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Research article

Comparison between Glidescope, Airtraq and Macintosh laryngoscopy for emergency endotracheal intubation in intensive care unit: Randomized controlled trial

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ABSTRACT

Background: Emergency endotracheal intubation in intensive care is a major challenge that can be associated with life-threatening complications. The aim of this study was to evaluate the success of the first attempt of endotracheal intubation and incidence of complications using Macintosh laryngoscopy, Airtraq or Glidescope during emergency intubation in intensive care.

Patients and methods: One hundred twenty adult intensive care patients of ASA physical status III and IV who required emergency endotracheal intubation were randomly allocated into 3 groups. Group M (40 patients) were intubated using Macintosh laryngoscopy. Group G (40 patients) were intubated using Glidescope. Group A (40 patients) were intubated using Airtraq. The primary outcome was the success of the first attempt of endotracheal intubation. Secondary outcomes included the number of intubation attempts, duration of intubation, glottic view as assessed by Cormack-Lehane grade (C&L grade) and incidence of complications.

Results: Success of the first attempt of endotracheal intubation was significantly higher in both groups G and A compared to group M ($p < 0.05$). The number of intubation attempts was significantly higher in group M compared to both groups G and A ($p < 0.05$). The duration of endotracheal intubation was 28.80 ± 10.27 s in group M compared to 31.45 ± 12.17 s in group G and 32.25 ± 11.96 s in group A ($p > 0.05$). The C&L grade was significantly better in both groups G and A compared to group M ($p < 0.05$). No statistically significant difference between the three groups in HR or MAP. The incidence of oxygen desaturation was significantly more in group M compared to groups G and A. No statistically significant difference between the 3 studied groups regarding the incidence of other complications.

Conclusion: Both Glidescope and Airtraq have higher first attempt success rate with a better glottic view and less incidence of oxygen desaturation than Macintosh laryngoscopy during emergency intubation in intensive care.

1. Introduction

Emergency endotracheal intubation in intensive care unit is a life-saving procedure that can be associated with difficult intubation and serious complications. The incidence of difficult intubations in critically ill patients is 10–20% [1–3]. Awake fiberoptic intubation is the gold standard for endotracheal intubation in patients with predicted difficult airway [4] however, we can't use for emergency endotracheal intubation.

Life-threatening complications such as pulmonary aspiration, hypoxia, hemodynamic instability, arrhythmias and cardiac arrest can occur during endotracheal intubation especially with multiple attempts or failed endotracheal intubation [5–7]. Optimization of glottic view, decreasing the number of intubation attempts and shortening the duration of intubation might reduce the incidence of such complications.

Macintosh direct laryngoscopy is the most frequently used technique for endotracheal intubation in anesthesia and intensive care. Many indirect video laryngoscopes were introduced as alternative tools for endotracheal intubation. The American Society of Anesthesiologists recommended the use of video laryngoscopy for patients with suspected difficult intubation [8]. A debate is still present about the advantage of video laryngoscopy over direct laryngoscopy regarding the success of endotracheal intubation and incidence of complications in intensive care patients [9].

Airtraq is an optical laryngoscope with color-coded different sizes. It

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has two channels; the first channel is a track to preload the endotracheal tube through it. The other channel consists of the imaging system formed of mirrors and lenses to magnify the airway image [10,11].

The Glidescope cobalt is a video laryngoscopy that has a reusable video baton with disposable blades of different sizes. It has a camera that provides a wide field of view with a clear picture on the monitor screen [12].

The aim of this study was to evaluate the success of the first attempt of endotracheal intubation, the number of attempts of endotracheal intubation, duration of endotracheal intubation and incidence of complications during emergency endotracheal intubation in ICU using either Macintosh laryngoscopy, Airtraq or Glidescope video laryngoscope. We hypothesized that the use of a video laryngoscope would improve the success of the first attempt of endotracheal intubation with a better glottic view and reduce the incidence of complications.

2. Patients and methods

2.1. Study design

This prospective, randomized controlled study was carried out in Zagazig University Hospital surgical intensive care unit from April 2016 to December 2017 after approval of our institutional review board (IRB). One hundred twenty adult intensive care patients of ASA physical status III and IV aged more than 18 years who required emergency endotracheal intubation were included in this study (Fig. 1). Patients were randomly allocated according to a computer-generated random number with and use of sealed opaque envelopes for allocation concealment into one of three groups.

