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Research Article

Air-Q the Intubating Laryngeal Airway: Comparative study of hemodynamic stress responses to tracheal intubation via Air-Q and direct laryngoscopy

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KEYWORDS

Air-Q;
Direct laryngoscopy (DLS);
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Abstract *Background*: Tracheal intubation is the gold standard for securing airway. Tracheal intubation through DLS produces marked hemodynamic stress responses. The Air-Q is a new supraglottic airway device. The purpose of this study was to determine whether endotracheal intubation through Air-Q is associated with lesser hemodynamic stress responses.
Methods: 60 patients scheduled for elective surgery under general anesthesia requiring endotracheal intubation were randomly assigned into two groups. Direct laryngoscopy group and Air-Q group. Blood pressure and heart rate were recorded before, after induction, immediately after intubation and every minute for 4 min after intubation. The intubation time was recorded. Upon removal of the Air-Q, trauma to the upper airway was reported.
Results: The intubation time was shorter in the DLS group compared with the Air-Q group (P value < 0.05). A significant reduction in BP was evident after the induction of anesthesia in both groups. Immediately after intubation, there was a significant increase in BP compared with the pre-intubation values. A decline was inspected between 1 and 4 min postintubation in both groups with significant difference immediately, at 1 and 2 min postintubation between the two groups. There were significant increase in HR immediately, at 1 and 2 min postintubation compared with the

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preintubation values, but there was no significant difference at each time point between two groups. Sore throat was more in the Air-Q group (P value < 0.05).
Conclusion: The hemodynamic stress response to intubation by Air-Q is less than that of DLS despite the longer duration of the former.

1. Introduction

Airway management remains an important problem in the practice of anesthesia [1]. Tracheal intubation is still the gold standard for securing the airway. Direct laryngoscopy to facilitate tracheal intubation produces marked hemodynamic stress responses. These responses are more pronounced in hypertensive patients [2]. Furthermore; the hemodynamic changes after tracheal intubation increase as the degree of airway difficulty increases. Although these hemodynamic changes are short lived; it may be life threatening in high-risk patients with cardiac, cerebral and vascular diseases [3]. In otherwise healthy patients, such responses can be attenuated by providing deep anesthesia. In hypertensive and cardiac patients, this approach would lead to a high incidence of hypotension. On the other hand light anesthetic depth carries the potential of detrimental effects of hypertension and tachycardia [4].

Laryngoscopic stimulation of oropharyngolaryngeal structures is the most important factor in the hemodynamic stress response associated with tracheal intubation. In a late study a group of researchers tried to separate the effect of laryngoscopy from that of tracheal intubation. They found no significant difference in the cardiovascular response of direct laryngoscopy, with and without tracheal intubation. And concluded that the laryngoscopy itself is the major contributor to the stress response [5].

So, tracheal intubation techniques that avoid or minimize oropharyngolaryngeal stimulation might attenuate the hemodynamic stress response. Nonlaryngoscopic intubation devices such as fiberoptic intubating devices, the mask adapter, the Augustine guide™, the Trachlight™, lightwand and intubating supraglottic airways might be used to achieve such purpose [6].

Many supraglottic airways were designed to allow safe ventilation as well as reliable blind intubation. The Air-Q™ Intubating Laryngeal Airway (ILA™, Cookgas LLC, Mercury Medical, Clearwater, FL, USA) is a new supraglottic airway device that in addition to allowing for airway maintenance under general anesthesia, it allows for tracheal intubation with a cuffed tracheal tube in both adults and pediatric patients [7].

In the present study, we compared hemodynamic stress responses due to endotracheal intubation using direct laryngoscopy and blind endotracheal intubation via Air-Q in healthy adult patients under general anesthesia.

2. Patients and methods

After obtaining institutional ethics committee approval we recruited 60 adult ASA physical status I–II patients, scheduled for elective surgery under general anesthesia requiring endotracheal intubation. Written informed consent was obtained from all patients enrolled in the study. Age < 18 yr, patients with obvious malformations of the airway or having limited mouth opening (less than 2.3 cm), patients who were at risk of regurgitation, had a BMI > 40 kg/m^2, or were allergic to any drugs in the protocol were excluded from the study. Patients with uncontrolled hypertension, uncontrolled cardiac, CNS or pulmonary diseases were also excluded.

