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Comparison of Airtraq® and Macintosh laryngoscope applied by nurses in manikins with normal and difficult airways: pilot data

Porównanie intubacji z wykorzystaniem Airtraq® i laryngoskopu Macintosha w warunkach normalnych i trudnych dróg oddechowych wykonywanej przez pielęgniarki. Badanie pilotażowe

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S u m m a r y

Introduction. Endotracheal intubation is currently the gold standard of airway management. In direct laryngoscopy in pre-hospital settings, though, it turns out insufficiently effective.

Aim. The study purpose was to compare direct laryngoscopy and videolaryngoscopy for endotracheal intubation performed by nurses in normal and difficult airway conditions.

Material and methods. This randomized cross-over study involved 27 nurses. The protocol was approved by the Institutional Review Board of the Polish Society of Disaster Medicine (approval number: 32.04.2018.IRB). The participants performed intubation using a Macintosh laryngoscope (MAC) and an Airtraq® videolaryngoscope (ATQ) in 2 study scenarios: A – normal airway; B – difficult airway. For this latter purpose, the manikin had the cervical spine immobilized with a standard one-piece cervical collar.

Results. The effectiveness of the first intubation attempt with MAC and ATQ was varied both in scenario A: 66.7 and 92.6% (p = 0.007) and in scenario B: 14.8 and 70.4% (p = 0.001). The median intubation time in scenario A was 23 s (IQR: 22-33.5) for MAC and 17 s (IQR: 15.5-25) for ATQ (p = 0.031), respectively. In scenario B, this parameter value equaled 53 s (IQR: 48-67) for MAC and 26 s (IQR: 24-49) for ATQ (p < 0.001).

Conclusions. In the simulation study, nurses were able to perform endotracheal intubation with the use of ATQ with higher efficacy compared with direct laryngoscopy – this relationship was observed under both normal and difficult airway conditions.

S t r e s z c z e n i e

Wstęp. Zabezpieczenie dróg oddechowych z wykorzystaniem rurki intubacyjnej stanowi obecnie złoty standard postępowania. Intubacja z wykorzystaniem laryngoskopii bezpośredniej w warunkach przedszpitalnych jest obarczona niewystarczającą skutecznością.

Cel pracy. Celem pracy było porównanie laryngoskopii bezpośredniej i wideolaryngoskopii podczas intubacji dotchawiczej w warunkach normalnych i trudnych dróg oddechowych wykonywanej przez pielęgniarki.

Materiał i metody. W badaniu udział wzięło 27 pielęgniarek. Protokół badania został zaakceptowany przez Radę Programową Polskiego Towarzystwa Medycyny Katastrof (zgoda: 32.04.2018.IRB). Badanie przeprowadzono w oparciu o randomizowany krzyżowy model badania. Jego uczestnicy wykonywali intubację z wykorzystaniem laryngoskopu z łopatką Macintosha (MAC) oraz wideolaryngoskopu Airtraq® (ATQ) w dwóch scenariuszach badawczych: scenariusz A – normalne drogi oddechowe, scenariusz B – trudne drogi oddechowe. W tym celu „pacjent” miał unieruchomiony odcinek szyjny kręgosłupa za pomocą standardowego jednoczęściowego kołnierza szyjnego.

Wyniki. Skuteczność pierwszej próby intubacji z wykorzystaniem MAC i ATQ była zróżnicowana zarówno w przypadku scenariusza A: odpowiednio 66,7 i 92,6% (p = 0,007), jak i podczas scenariusza B: 14,8 i 70,4% (p = 0,001). Mediana czasu intubacji podczas scenariusza A wynosiła odpowiednio 23 sek. (IQR: 22-33,5) dla MAC oraz 17 sek. (IQR: 15,5-25) dla ATQ (p = 0,031). W przypadku scenariusza B mediana czasu intubacji dla MAC i ATQ wynosiła odpowiednio: 53 sek. (IQR: 48-67) i 26 sek. (IQR: 24-49; p < 0,001).