Group M (40 patients) were intubated using Macintosh laryngoscopy. Group G (40 patients) were intubated using glidescope cobalt video-laryngoscope (Verathon Medical, Bothell WA, USA). Group A (40 patients) were intubated using Airtraq (Prodol Meditec S.A., Vizcaya, Spain). The primary outcome was the success of the first attempt of endotracheal intubation because it is the main aim in emergency situations. Secondary outcomes included the number of attempts of endotracheal intubation, duration of endotracheal intubation, glottic view as assessed by Cormack-Lehane grade (C&L grade) [13] and incidence of complications.

Inclusion criteria were, age more than18 years, intensive care unit patients need emergency endotracheal intubation.

Exclusion criteria included patients required endotracheal intubation due to cardiac arrest, severe oxygen desaturation (Spo2 < 80%) and patients with diagnosed or predicted cervical spine injury.

Intubation was done by ICU physician with more than 3 years of experience in anesthesia and intensive care and performed more than 30 intubations with each of Airtraq and Glidescope. All patients were intubated by an oral endotracheal tube with a stylet for all intubations. All patients were monitored for oxygen saturation, electrocardiography and blood pressure. The endotracheal tube position was confirmed by capnography.

After preoxygenation with 100% oxygen, rapid sequence induction (RSI) with cricoid pressure was performed. Induction agents included propofol 1–2 mg/kg or ketamine 1–2 mg/kg were titrated according to the patient response and hemodynamics. Fentanyl 1–2 mcg/kg and rocuronium 1 mg/kg were given then intubation was attempted after one minute.

An attempt is defined as an introduction of the laryngoscope into the mouth and its removal regardless of whether an endotracheal tube was inserted or not. If the oxygen saturation dropped below 90% the attempt was terminated and considered as a failed attempt. The duration of intubation is defined as the time from laryngoscope was first inserted into the patient's mouth until the appearance of the first

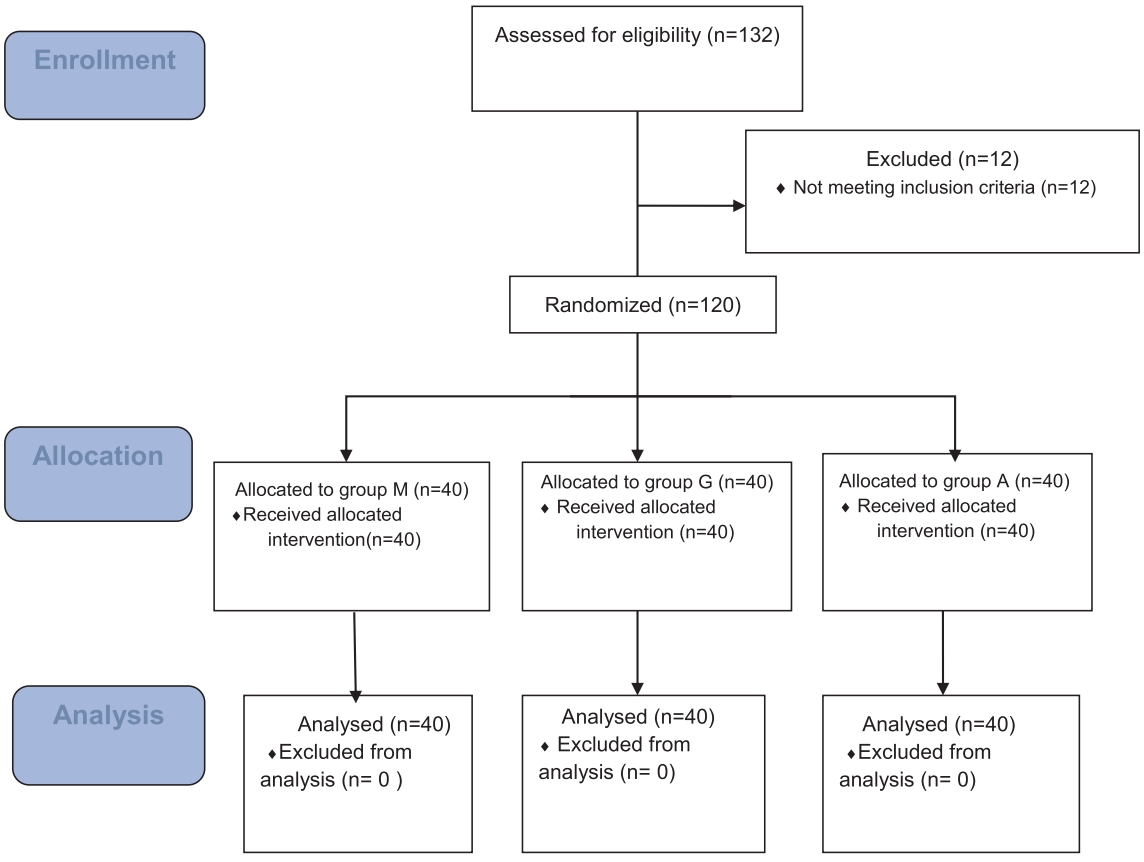

Fig. 1. Consort flow-diagram demonstrating patients enrollment, randomization, allocation and analysis.

capnography wave. Failed endotracheal intubation is defined as failure to intubate the patient after 3 attempts using the same laryngoscope.

