ORIGINAL ARTICLE

Use of Airtraq, C-Mac, and Glidescope laryngoscope is better than Macintosh in novice medical students' hands: A manikin study

Abdullah M. Kaki,
Waleed A. AlMarakbi,
Hazem M. Fawzi[1],
Abdulaziz M. Boker

Department of Anaesthesia, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia, [1]*Department of Anaesthesiology, Ain Shams University, Cairo, Egypt*

Address for correspondence:
Dr. Abdullah M. Kaki,
Department of Anaesthesia & Critical Care, Faculty of Medicine, King Abdulaziz University Hospital, P.O. Box 2907, Jeddah 21461, Saudi Arabia.
E-mail: amkaki@yahoo.com

ABSTRACT

Background and Aim: Obtaining patent airway is a crucial task for many physicians. When opportunities to practice intubations on patients are really limited, skill gaining methods are needed. We conducted a study among novice 6th year medical students to assess their ability to intubate the trachea in normal airway in manikin using four airway tools. **Setting and Design:** Prospective, cohort study conducted at simulation center of university-based, tertiary care hospital. **Methods:** Fifty medical students performed either oral or nasal tracheal intubation using the following four intubating tools: C-Mac videolaryngoscope, Glidescope, and Airtraq in comparison with regular Macintosh laryngoscope. Intubation time, visualization of glottic opening, ease of intubation, satisfaction of participants, incidence of dental trauma, and the need for optimization manoeuvres' use among different airway tools were recorded. **Results:** In oral intubation, Airtraq was better than others in regard to intubation time, glottic opening, ease of intubation, and the need for external laryngeal pressure application, followed by Glidescope, C-Mac, and finally Macintosh laryngoscope ($P<0.001$). Airtraq and Glidescope associated with less dental trauma than C-Mac and Macintosh. In nasal route, fastest intubation time was reported with Airtraq followed by Glidescope, C-Mac, and lastly Macintosh. Airtraq, Glidescope, and C-Mac were similar to each other and better than the Macintosh in regard to ease of intubation, satisfaction, and number of attempts ($P\leq0.008$). **Conclusions:** New devices like Airtraq, Glidescope, and C-Mac are better than the regular Macintosh when used by novice medical students for oral and nasal intubation on manikin.

Key words: *Airtraq, airway tools, C-Mac video laryngoscope, Glidescope, Macintosh laryngoscope, medical students*

INTRODUCTION

Maintenance of patent airway is a lifesaving manoeuvre to many patients.[1,2] It is a difficult skill to acquire and to maintain, especially with limited training opportunities.[3] Proper training and appropriate equipment are essential to maintain such skill. Training on simulators is commonly accepted technique to train doctors prior to patient contact.[4]

In our medical school, students have a limited chance to learn airway management on patients. We aimed to assess their ability to use different intubation laryngoscopes: Macintosh (DL), Airtraq (AT), C-Mac (VS), and Glidescope (GS), for oral and nasal tracheal intubation in manikin.

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METHODS

Following institutional ethics committee approval, 100 medical students who had no prior airway management experience were chosen to participate in this prospective cohort study. Participants were divided into two groups, using one group for oral tracheal intubation and the second group for nasal intubation. Students were assigned to each group haphazardly with the aid of a table of random number. Information about the voluntary and anonymous nature of the study was described to all students.

Following brief didactic instruction, all participants performed tracheal intubation using each of the

following tools: regular Macintosh laryngoscope, C-Mac videolaryngoscope (Karl Storz Endoscopy, Tuttlingen, Germany), Glidescope (Armstrong Medical Ltd, Golerainem, Northern Ireland), and Airtraq (Airtraq Medical Ltd, Edinburgh, UK) device in manikin (Laerdal, Stavanger, Norway).

All students were familiar with the simulator environment and manikin use as a routine part of their teaching curriculum. All intubation was performed using 7.5 mm cuffed endotracheal tubes (ETT) in a normal manikin's airway.

Duration of tracheal intubation which was defined as the time taken from insertion of the blade between the incisors until ETT was deemed to be correctly positioned in the trachea was recorded in seconds. Correct placement of ETT was confirmed by watching the tube passing the vocal cords and the detection of chest expansion. A failed attempt was defined as an attempt in which the tracheal intubation was not achieved after 120 seconds for oral intubation and 160 seconds for nasal intubation.