Wnioski. W przeprowadzonym badaniu symulacyjnym pielęgniarki były w stanie z większą skutecznością wykonać intubację dotchawiczą z zastosowaniem wideolaryngoskopu Airtraq® aniżeli w oparciu o laryngoskopię bezpośrednią – zależność ta była obserwowana zarówno w warunkach normalnych, jak i trudnych dróg oddechowych.

**Conflict of interest
Konflikt interesów**

None
Brak konfliktu interesów

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INTRODUCTION

Tracheal intubation is currently one of the basic methods of airway management both in children and adults (1, 2). In some cases, such as cardiopulmonary resuscitation, endotracheal intubation is considered the gold standard of airway management. It allows for continuous chest compressions without the need for any interruptions for emergency breaths (3-5). However, it is recommended that endotracheal intubation should be performed by the most experienced person in the team (6, 7). This is due to the possibility of numerous potential complications, such as tooth injury, soft tissue damage and bleeding, epiglottis injury resulting from arytenoid cartilage dislocation or tracheal rupture and pneumomediastinum (8, 9).

Owing to its common availability, the most commonly applied endotracheal intubation technique is direct laryngoscopy with the use of Miller or Macintosh (MAC) blade laryngoscopes. However, the effectiveness of this method of intubation in pre-hospital conditions is insufficient (10, 11).

Alter et al. (12) indicate that the effectiveness of the first intubation attempt was 86% with the use of a MAC curved blade laryngoscope and 73% in the case of Miller laryngoscope. Sakles et al. (13), on the other hand, evaluated the effectiveness of intubation in an emergency department, indicating that the effectiveness of direct laryngoscopy was 86.6%. In the case of pediatric patients, the effectiveness of intubation is even lower than in adults (13-15). However, it is worth noting that in hospital conditions endotracheal intubation is usually performed by anesthesiologists or emergency physicians. In airway management applied in pre-hospital conditions, in an outpatient clinic, or by emergency medical service teams, paramedics and nurses can only rely on their own skills and knowledge. Therefore, the search for alternative endotracheal intubation methods is so important from the point of view of emergency medicine.

AIM

The aim of the study was to compare the effectiveness of endotracheal intubation based on direct laryngoscopy and videolaryngoscopy performed by nurses in normal and difficult airway conditions.

MATERIAL AND METHODS

Study design and participants

The study was designed as a prospective randomized cross-over simulation study. The protocol was approved by the Institutional Review Board of the Polish Society of Disaster Medicine (approval number: 32.04.2018.IRB). The research involved 27 nurses. Voluntary written informed consent was obtained from each participant. All participants were specialized in nursing in anesthesiology and intensive care or emergency medicine.

Simulation devices

Before the study, all participants took part in a training in endotracheal intubation with the use of direct laryngoscopy and videolaryngoscopy. At the end of the training, the correct technique of intubation with the use of MAC and ATQ was demonstrated. In the case of ATQ intubation, a special overlay was used for smartphone imaging (fig. 1).

Fig. 1. Airtraq videolaryngoscope

Then the participants took part in a 30-minute practical training, during which they had the opportunity to practice intubation with the use of the tested techniques. For this purpose, an AT Kelly Torso (Laerdal, Stavanger, Norway) airway management manikin was used.

One week after the practical training, the nurses participated in the target study, during which they were asked to perform endotracheal intubation with the use of MAC and ATQ in 2 research scenarios: A – normal airway, B – difficult airway. For the latter purpose, the manikin had the cervical spine immobilized with a standard one-piece cervical collar.

An adult Resusci Anne simulator (Laerdal, Stavanger, Norway) was used to simulate a patient requiring immediate endotracheal intubation. The simulator was placed on a flat floor in a brightly lit room.