Hemodynamic parameters (heart rate and mean arterial blood pressure) and oxygen saturation were recorded just before, during the 1, 2, 3, 4, 5 and 10 min after endotracheal intubation.

Complications including oxygen desaturation < 90%, arrhythmias, esophageal intubation and lip, dental or oropharyngeal injuries were recorded.

2.2. Sample size calculation

A power analysis using Chi- square test was done for independent samples on the frequency of patients with success of the first attempt of endotracheal intubation because it was the main outcome variable in the present study. A pilot study was performed before starting this study showed that frequency of patients with success of the first attempt of endotracheal intubation was 72% in group M, 96% in group G and 94% in group A. Taking power 0.8 and alpha error 0.05, a minimum sample size of 33 patients was calculated for each group. We expected a rate of 20% exclusion after randomization so we added another 7 patients for each group (MedCalc 13 for windows, MedCalc Software bvba, Ostend, Belgium).

2.3. Statistical analysis

Continuous variables were expressed as mean ± SD and categorical variables were expressed as number (percentage). Continuous variables were checked for normality using Shapiro-Wilk test. One-way ANOVA test was used for comparing normally distributed data while Kruskal Wallis H test was used for non-normally distributed data. Percent of categorical variables were compared using Chi-square test. All tests were two sided. P-value < 0.05 was considered statistically significant. Statistical Package for Social Science version 20.0 (SPSS Inc., Chicago, IL, USA) and MedCalc for windows version 13 (MedCalc Software bvba, Ostend, Belgium) was used for analysis of all data.

3. Results

Patients characteristics were comparable in the three studied groups ($p > 0.05$) (Table1).

The success of the first attempt of endotracheal intubation was significantly higher in both groups G (38 patients) and A (37 patients) compared to group M (29 patients) (95%and 92.5% compared to 72.5%) ($p < 0.05$). The number of intubation attempts was significantly higher in group M compared to both groups G and A ($p < 0.05$). Eight patients in group M were intubated from the second attempt compared to 2 patients in each of groups G and A. Three patients in group M required 3 attempts of endotracheal intubation compared to one patient in group A and no patients in group G. One of these 3 patients in group M couldn't be intubated after the third attempt and was considered as failed intubation. This patient with failed intubation in group M was successfully intubated within few second with an intubating laryngeal mask after the three failed trials using the Macintosh laryngoscopy. The duration of endotracheal intubation was 28.80 ± 10.27 s in group M (of all 40 cases including the patient with failed intubation after 3 attempts) compared to 31.45 ± 12.17 s in group G and 32.25 ± 11.96 s in group A ($p > 0.05$) (Table 2). The C& L grade was significantly better in both groups G and A compared to group M. Only 19 patients (47.5%) in group M had C&L grade **I** compared to 32 patients (80%) in group G and 30 patients(75%) in group A. Nine patients (22.5%) in group M had C&L grade II compared to 6 patients (15%) in group G and 7 patients (17.5%) in group A. Ten patients (25%) in group M had C&L grade III compared to 2 patients (5%) in each of groups G and A. Two patients (5%) in group M were C&L grade **IV** compared to one patient (2.5%) in group A and no patients in group G (Fig. 2).

Although the heart rate (HR) and mean arterial blood pressure (MAP) increased during intubation, there was no statistically significant difference between the three studied groups in HR (Fig. 3) or MAP (Fig. 4).

The incidence of oxygen desaturation was significantly more in group M (10 patients) (25%) compared to 2 patients (5%) in group G and 3 patients (7.5%) in group A. There was no statistically significant difference between the 3 studied groups regarding the incidence of other complications ($p > 0.05$) (Table 3).

4. Discussion

Emergency endotracheal intubation in critically ill patients with borderline or poor cardiovascular and respiratory reserve is a major challenge. This study was carried out to compare between Macintosh laryngoscopy, Airtraq and glideslope for emergency endotracheal intubation in the intensive care unit.