The Cormack and Lehane (C and L) grading system, although originally designed to compare glottic views at direct laryngoscopy,[5] was used to compare the direct and indirect laryngoscopic views achieved in this study. In addition to that, Percentage of Glottis Opening was measured, where 0% means none of the glottis is seen and 100% means the entire glottis is seen.[6] Both grading systems were explained to each student prior to performance of intubation as part of his orientation. Complication in the form of dental trauma was calculated by measuring the number of audible clicks heard during the procedure. Also, the ease of intubation was measured by asking every student to evaluate the ease of his intubation attempt for each device using a linear scale (0 = easy, 10 = difficult). However, the need for external pressure manoeuvre and the use of Magill intubating forceps were recorded with yes (used = 1) or no (not used = 0). In addition to that, the need for other optimization manoeuvre was reported in the form of: 1 = head extension, 2 = use of boogie, 3 = use of intubating stylet. Finally, satisfaction of the students with each tools was measured with satisfaction score (1 = poor satisfaction, 2 = good, 3 = very good, 4 = excellent level of satisfaction). Data for both oral and nasal tracheal intubation trials were collected and analyzed.

Statistical analysis

Data were collected, coded, tabulated, and then analyzed using SPSS® v.12.0 computer package. Numerical variables were presented as mean±standard deviation, while categorical data were presented as frequency (percentage). Error bars represented 95% confidence interval. Analyses of numerical and categorical variables were performed by paired *t*-test and McNemar's test, respectively. Bonferroni correction of the significant level was applied as multiple comparisons were indicated. A difference with the adjusted *P* value <0.05 was considered statistically significant.

RESULTS

In the oral route, the duration of tracheal intubation attempt was significantly shorter with Airtraq, than Glidescope, followed by C-Mac and finally Macintosh laryngoscope ($P<0.001$) [Figure 1]. In a similar way, visualization of glottic opening [Table 1], ease of intubation [Figure 2], and satisfaction of the participating students [Figure 3] were all better with Airtraq in comparison with other tools ($P<0.001$). Regarding C and L grade, vocal cords were more clearly seen using Glidescope, followed by Airtraq, C-Mac videolaryngoscope, and direct Macintosh [Table 1], but the difference between Airtraq and either Glidescope or C-Mac was not statistically significant ($P>0.05$). The lowest incidence of dental trauma was reported with Airtraq and Glidescope, while the highest dental injury was noticed with the use of direct Macintosh [Table 2]. Similar to that, higher

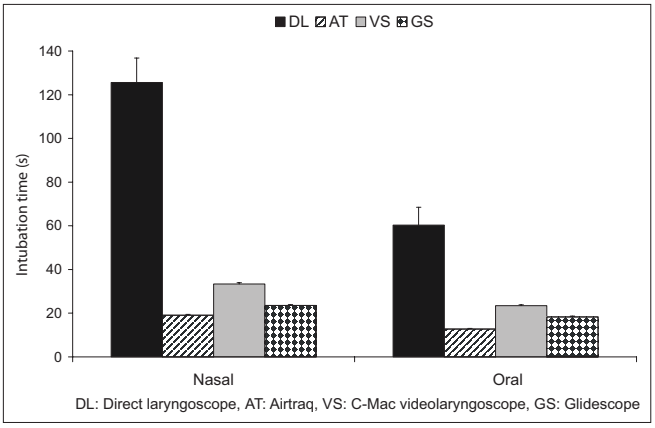

Figure 1: Intubation time for oral and nasal route using the various airway tools

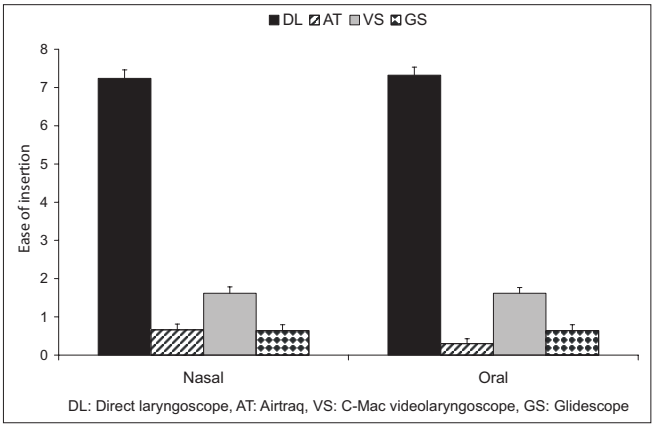

Figure 2: Ease of intubation using various airway tools via oral and nasal route

need for optimization manoeuvres were reported with direct Macintosh, then C-Mac, and Glidescope, while no manoeuvres were needed for Airtraq [Table 2]. Regarding the number of attempts, direct Macintosh associated with the highest number of attempts in comparison with other devices [Table 2]. Similar to that, application of external pressure during intubation was higher with Macintosh than C-Mac, Glidescope, and Airtraq.