The participants were allowed one endotracheal intubation attempt. The order of both the participants and the research methods was random, determined with the coin toss technique. The detailed procedure of randomization is presented in figure 2.
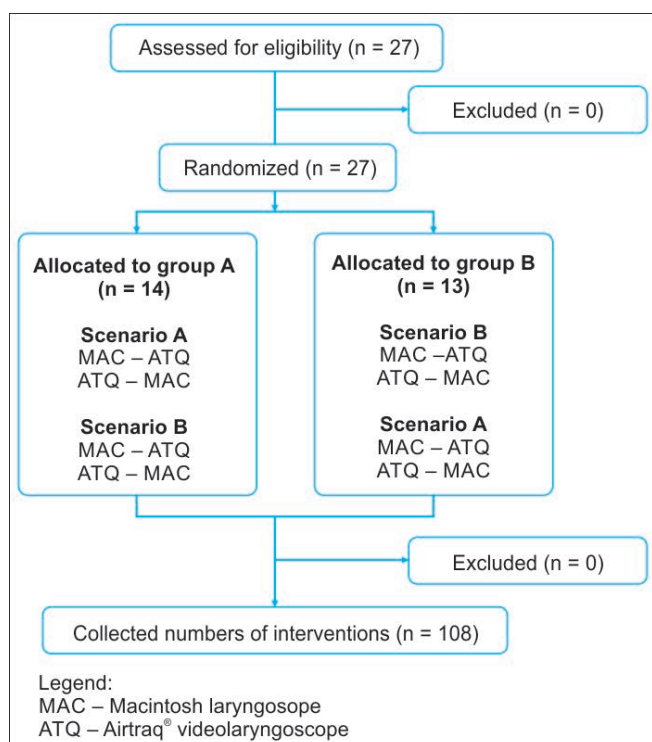
Fig. 2. Randomization flow chart

Measurements

The main parameter measured during the study was the effectiveness of the first endotracheal intubation attempt, defined by effective ventilation with a self-inflating bag connected to the endotracheal tube and the manikin chest rise during the ventilation attempt.

Additionally, the effectiveness of intubation was confirmed by specialized simulator software. Intubation time, defined as the time from grasping a laryngoscope to the chest rise with a ventilation attempt, was also measured, as well as the degree of glottis visibility in accordance with the Cormack-Lehane scale (16). After the intubation attempts, the participants evaluated the ease of intubation using a 100-degree visual analog scale (VAS), where 1 marked a procedure easy to perform and 100 – a procedure impossible to perform.

Statistical analysis

All statistical analyses were performed with the STATISTICA ver. 13.3 EN (StatSoft, Tulsa, OK, USA) software. All data are described as median values with an interquartile range (IQR) or numbers and percentages. Categorical variables were analyzed with the chi-square test. The Kruskal-Wallis test was applied to analyze differences in continuous variables between the 2 groups. Thereafter, post-hoc tests for the 2 groups were performed with the Mann-Whitney test. Statistical significance was assumed when the p-value was less than 0.05 in the two-sided test.

RESULTS

Study participants

The study involved 27 nurses, all of whom were women. Their median age was 38.5 years (IQR: 32-45), and median work experience 12.5 years (IQR: 6-21). All participants declared the ability to perform endotracheal intubation with the use of direct laryngoscopy. The results of the study are presented in tables 1 and 2.

Tab. 1. Endotracheal intubation data in scenario A

Procedure	MAC	ATQ	p-value
First attempt success rate (%)	18 (66.7%)	25 (92.6%)	0.007
Intubation time (s)	23 (IQR: 22-33.5)	17 (IQR: 15.5-25)	0.031
Cormack-Lehane scale 1 2 3 4	10 (37.0%) 12 (44.4%) 5 (18.6%) –	24 (88.9%) 3 (11.1%) – –	0.016
Ease of use (1-100)	45 (IQR: 38-55)	30 (IQR: 27-39)	0.001

Tab. 2. Endotracheal intubation data in scenario B

Procedure	MAC	ATQ	p-value
First attempt success rate (%)	4 (14.8%)	19 (70.4%)	0.001
Intubation time (s)	53 (IQR: 48-67)	26 (IQR: 24-49)	< 0.001
Cormack-Lehane scale 1 2 3 4	– 8 (29.6%) 16 (59.3%) 3 (11.1%)	7 (25.9%) 18 (66.7%) 2 (7.4%) –	< 0.001
Ease of use (1-100)	63 (IQR: 56-81)	45 (IQR: 32-51)	< 0.001

Intubation success rate

The effectiveness of the first intubation attempt was 66.7% for MAC and 92.6% for ATQ (p = 0.007) in scenario A, and 14.8% for MAC and 70.4% for ATQ (p = 0.001) in scenario B.