Patients were randomly assigned into one of two equal groups: Direct laryngoscopy group (DLS Group): where 30 patients were intubated with direct laryngoscopy using Macintosh laryngoscope and Air-Q Intubating Laryngeal Airway group (Air-Q Group): where 30 patients were blindly intubated through Air-Q.

In the preoperative holding area, airway was assessed according to the risk index of El-Ganzouri for difficult tracheal intubation and the index scores were recorded (Table 1) [1]. Baseline blood pressure (BP) and heart rate (HR) were also recorded. A14-gauge IV catheter was inserted in an upper extremity vein and 2–3 mg midazolam was given and a warm Lactated Ringer's solution was infused.

In the operating room an electrocardiograph, pulse oximeter, noninvasive blood pressure monitor and peripheral nerve stimulator were applied using a multifunction monitor (Datex–Ohmeda). Patients were in the supine position with

Table 1 Risk index of El-Ganzouri for difficult tracheal intubation.

Variable	Finding	Points
Mouth opening	$\geqslant 4$ cm	0
	< 4 cm	1
Thyromental distance	> 6.5 cm	0
	6.0–6.5 cm	1
	< 6.0 cm	2
Mallampati score	I	0
	II	1
	III	2
Neck movement	$> 90°$	0
	80–90°	1
	$< 80°$	2
Ability to prognath	Yes	0
	No	1
Body weight	< 90 kg	0
	90–110 kg	1
	> 110 kg	2
History of difficult intubation	None	0
	Questionable	1
	Definite	2

Risk index score = (points for mouth opening) + (points for thyromental distance) + (points for Mallampati score) + (points for neck movement) + (points for ability to prognath) + (points for body weight) + (points for history of difficult intubation).
Interpretation: minimum score = 0, maximum score = 12, index score < 4 = unlikely to be difficult, index score $\geqslant 4$ = likely will be difficult.

the patients' head elevated on a standard firm pillow 7 cm in height.

After preoxygenation via a face mask for 5 min, Lidocaine 0.5 mg/kg was given IV to reduce propofol injection pain. Anesthesia was induced 30 s later with fentanyl (2 μg/kg), propofol (2.5 mg/kg) and atracurium besylate (0.5 mg/kg).

In DLS Group, patients were ventilated with isoflurane 1.5% in oxygen via a face mask until neuromuscular blockade was complete and the train-of-four count was zero. The tracheal intubations were performed by experienced anesthesiologists and were facilitated by direct laryngoscopy size 3 or 4 Macintosh laryngoscope. PVC Murphy-type cuffed tracheal tube with internal diameter of 7.0 and 7.5 mm were used for female and male patients, respectively. The tracheal tube was stiffened with a stylet and if the vocal cords were not seen, optimal external laryngeal manipulation was applied to improve the laryngoscopic view. After intubation the tube cuff was inflated with air and the breathing circuit was connected and manual positive pressure ventilation is started. The correct endotracheal placement was confirmed by the appearance of expiratory carbon dioxide waveform and auscultation of chest.

In Air-Q Group, A Reusable Air-Q Intubating Laryngeal Airways size 3.5 for body weights 50–70 kg and size 4.5 for body weights 70–100 kg were used. After IV induction of anesthesia, a well lubricated semi inflated (dimpled) Air-Q with suitable size was inserted, the cuff was then inflated with 3–6 ml air so as to avoid over inflation. Manual positive pressure ventilation was then begun through the Air-Q. If carbon dioxide waveform did not appear the Air-Q was withdrawn few centimeters then reinserted. Patients were then ventilated with isoflurane 1.5% via the Air-Q until the train-of-four count was zero. Then experienced anesthesiologist attempted to pass a well lubricated standard 7.0 or 7.5 mm tracheal tube blindly beyond the epiglottic elevator bar, the tube cuff was inflated with air and the breathing circuit was connected and manual positive pressure ventilation is started. The correct endotracheal placement was confirmed by the appearance of expiratory carbon dioxide waveform and auscultation of chest.

After confirmation of successful intubation, the Air-Q cuff was immediately deflated then it was removed with the aid of a removal stylet. Upon removal of the Air-Q, any blood visible on the device, indicative of trauma to the upper airway was reported.