The results of external laryngeal pressure application and the use of Magill intubating forceps were analyzed in the form of cross tabulation with "0" meant "not needed or negative" and "1" meant "needed or positive." Thirty-seven external laryngeal pressures were applied during direct Macintosh's use, eight for C Mac laryngoscope, and none for Airtraq or Glidescope use ($P \leq 0.008$). No student has used Magill forceps during oral intubation.

In the nasal route, the shortest intubation time was recorded with Airtraq laryngoscopes' use (19.1±1.36 sec), followed by Glidescope (23.5±1.66 sec), C-Mac (33.4±1.95 sec), and finally direct Macintosh (125.6±40.47 sec) ($P<0.001$) [Figure 1]. Better visualization of both glottic opening and vocal cords (C and L grade) were noticed with Airtraq, then Glidescope, C-Mac, and lastly with Macintosh [Table 1]. Ease of intubation and students' satisfaction are presented in Figures 2 and 3, respectively. The best results were recorded with Airtraq and Glidescope without any statistical significance. Higher number of intubation attempts was required with direct Macintosh laryngoscope [Table 2]. The lower incidence of dental trauma was reported with Airtraq and Glidescope, followed by the C-Mac, while the Macintosh associated with the highest incidence of trauma ($P<0.001$) [Table 2]. Application of optimization manoeuvres was highly needed with Macintosh use (94%) and none was needed for Glidescope or Airtraq's use [Table 2]. External laryngeal pressure was highly needed with direct Macintosh laryngoscope (84%), followed by C Mac laryngoscope (16%), and it was not needed for both Airtraq and Glidescope ($P \leq 0.008$). Magill forceps was used by 44, 35, and four students with Macintosh, C Mac, and Glidescope use for nasal intubation, respectively. None of them required Magill forceps for Airtraq intubation ($P<0.001$).

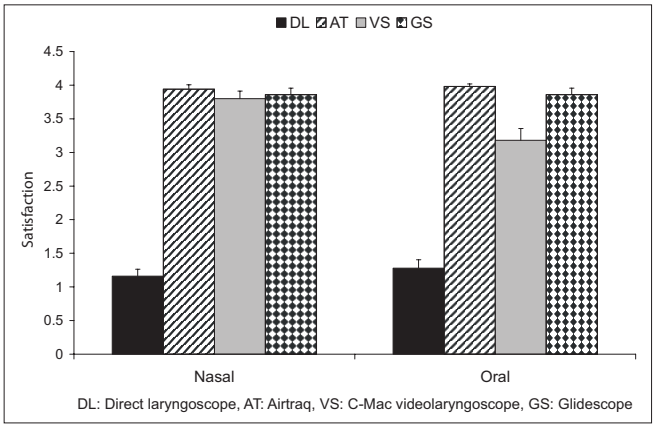

Figure 3: Candidates' satisfaction regarding the use of deferent airway tools in oral and nasal way

DISCUSSION

The key finding of this study is that Airtraq, Glidescope, and C-Mac videolaryngoscopes provide better intubation conditions than regular Macintosh in novice medical students' hands in manikin. Tracheal intubation is the preferred technique to secure the airway. The curved laryngoscope blade described by Macintosh in 1943 remained the most popular device for tracheal intubation, and considered by many as the golden standard.[7] However,

Table 1: Glottic visualization using various intubating tools for both oral and nasal intubation