The success of the first attempt of endotracheal intubation was significantly higher in both glideslope and Airtraq groups compared to Macintosh group. Only 2 patients in glidescope group and 3 patients in Airtraq group required more than one attempt for endotracheal intubation compared to 11 patients in Macintosh group. This higher success rate can be attributed to the better glottic view with Airtraq and glidescope compared to Macintosh laryngoscope. The number of intubation attempts was significantly less in glidescope and Airtraq groups than Macintosh group. Our results are consistent with the study done by Silverberg et al. [14] who found that first attempt success rate was significantly higher with glidescope compared to direct laryngoscopy during urgent endotracheal intubation. Maharaj et al. [15] found that Airtraq had a higher success of the first intubation attempt compared to Macintosh laryngoscope in patients at increased risk for difficult intubation. Sakles et al. [16] showed higher first attempt success rate with glidescope than Macintosh during intubation in the emergency department. Also, Michailidou et al. found that the success rate of emergency endotracheal intubation in trauma patients was higher with video laryngoscopy than direct laryngoscopy [17]. In contrast to our

Table 1
Comparison between the studied groups as regard patient characteristics.

Demographic data	Group M (N = 40)	Group G (N = 40)	Group A (N = 40)	p-value
Age (years): Mean ± SD	42.19 ± 13.52	44.34 ± 13.40	41.96 ± 15.27	0.709*
Sex: Male/Female: Number (%)	26 (65%)/14 (35%)	27 (67.5%)/13 (32.5%)	25 (62.5%)/15 (37.5%)	0.896§
APACHE: Mean ± SD	19.92 ± 5.16	22.17 ± 5.85	21.45 ± 5.31	0.159●
BMI (kg/m^2): Mean ± SD	26.57 ± 4.86	25.65 ± 5.34	24.82 ± 4.65	0.292*

N = Total number of patients in each group.
Quantitative data were expressed as the mean ± SD.
Qualitative data were expressed as a number (percentage).
* One Way ANOVA test.
● Kruskal Wallis H test.
§ Chi-square test; $p < 0.05$ is significant.

Table 2
Comparison between the studied groups as regard intubation criteria.

Intubation criteria	Group M (N = 40)	Group G (N = 40)	Group A (N = 40)	p-value
Success of first attempt of endotracheal intubation: Number (%)	29 (72.5%)[‡,♯]	38 (95%)	37 (92.5%)	0.005[§]
No of intubation attempts				
1 attempt: Number (%)	29 (72.5%)[‡,♯]	38 (95%)	37 (92.5%)	0.028[§]
2 attempts: Number (%)	8 (20%)	2 (5%)	2 (5%)	
3 attempts: Number (%)	3 (7.5%)	0 (0%)	1 (2.5%)	
Failed endotracheal intubation: Number (%)	1 (2.5%)	0 (0%)	0 (0%)	0.365[§]
Duration of intubation(seconds): Mean ± SD	28.80 ± 10.27	31.45 ± 12.17	32.25 ± 11.96	0.552[●]

N = Total number of patients in each group.
Quantitative data were expressed as the mean ± SD.
Qualitative data were expressed as a number (percentage).
● Kruskal Wallis H test.
§ Chi-square test; $p < 0.05$ is significant.
‡ Significant difference between Group M and Group G.
♯ Significant difference between Group M and Group A.