A maximum of two blind intubation attempts were allowed in the Air-Q group. Where in the second attempt the device was withdrawn 5–8 cm with mandibular lift during reinsertion of the Air-Q. A bougie was passed through the tracheal tube within the Air-Q with the coudé tip anterior. Then the tracheal tube was advanced over the bougie. The patient's lungs were ventilated between attempts if needed. After two unsuccessful attempts of Air-Q insertion or two unsuccessful blind intubations, or if oxygen saturation fell to 90%, direct laryngoscopy was utilized.

BP and HR were recorded in the preoperative holding area, after anesthetic induction (preintubation values), immediately after intubation and every minute for 4 min afterwards.

The intubation time was recorded using a stop watch: namely the time from cessation of manual ventilation using a facemask to restarting of ventilation through the tracheal tube and appearance of the capnography waveform, in DLS Group; And from cessation of manual ventilation via Air-Q till starting ventilation through the endotracheal tube and appearance of the capnography waveform, in Air-Q Group. If the first intubation attempt failed, the time of the second attempt was similarly recorded.

After the successful intubation, the tracheal tube was connected to the anesthesia breathing system for intermittent positive-pressure ventilation. Anesthesia was maintained with isoflurane, oxygen and supplementary atracurium.

Before leaving the PACU the patients were questioned about sore throat and hoarseness. When hoarseness and/or sore throat were noted, daily assessment was done till the patient had no complaint.

2.1. Statistical analysis

All the data were analyzed by using the Statistical Package for the Social Science (SPSS) version 13. Demographic and clinical data from the two groups were compared using two tailed *t*-test and Chi-square test as appropriate. Inter- and intra-group differences among the hemodynamic variables recorded over time were analyzed by using two-way analysis of variance for repeated measures and paired and unpaired *t*-tests with Bonferroni post-test analysis as appropriate. All quantitative data are expressed as mean ± standard deviation (mean ± SD). A P value less than 0.05 was considered statistically significant.

3. Results

A total of 60 patients were enrolled in the study, 30 patients in the DLS group and 30 patients in the Air-Q group. Patients excluded in Air-Q group because of failed intubation after two attempts were replaced by new patients. The two groups were matched in age, weight, height, sex and ASA classification (Table 2). Oxygen saturation was maintained above 95% at all times in all patients.z

The mean length of time for successful endotracheal intubation was shorter in the DLG group compared with the Air-Q group (P value < 0.05) (Fig. 1).

Changes in systolic, diastolic arterial blood pressure are listed in Table 3. A significant reduction in BP was evident after the induction of general anesthesia in both groups. Immediately after tracheal intubation, there was a significant increase in those parameters compared with the preintubation values. A gradual decline was inspected between 1 and 4 min postintubation in both groups. Analysis of variance showed significant difference immediately, at 1 min and at 2 min after intubation between the two groups.

There were significant increase in HR immediately, at 1 min and at 2 min postintubation compared with the preintubation

Table 2 Patients' characteristics and intubation time.

	DLS group (n = 30)	Air-Q group (n = 30)
Age (ys)	58 ± 7	59 ± 12
Sex (M/F)	13/17	16/14
Weight (kg)	80 ± 12	85 ± 7
Height (cm)	160 ± 11	159 ± 10
ASA (I/II)	12/18	17/13

Data are presented as mean ± SD.
DLS = direct laryngoscope.

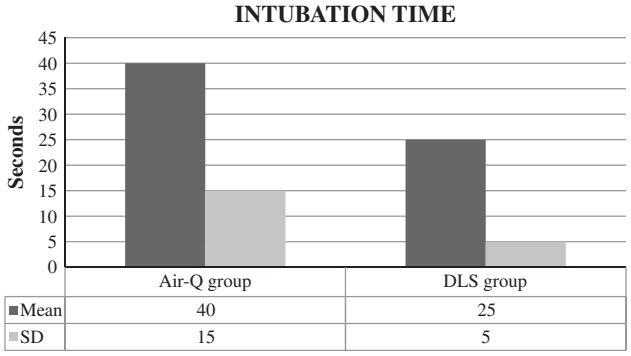

Figure 1 Intubation time in Air-Q and DLS groups.

values, but there was no significant difference at each time point between the two groups (Table 4).