	Oral intubation		Nasal intubation	
	Mean±SD	*P* value	Mean±SD	*P* value
Visualization of airway				
(DL) *vs* (AT)	(51.0±26.75) vs (98.1±2.45)	<0.001	(46.0±23.21) vs (98.2±2.63)	<0.001
(DL) *vs* (VS)	(51.0±26.75) vs (91.5±2.72)	<0.001	(46.0±23.21) vs (91.6±2.36)	<0.001
(DL) *vs* (GS)	(51.0±26.75) vs (97.1±2.49)	<0.001	(46.0±23.21) vs (97.0±2.47)	<0.001
(AT) *vs* (VS)	(98.1±2.45) vs (91.5±2.72)	<0.001	(98.2±2.63) vs (91.6±2.36)	<0.001
(AT) *vs* (GS)	(98.1±2.45) vs (97.1±2.49)	0.040	(98.2±2.63) vs (97.0±2.47)	0.017
(VS) *vs* (GS)	(91.5±2.72) vs (97.1±2.49)	<0.001	(91.6±2.36) vs (97.0±2.47)	<0.001
C and L grade				
(DL) *vs* (AT)	(2.08±0.63) vs (1.12±0.33)	<0.001	(2.22±0.51) vs (1.10±0.3)	<0.001
(DL) *vs* (VS)	(2.08±0.63) vs (1.22 0.42)	<0.001	(2.22±0.51) vs (1.14±0.35)	<0.001
(DL) *vs* (GS)	(2.08±0.63) vs (1.06 0.24)	<0.001	(2.22±0.51)±(1.08±0.27)	<0.001
(AT) *vs* (VS)	(1.12±0.33) vs (1.22 0.42)	0.166	(1.10±0.3) vs (1.14±0.35)	0.564
(AT) *vs* (GS)	(1.12±0.33) vs (1.06 0.24)	0.317	(1.10±0.3) vs (1.08±0.27)	0.739
(VS) vs (GS)	(1.22±0.42) vs (1.06±0.24)	0.033	(1.14±0.35) vs (1.08±0.27)	0.317

DL: Direct laryngoscope, AT: Airtraq, VS: C-Mac videolaryngoscope, GS: Glidescope, C and L grade: Cormack and Lehane grade

Table 2: Characters of airway management in both oral and nasal intubation

	Oral route		Nasal route	
	Mean SD	*P* value	Mean±SD	*P* value
Number of attempts				
(DL) *vs* (AT)	(1.36±0.49) vs (1.00±0.0)	<0.001	(1.88±0.56) vs (1.02±0.14)	<0.001
(DL) *vs* (VS)	(1.36±0.49) vs (1.00 0.0)	<0.001	(1.88±0.56) vs (1.04±0.2)	<0.001
(DL) *vs* (GS)	(1.36±0.49) vs (1.00±0.0)	<0.001	(1.88±0.56) vs (1.00±0.0)	<0.001
(AT) *vs* (VS)	(1.00±0.0) vs (1.00±0.0)	1.00	(1.02±0.14) vs (1.04±0.2)	0.564
(AT) *vs* (GS)	(1.00±0.0) vs (1.00±0.0)	1.00	(1.02±0.14) vs (1.00±0.0)	0.317
(VS) *vs* (GS)	(1.00±0.0) vs (1.00±0.0)	1.00	(1.04±0.2) vs (1.00±0.0)	0.157
Incidence of dental trauma				
(DL) *vs* (AT)	(2.24±0.59) vs (0.12±0.33)	<0.001	(2.26±0.57) vs (0.08±0.27)	<0.001
(DL) *vs* (VS)	(2.24±0.59) vs (1.36±0.49)	<0.001	(2.26±0.57) vs (1.4±0.6)	<0.001
(DL) *vs* (GS)	(2.24±0.59) vs (0.24±0.43)	<0.001	(2.26±0.57) vs (0.22±0.6)	<0.001
(AT) *vs* (VS)	(0.12±0.33) vs (1.36±0.49)	<0.001	(0.08±0.27) vs (1.4±0.6)	<0.001
(AT) *vs* (GS)	(0.12±0.33) vs (0.24±0.43)	0.109	(0.08±0.27) vs (0.22±0.6)	0.154
(VS) *vs* (GS)	(1.36±0.49) vs (0.24±0.43)	<0.001	(1.4±0.6) vs (0.22±0.6)	<0.001
Need for optimization				
(DL) *vs* (AT)	(1.84±0.47) vs (0.00±0.00)	<0.001	(0.94±0.2) vs (0.00±0.00)	<0.001
(DL) *vs* (VS)	(1.84±0.47) vs (0.84±0.47)	<0.001	(0.94±0.2) vs (0.18±0.4)	<0.001
(DL) *vs* (GS)	(1.84±0.47) vs (0.54±0.50)	<0.001	(0.94±0.2) vs (0.00±0.00)	<0.001
(AT) *vs* (VS)	(0.00±0.00) vs (0.84±0.47)	<0.001	(0.00±0.00) vs (0.18±0.4)	0.004
(AT) *vs* (GS)	(0.00±0.00) vs (0.54±0.50)	<0.001	(0.00±0.00) vs (0.00±0.00)	
(VS) *vs* (GS)	(0.84±0.47) vs (0.54±0.50)	0.004	(0.18±0.4) vs (0.00±0.00)	0.004