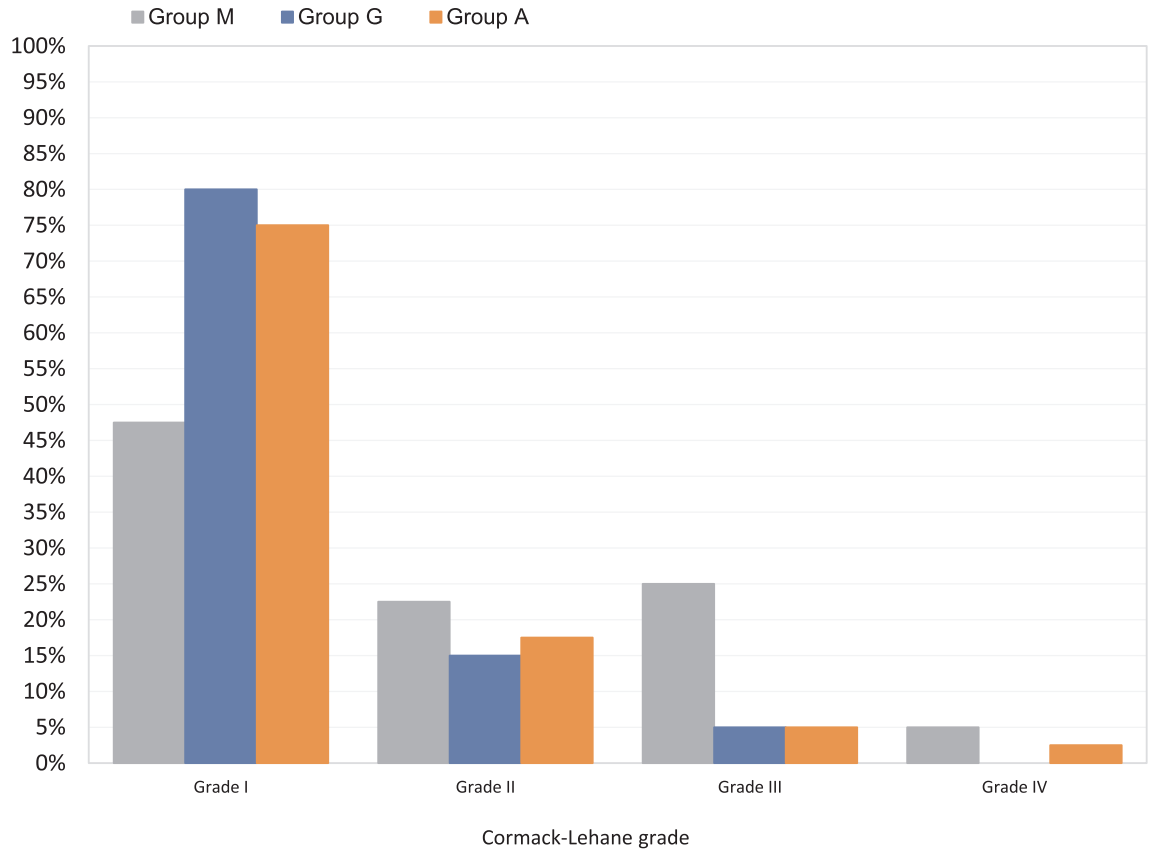

Fig. 2. Bar chart shows comparison between the studied groups as regard Cormack-Lehane grade.

results Platts-Mills et al. found a similar success rate of the first attempt of intubation between glidescope and direct laryngoscopy in emergency department [18], but in their study , the choice of intubation device was left to the provider with the preference of direct laryngoscopy during cardiac arrest. Another study done by Lascarrou et al. [19] showed that video laryngoscopy did not improve first-pass orotracheal intubation in intensive care patients when compared with direct laryngoscopy. But they used McGrath video laryngoscope for nonemergency intubation by both non-expert and expert physicians. Chalkeidis et al. [20] found that Airtraq was easier than Macintosh for use during routine endotracheal intubation excluding patients with predicted difficult intubation.

The current study revealed insignificant differences in duration of endotracheal intubation among the studied groups, although the glidescope and Airtraq have a slightly longer duration than Macintosh group.

Consistent with our results Maharaj et al. [11] found no significant difference between Airtraq and Macintosh laryngoscopy regarding the time needed for routine endotracheal intubation. Also, Chalkeidis et al. [20] in their study found no significant difference for the intubation time between direct laryngoscopy and Airtraq among experienced anesthetist.

Platts-Mills [18] found that glidescope takes longer time than direct laryngoscopy during emergency endotracheal intubation while Lim et al. [21] found that glidescope takes a shorter time than direct laryngoscopy in patients with cervical immobility. This variation in the results regarding the duration of intubation can be attributed to the difference in the level of experience of the intubating physician, the

