIII, IV/I, II, III, IV
BMI>30	6 (2/2/2/0)	6 (3/1/2/0)	2/6-2/6
Mallampati Score III and IV	6 (2/0/4/0)	11 (5/4/2/0)	4/6-2/11
Snoring history (+)	17 (8/4/5/0)	15 (9/4/2/0)	5/17-2/15
MO<3.5 cm	0	0	0
U.L.B.T Grade-III	0	1 (1/0/0/0)	0/0-0/1
TMD<6 cm	0	0	0
SMD<12.5 cm	1 (0/1/0/0)	0 (0/0/0/0)	1/1-0/0
BMI: body mass index; MO: mouth opening; U.L.B.T: upper lip bite test; TMD: thyromental distance; SMD: sternomental distance; C-L: Cormack–Lehane score			

laryngoscope. In the very same study, it was also reported that using the Airtraq laryngoscope was easier.

In the study conducted by Jae-Chul Koh et al. (5), the Macintosh and Airtraq laryngoscopes were compared in terms of larynx image and intubation convenience in patients with cervical spine immobilization and limited mouth opening, and the Airtraq laryngoscope was concluded to provide a better imaging and have a higher intubation success on the first attempt.

In a meta-analysis examining the findings of 12 randomized controlled studies that compared the Airtraq and Macintosh laryngoscopes between 2006 and 2011, it was concluded that intubation time and oesophageal intubation risks significantly decreased with the Airtraq laryngoscope (6). However, in our study, similar to some studies in literature (7), although intubation time was longer to some extent in the Airtraq laryngoscope, no statistically significant difference was observed between the groups. We believe that this difference in intubation time results from extra measures to prevent mucosal injury during the process and the differences between manipulations compared to that of conventional laryngoscope during imaging and a decrease in image quality in presence of secretions.

In a study conducted by López-Negrete et al. (7), the imaging success of the Macintosh and Airtraq laryngoscopes and the anticipation degrees of difficult intubation indicators in patients in whom the Airtraq laryngoscope had been used was examined. The Airtraq laryngoscope was found to reduce adverse conditions in imaging. It was observed that conventional methods used in anticipation of difficult intubation had been less effective in terms of difficult intubation detection degrees after Airtraq laryngoscope administration.

In another study conducted by Nishiyama (8), in terms of imaging capability, in patients who were easily intubated, it was reported that the Macintosh and Airtraq laryngoscopes were more successful than Airwayscope. Additionally, in patients with difficult intubation, the Airtraq laryngoscope was more useful than the Macintosh laryngoscope and Airwayscope.

In a retrospective study conducted by Gellerfors et al. (9) in 2014, the results of successful intubation using the Airtraq laryngoscope were higher than the ones conducted in previous studies.

Furthermore, in a meta-analysis, which included 16 randomized controlled studies, conducted by Hirabayashi et al. (10) in 2013, it was observed that the Airtraq laryngoscope provided a significant advantage over the Macintosh laryngoscope in difficult intubation cases.

Ali et al. (11), after comparing intubations in which the Airtraq and conventional laryngoscopes were applied on 34 paediatric patients in 2013, were of the opinion that the paediatric Airtraq laryngoscope improved intubation conditions with fewer complications.

In 2013, Sherrer et al. (12) compared the Macintosh, Airtraq and McCoy laryngoscopes and intubations with LMA on a simulation model with high precision and performed 140 intubations in which 35 anaesthesiologists participated. Although no significant difference was observed in intubation success and duration in the model with normal airway and intubations in the model that required cervical stabilization, it was indicated that the Airtraq laryngoscope provided the best glottis imaging and used less force for intubation.

In our study, during the intubation of all the patients in the Airtraq laryngoscope group, we used one of the facilitating

manoeuvres in only three patients. For 15 patients in the Macintosh laryngoscope group, intubation was performed by means of one or more manoeuvres. In the Macintosh laryngoscope group, we think that the head positioning manoeuvre was significantly considerable. This result once again revealed that using the Airtraq laryngoscope is more advantageous for the intubation of patients with difficult intubation suspicion and limited neck mobility.

The incidence rate of difficult intubation in patients with anticipated difficult intubation according to the Mallampati score was 4/6 in the Macintosh laryngoscope group and 2/11 in the Airtraq laryngoscope group. This result supports the fact that the Airtraq laryngoscope provides a better laryngoscopic image.

The statistically significant difference we reported in favour of the Airtraq laryngoscope was once again indicated in terms of the C-L classification that Airtraq laryngoscope has more advantages than the Macintosh laryngoscope in laryngeal structure imaging.

The Airtraq laryngoscope, however, has some disadvantages, such as high cost resulting from being disposable, problems in imaging due to oedema and secretions, manipulations being different from classic laryngoscope during imaging and intubation experience via Airtraq laryngoscope necessity (4-12).

The limitation of this study is the small number of patients with a high risk of difficult intubation. The more patients we have, the more probabilities there will be of encountering difficult intubation and the more new information we will obtain. Our goal is to plan further studies on this subject and work with a larger group of patients.

Conclusion

In cases that are considered to be difficult intubation, by obtaining better oropharynx and glottis images and providing a more successful intubation in patients with head extension limitations, we decided that the Airtraq laryngoscope is superior to the Macintosh laryngoscope.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Gülhane Military Medical Academy.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - T.E., E.K.; Design - T.E., E.K.; Supervision - T.P.; Materials - T.E., S.D., F.Ş.; Data Collection and/or Processing - T.E., F.Ş.; Analysis and/or Interpretation - T.E., S.D., F.Ş., E.K.; Literature Review - T.E., T.P.; Writer - T.E., S.D., F.Ş., T.P., E.K.; Critical Review - E.K., T.P.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

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