DL: Direct laryngoscope, AT: Airtraq, VS: C-Mac videolaryngoscope, GS: Glidescope

tracheal intubation using direct laryngoscopy performed by untrained medical personnel bears a high risk of failure.[8-14] Airtraq and Glidescope provide a direct view of the glottis without alignment of the mouth, pharynx, and trachea.[15,16] Alignment of the airway might explain in part the difficulty in acquiring the skill of tracheal intubation, mainly when the conventional approaches of direct Macintosh laryngoscope is used for intubation.[8] Many studies reported the difficulty of gaining and maintaining intubation skills, particularly when the intubation opportunities are limited and non-anesthesiologists are asked to perform tracheal intubation in emergency situations.[17-19] Similar to our study, many investigators proved that Airtraq was better than regular Macintosh in relation to intubation time and the view of the glottis,[20,21] while others documented that Glidescope was better than or equal to regular Macintosh.[16,22,23]

McElwain *et al.*, in a study conducted among experienced anesthetists, reported that the duration of tracheal intubation attempts were similar with C-MAC, Macintosh, and Airtraq laryngoscopes, while Glidescope performance was less than the other.[24] The best glottic views were reported with C-MAC and Airtraq, while C-MAC was rated as the easiest device to use by the anesthetists.[24] In manikin study and among medical student, Savoldelli *et al.* reported that Airtraq consistently provided the most rapid intubation, with a superior laryngeal view when compared with Glidescope.[25] Chalkeidis *et al.* reported that Airtraq laryngoscope is easier to use when compared with direct laryngoscope, although he did not find any significant advantages over the Macintosh laryngoscope in routine airway management.[26] Other investigators reported that Airtraq, Glidescope, and McGrath laryngoscopes are easy to use and have a steep learning curve.[16,27-29] The most common encountered problem with Glidescope use is the inability to direct the ETT toward the glottis, even with an excellent view.[16]

In this study, dental trauma was less frequent with Airtraq and Glidescope, then C-Mac and more frequent with the Macintosh laryngoscope. This is similar to Fung *et al.'s* finding in which incidence of dental trauma was less with Airtraq laryngoscope.[30] Literature reviews revealed no association between Glidescope use and dental injury.[31]

We reported that the number of needed attempts for intubation was equal between the three indirect laryngoscopes and less than Macintosh. This is similar to the findings of previous study in which Glidescope was better than Macintosh in the number of needed attempts.[32] Other studies found that Airtraq laryngoscope facilitated tracheal intubation even when non-expert persons performed the intubation, in easy and difficult airway cases, and when attempts with direct laryngoscopy failed to achieve that.[33,34]

When nasal intubation was used, intubation time was

shorter with Airtraq than Glidescope, C-Mac, and direct laryngoscope, while the glottic opening visualization was the same with Airtraq and Glidescope, but both were better than C-Mac and Macintosh. This is similar to previous reporting in which Airtraq laryngoscope offered a potential advantages over standard direct laryngoscopy for nasotracheal intubation,[35,36] and Glidescope was superior to Macintosh in airway management by novices and experts.[36-38]

Participants were more satisfied and performed less number of attempts of intubations, using the new three devices opposite to Macintosh laryngoscopy. Similar finding was reported with Glidescope when compared with direct Macintosh.[38]

Savoldelli *et al*. reported that the learning curve with the Airtraq is faster than other tools[39] and this might be the situation in our case.

Although the selection of novice medical students to perform tracheal intubation in this study and not experienced anesthetists was aiming toward the assessment of their learning ability to intubate the trachea using new airway devices and to reflect the possibility of using such devices to secure the airway by non-skilful personnel who might face the need for urgent tracheal intubation in his daily practice, several limitations were noticed. Airway management is a complex problem which might not be simulated by the manikin. We did not address the other characteristics of each device such as ease of assembly and handling, fogging resistant, and the ability to visualize the glottis in the presence of secretion or blood, and a third limitation of our study is the performance of intubation in ease airway and in manikin and not real patients with difficult airway.

In conclusion, the new intubation devices: Airtraq, Glidescope, and C-Mac, provide better airway management than the classical regular Macintosh when used by novice medical students with no previous training for oral and nasal intubation. Further studies are needed to assess that among real patients and in difficult airway scenarios.

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