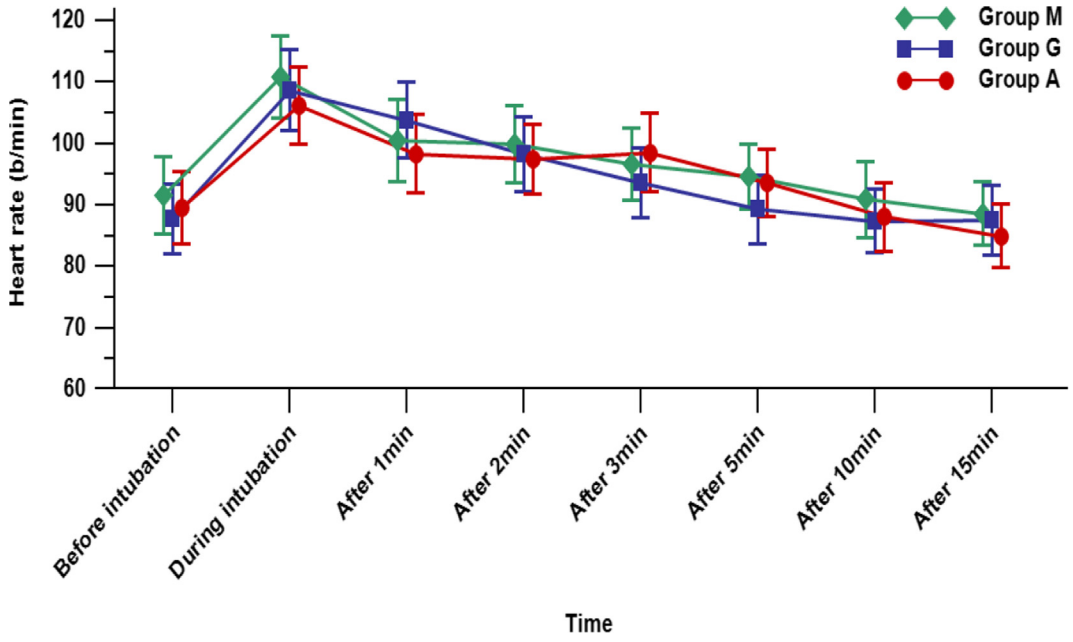

Fig. 3. Marker & Error bar with connecting lines graph shows comparison between the studied groups as regard heart rate (b/min); Marker represents mean, Y-error bar represents 95%confidence interval of the mean.

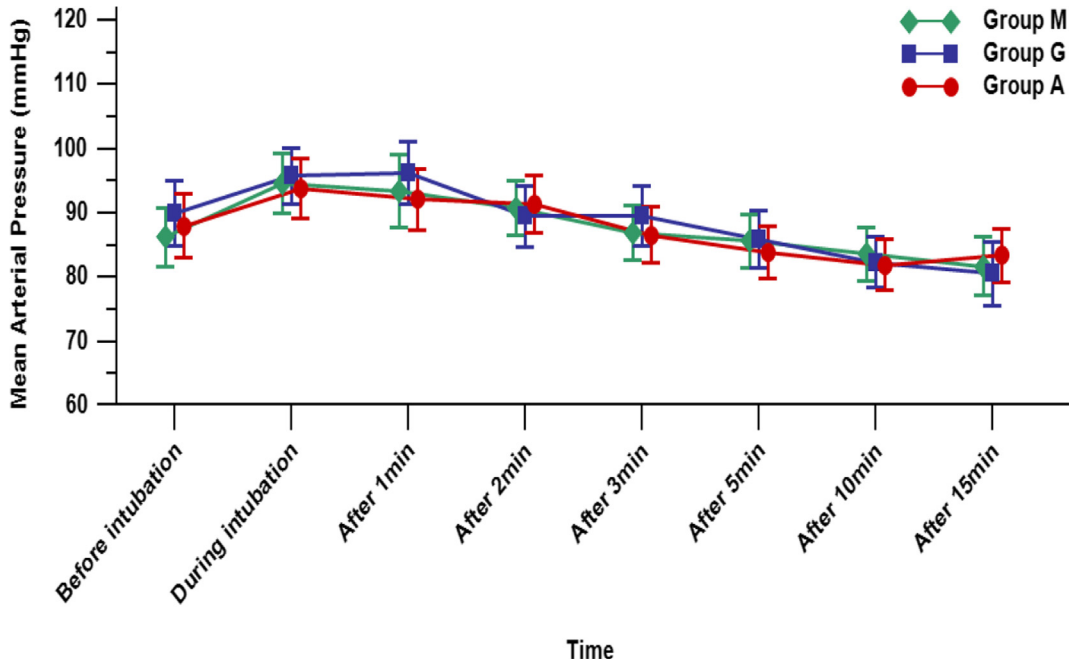

Fig. 4. Marker & Error bar with connecting lines graph shows comparison between the studied groups as regard mean arterial pressure (mmHg); Marker represent s mean, Y-error bar represents 95%confidence interval of the mean.

degree of airway difficulty and the nature of the studied patients.

In the current study, Cormack-Lehane grade view was significantly better in both glidescope and Airtraq groups compared to Macintosh group. This better C&L grade may be the reason for the higher success rate of first attempt of endotracheal intubation with Airtraq and glidescope with less number of intubation attempts. Our results are consistent with the results of Lim et al. [21] who found that glidescope provided better C& L grade when used for endotracheal intubation in the emergency department. Nodoko et al. [22] found that patients intubated with Airtraq had a better C& L grade compared to Macintosh laryngoscopy in morbidly obese patients. Improved glottic visualization and first attempt success rate were also reported with video laryngoscopy in medical intensive care [23].

The current study revealed an insignificant difference in MAP and HR between the three studied groups. In agreement with our results, Siddiqui et al. [24] found no significant difference in MAP and HR among the studied groups using direct laryngoscopy, Glidescope and Trachlight during elective surgery. McElwain et al. [25] and Koh et al. [26] reported a non-significant difference in hemodynamics in patients with cervical immobilization intubated with Airtraq or Macintosh.