Intubation time

The time of intubation with the use of the tested intubation techniques in the research scenarios is presented in figure 3. In scenario A, the median intubation time with the distinct devices varied and amounted to 23 s (IQR: 22-33.5) for MAC and 17 s (IQR: 15.5-25) for ATQ (p = 0.031). In scenario B, the median intubation time for MAC equaled 53 s (IQR: 48-67); for ATQ, it was statistically significantly longer: 26 s (IQR: 24-49) (p < 0.001).

Cormack-Lehane grade

The degree of glottis visibility in both scenarios turned out better when ATQ was applied as compared with MAC (tab. 1, 2).

Ease of use scale

The ease of intubation assessed by the study participants is presented in figure 4. In scenario A, the ease of intubation in the case of MAC was 45 points (IQR: 38-55) and turned out statistically significantly higher than in the case of ATQ: 30 points (IQR: 27-39) (p = 0.001). In scenario B, statistically significant differences in the assessment of intubation ease were also observed:

63 points (IQR: 56-81) for MAC vs. 45 points (IQR: 32-51) for ATQ (p < 0.001).

DISCUSSION

Endotracheal intubation is currently one of the basic methods of airway management (17, 18). It is enables asynchronous resuscitation, which significantly improves the quality of cardiopulmonary resuscitation and thus increases the chances of the return of spontaneous circulation. However, as many studies indicate, the effectiveness of endotracheal intubation in pre-hospital settings is insufficient (4). The problem is particularly evident in difficult airways (19-22).

ATQ is a well-known videolaryngoscope and several studies have been carried out to compare its efficiency in various settings. It is available in many hospitals; in a survey performed in all UK National Health Service hospitals, the most widely available devices were ATQ, GlideScope, and C-MAC (23).

Our study showed that nurses were able to perform endotracheal intubation with higher efficacy with ATQ as compared with MAC. Several studies provided similar results in other groups of medical personnel and intubation settings.

In a prospective randomized controlled trial comparing 3 unchannelled videolaryngoscopes (KingVision™, Airtraq™, A.P. Advance™ MAC) and the standard MAC in 480 patients, the first attempt success rates were: KingVision 90% (95% CI: 83-94%), ATQ 82% (74-88%), A.P. Advance MAC 49% (40-58%), MAC 44% (35-53%) (p < 0.001). The authors suggested that ATQ and KingVision performed better than other laryngoscopes (24). Gómez-Ríos et al. (19) performed a study comparing the McGrath MAC and ATQ NT with a MAC laryngoscope among 63 anesthetists with different levels of experience; a manikin model of easy or difficult airways was applied. The McGrath MAC had the best first attempt success rate (98.4 vs. 96.8 and 95.8%; p < 0.001 for ATQ NT and MAC, respectively). In this study, ATQ and McGrath laryngoscopes appeared superior to MAC in terms of glottic view quality, intubation times, and rates of success, especially in difficult airways.

In a prospective randomized clinical trial, 80 patients ASA I-II, 18-65-year-old, scheduled for general anesthesia were intubated with the use of MAC and ATQ. An advantage of ATQ over MAC was observed owing to better oropharyngeal and glottic areas view in addition to facilitating intubation in patients with limited head extension (25).

Zhao et al. (26), in a study on intubation performed by medical students, revealed that intubation success rate was significantly higher in the ATQ group than in the MAC group (87.8 vs. 66.7%; p < 0.05). It was concluded that ATQ offered a higher intubation success rate and shorter intubation duration compared with MAC.