In contrast to our results, Maharaj et al. found less hemodynamic stimulation with Airtraq compared to Macintosh laryngoscopy in patients with predicted difficult intubation [15]. Dashti et al. reported less hemodynamic alterations in patients with untreated hypertension

Table 3
Comparison between the studied groups as regard incidence of complications.

Incidence of complications	Group M (N = 40)	Group G (N = 40)	Group A (N = 40)	p-value[§]
Oxygen desaturation: Number (%)	10 (25%)[‡,♯]	2 (5%)	3 (7.5%)	0.013
Arrhythmia: Number (%)	2 (5%)	2 (5%)	3 (7.5%)	0.859
Esophageal intubation: Number (%)	2 (5%)	0 (0%)	0 (0%)	0.131
Lip injury: Number (%)	2 (5%)	1 (2.5%)	1 (2.5%)	0.088
Dental injury: Number (%)	1 (2.5%)	0 (0%)	0 (0%)	0.365
Oropharyngeal injury: Number (%)	2 (5%)	3 (7.5%)	2 (5%)	0.859

N = Total number of patients in each group.
Qualitative data were expressed as number (percentage).
[§] Chi-square test; $p < 0.05$ is significant.
[‡] Significant difference between Group M and Group G.
[♯] Significant difference between Group M and Group A.

during intubation with glidescope compared to Macintosh laryngoscopy [27].

Except for the incidence of oxygen desaturation, there was no significant difference among the three groups regarding the incidence of complications. Oxygen saturation dropped below 90% in 25% of patients in Macintosh group versus only 5% of patients in glidescope group and 7.5% of patients in Airtraq group. This higher incidence of oxygen desaturation in patients intubated with Macintosh laryngoscope can be attributed to the lower success rate of the first attempt of endotracheal intubation. Silverberg et al. found no significant difference in the incidence of complications between glidescope and Macintosh laryngoscopy during urgent intubation [14]. Maharaj et al. [15] found that patients intubated with Airtraq had a significantly lower degree of oxygen desaturation and incidence of other complications than Macintosh laryngoscopy in patients with predicted difficult intubation.

The current study has some Limitations, firstly blinding was not feasible as it was impossible for the intubating physician to be blind with the laryngoscopic device used for intubation. Secondly, the experience of the intubating physician was more with Macintosh laryngoscopy compared to Airtraq and glidescope as it is more frequently used in routine practice, but this was the same for all the physicians participated in the study.

5. Conclusion

Both glidescope and Airtraq offer a higher first attempt success rate with a better glottic view and less number of intubation attempts than Macintosh laryngoscopy during emergency endotracheal intubation in intensive care patients. Although the duration of intubation was comparable among the three laryngoscopies, the incidence of oxygen desaturation was significantly lower with both Airtraq and glidescope than Macintosh laryngoscope with no significant difference regarding the incidence of other complications.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

[1] Heuer JF, Barwing TA, Barwing J, Russo SG, Bleckmann E, Quintel M, et al. Incidence of difficult intubation in intensive care patients: Analysis of contributing factors. Anaesth Intensive Care 2012;40:120–7.
[2] Jaber S, Amraoui J, Lefrant JY, Arich C, Cohendy R, Landreau L, et al. Clinical practice and risk factors for immediate complications of endotracheal intubation in the intensive care unit: A prospective, multiple-center study. Crit Care Med 2006;34:2355–61.
[3] Mort TC. The incidence and risk factors for cardiac arrest during emergency tracheal intubation: a justification for incorporating the ASA Guidelines in the remote location. J Clin Anesth 2004;16:508–16.
[4] Collins SR, Blank RS. Fiberoptic intubation: An overview and update. Respiratory Care 2014;59(6):865–80.
[5] Martin LD, Mhyre JM, Shanks AM, Tremper KK, Kheterpal S. emergency tracheal intubations at a university hospital: airway outcomes and complications. Anesthesiology 2011;114:42–8.
[6] De Jong A, Molinari N, Terzi N, Mongardon N, Arnal JM, Guitton C, et al. Early identification of patients at risk for difficult intubation in ICU: Development and validation of the MACOCHA score in a multicenter cohort study. Am J Respir Crit Care Med 2013;187:832–9.
[7] Simpson GD, Ross MJ, McKeown DW, Ray DC. Tracheal intubation in the critically ill: a multi-center national study of practice and complications. Br J Anaesth 2012;108:792–9.
[8] Apfelbaum JL, Hagberg CA, Caplan RA, Blitt CD, Connis RT, Nickinovich DG, et al. Practice guidelines for management of the difficult airway: An updated report by the American society of anesthesiologists task force on management of the difficult airway. Anesthesiology 2013;118:251–70.
[9] Larsson A, Dhonneur G. Video laryngoscopy: Towards a new standard method for tracheal intubation in the ICU? Intensive Care Med 2013;39:2220–2.
[10] Ford PN, Hamer C, Medakkar S. Use of the Airtraq in the difficult airway. Eur J Anaesthesiol 2007;24:730–1.
[11] Maharaj CH, Higgins BD, Harte BH, Laffey JG. Evaluation of intubation using the Airtraq or Macintosh laryngoscope by anaesthetists in easy and simulated difficult laryngoscopy - A manikin study. Anaesthesia 2006;61:469–77.
[12] Karalapillai D, Darvall J, Mandeville J, Ellard L, Graham J, Weinberg L. A review of video laryngoscopes relevant to the intensive care unit. Indian J Crit Care Med 2014;18:442–52.
[13] Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia 1984;39(11):1105–11.
[14] Silverberg MJ, Li N, Acquah SO, Kory PD. Comparison of video laryngoscopy versus direct laryngoscopy during urgent endotracheal intubation: A randomized controlled trial. Crit Care Med 2015;43(3):636–41.
[15] Maharaj CH, Costello JF, Harte BH, Laffey JG. Evaluation of the Airtraq and Macintosh laryngoscopes in patients at increased risk for difficult tracheal intubation. Anaesthesia 2008;63:182–8.
[16] Sakles JC, Patanwala AE, Mosier JM, Dicken JM. Comparison of video laryngoscopy to direct laryngoscopy for intubation of patients with difficult airway characteristics in the emergency department. Intern Emerg Med 2014;9:93–8.
[17] Michailidou M, O'Keeffe T, Mosier JM, Friese RS, Joseph B, Rhee P, Sakles JC. A comparison of video laryngoscopy to direct laryngoscopy for the emergency intubation of trauma patients. World J Surg 2015;39(3):782–8.
[18] Platts-Mills TF, Campagne D, Chinnock B, Snowden B, Glickman LT, Hendey GW. A comparison of Glidescope video laryngoscopy versus direct laryngoscopy intubation in the emergency department. Acad Emerg Med 2009;16(9):866–71.
[19] Lascarrou JB, Boisrame-Helms J, Bailly A, Le Thuaut A, Kamel T, Mercier E, et al. Video laryngoscopy vs direct laryngoscopy on successful first-pass orotracheal intubation among ICU patients: a randomized clinical trial. JAMA 2017;317(5):483–93.
[20] Chalkeidis O, Kotsovolis G, Kalakonas A, Filippidou M, Triantafyllou C, et al. A comparison between the Airtraq® and macintosh laryngoscopes for routine airway management by experienced anesthesiologists: a randomized clinical trial. Acta Anaesthesiol Taiwan 2010;48(1):15–20.
[21] Lim HC, Goh SH. Utilization of a Glidescope video laryngoscope for orotracheal intubations in different emergency airway management settings. Eur J Emerg Med 2009;16:68–73.
[22] Ndoko SK, Amathieu R, Tual L, Polliand C, Kamoun W, El Housseini L, et al. Tracheal intubation of morbidly obese patients: a randomized trial comparing performance of Macintosh and Airtraq laryngoscopes. Br J Anaesth 2008;100:263–8.
[23] Mosier JM, Whitemore SP, Bloom JW, Snyder LS, Graham LA, Carr GE, et al. Video laryngoscopy improves intubation success and reduces esophageal intubations compared to direct laryngoscopy in the medical intensive care unit. Crit Care 2013;17(5):R237.
[24] Siddiqui N, Katznelson R, Friedman Z. Heart rate/blood pressure response and airway morbidity following tracheal intubation with direct laryngoscopy, Glidescope and Trachlight: a randomized control trial. Eur J Anaesthesiol 2009;26(9):740–5.
[25] McElwain J, Laffey JG. Comparison of the C-MAC®, Airtraq®, and Macintosh laryngoscopes in patients undergoing tracheal intubation with cervical spine immobilization. Br J Anaesth 2011;107:258–64.
[26] Koh JC, Lee JS, Lee YW, Chang CH. Comparison of the laryngeal view during intubation using Airtraq and Macintosh laryngoscopes in patients with cervical spine immobilization and mouth opening limitation. Korean J Anesthesiol 2010;59(5):314–8.
[27] Dashti M, Amini S, Azarfarin R, Totonchi Z, Hatami M. Hemodynamic changes following endotracheal intubation with Glidescope® video- laryngoscope in patients with untreated hypertension. Res Cardiovasc Med 2014;3(2):;e:17598.