In a study comparing different type of videolaryngoscopes in morbidly obese patients, Castillo-Monzón et al. (27) stated that the average intubation time was 17.27 s for ATQ and 22.11 s for MAC (p = 0.279). ATQ improved the glottic view and reduced the necessary additional maneuvers for tracheal intubation. Das et al. (28), in a group of 90 patients intubated with MAC and ATQ, concluded that ATQ intubation was associated with significantly fewer rises in intraocular pressure and hemodynamic response to laryngoscopy and intubation. A meta-analysis performed by Hoshijima et al. (29) revealed that ATQ attenuated the hemodynamic response after tracheal intubation compared with MAC. In a study carried out by Wan et al. (30), ATQ was compared with McGrath series 5 videolaryngoscope in double-lumen tube (DLT) intubation performed by experienced anesthesiologists. It was revealed that the intubation success rate on the first attempt, as well as the incidence of DLT malposition and intubation-related complications were comparable between the ATQ and McGrath groups. The intubation time for McGrath turned out longer than that for ATQ (39.9 vs. 28.6 s; p < 0.05).

Several studies have been also performed on the use of ATQ in pediatric patients and simulations in pediatric manikins. Thakare and Malde (31) stated that ATQ could be also used in pediatric patients with quick, easy, and excellent glottic visualization. Szarpak et al. (32) compared the effectiveness of MAC and ATQ in 3 simulated CPR scenarios among 83 nurses performing endotracheal intubation in a pediatric manikin with normal airway scenario, normal airway with chest compressions scenario, and difficult airway with chest compressions scenario. In all scenarios, the success rate was significantly higher and the time to intubation was significantly shorter with ATQ than with MAC, with better glottic visualization.

In a study on intubation in a pediatric manikin, Szarpak et al. (33) observed that the mean time to intubation was 24.1 s and turned out significantly shorter than for the other tested devices (30.7 s for McGrath, 28.6 for GlideScope, and 39.3 for Miller laryngoscope). Owada et al. (34) performed a study in a pediatric manikin with Cormack-Lehane grade 4 view among 20 anesthetists. They revealed that ATQ provided a higher success rate and better visibility, and was associated with less dental trauma than the other devices in the difficult pediatric intubation model.

ATQ was also tested with adaptors to attach a smartphone with a camera to the laryngoscope eyepiece. The use of a smartphone with ATQ turned out to potentially facilitate instruction and communication during laryngoscopy (35). Helicopter emergency medical service (HEMS) personnel wearing helmets in grounded helicopters with a flight gear, in a manikin study with difficult simulated HEMS airway scenarios, were able to intubate with the shortest time and highest intubation success on the first attempt using ATQ and the S.A.L.T. device compared with the GlideScope Ranger laryngoscope (36).

One of the main indications for endotracheal intubation by medical personnel, including nurses, is

sudden cardiac arrest. However, it should be noted that the role of endotracheal intubation in cardiac arrest is changing over time. The current American Heart Association and European Resuscitation Council guidelines suggest that continuous uninterrupted chest compressions during cardiopulmonary resuscitation can be carried out not only in intubated patients but also when supraglottic airway devices are used. Wang et al. (37) compared the effectiveness of a strategy of initial laryngeal tube insertion vs. initial endotracheal intubation in adults with out-of-hospital cardiac arrest. They revealed that initial laryngeal tube insertion was associated with a significantly greater 72-hour survival. Young et al. (38) suggested that more than 240 procedures were necessary to achieve a 90% success rate to perform high quality endotracheal intubation. These results can dispute the role of endotracheal intubation in emergency medicine, especially in cardiac arrest outside the operating theater and emergency department.

The presented study has both limitations and strengths. One of the main limitations is that the study was performed in a simulator, not during real-life rescue operations. However, such a choice of the testing method was deliberate, and dictated by the possibility to fully standardize the examination (39, 40). In addition, only a patient simulator allows to perform randomized cross-over studies without any harm to the patient. The strength of the study is certainly its randomized cross-over design.

CONCLUSIONS

In the simulation study, nurses were able to perform endotracheal intubation with ATQ more effectively than with direct MAC laryngoscopy. This relationship was observed in both normal and difficult airway conditions.

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