The incidence of airway injury was more frequent in the Air-Q group than in the DLS group (6 of 30 versus 0 of 30; $P < 0.05$). Sore throat was correlated with airway trauma as evident by repeated attempts and/or observation of blood on the Air-Q.

4. Discussion

In our study we compared the hemodynamic stress response associating with blind tracheal intubation through the Air-Q with that of tracheal intubation by conventional DLS. The Air-Q was successfully used for oxygenation and ventilation as well as blind tracheal intubation. There were increases in both blood pressure and heart rate after tracheal intubation in both groups. In spite of significantly longer duration of intubation in Air-Q, the increases in blood pressure were significantly less in the Air-Q group than the DLS group. There were no differences in between the two groups as regards the increases in heart rates. The incidence of sore throat was more in Air-Q group than in DLS group.

To date data about the Air-Q is still limited. To our knowledge hemodynamic stress response due to blind tracheal intubation via the Air-Q has not been tested till the present time.

Since the Intubating Laryngeal Mask Airway (ILMA) was introduced into clinical practice in 1997 numerous clinical trials were performed. Studies comparing the hemodynamic stress responses due to intubation via the ILMA and via direct laryngoscopy (DLS) had conflicting results [8].

Regarding comparison between the hemodynamic stress responses due to intubation via the ILMA and via direct laryngoscopy (DLS) Kihara et al. found that ILMA attenuate the hemodynamic stress response to tracheal intubation compared with the DLS in hypertensive patients but not in normotensive patients. They attributed their results to less oropharyngolaryngeal stimulation in case of ILMA than DLS case but this was only clinically detectable in hypertensive patients [6]. In subsequent study, Kahl and colleagues have shown lesser cardiovascular and endocrine stress response associated with tracheal intubation through ILMA as compared to that via DLS. They concluded that the use of the ILMA device is a useful tool in high-risk patients [4]. Moreover, Bharti and Naik found that hemodynamic stress responses to tracheal intubation via ILMA were lesser than via DLS [9]. They assumed that a possible cause of lesser pressure response in ILMA group is the lesser oropharyngeal stimulation at supraglottic level by avoiding DLS. As well as at subglottic level due to soft tip, well lubricated silicone tube.

In the other hand Zhang et al. showed that pressor and tachycardiac responses due to tracheal intubation were similar

Table 4 Heart rate changes associated with the endotracheal intubation in the two groups.

	HR (bpm)	
	DLS group ($n = 30$)	Air-Q group ($n = 30$)
Baseline	75 ± 12	74 ± 15
Preintubation	73 ± 9	71 ± 9
Postintubation (min)		
Immediately	85 ± 12*	83 ± 11*
1 min	83 ± 8*	81 ± 9*
2 min	79 ± 8*	79 ± 5*
3 min	74 ± 12	75 ± 8
4 min	74 ± 10	73 ± 11

Data are presented as mean ± SD.
DLS = direct laryngoscope; HR = heart rate.
* $P \leqslant 0.05$ compared with the preintubation values in the same group.

Table 3 Blood pressure changes associated with the endotracheal intubation in the two groups.

	SBP (mmHg)		DBP (mmHg)	
	DLS group ($n = 30$)	Air-Q group ($n = 30$)	DLS group ($n = 30$)	Air-Q group ($n = 30$)
Baseline	132 ± 10	130 ± 15	81 ± 10	79 ± 9
Preintubation	115 ± 11**	110 ± 9**	73 ± 11**	69 ± 5**
Postintubation (min)				
Immediately	137 ± 10#*	129 ± 15*	90 ± 9#*	82 ± 12*
1 min	135 ± 14#*	128 ± 10*	88 ± 10#*	80 ± 10*
2 min	132 ± 10#*	126 ± 9*	85 ± 9#*	78 ± 11*
3 min	123 ± 11*	122 ± 15*	80 ± 10*	75 ± 13*
4 min	116 ± 9	114 ± 12	72 ± 8	67 ± 10

Data are presented as mean ± SD.
DLS = direct laryngoscope; SBP = systolic blood pressure; DBP = diastolic blood pressure.
* $P \leqslant 0.05$ compared with the preintubation values in the same group.
# $P \leqslant 0.05$ compared with the Air-Q values at the same time.
** $P \leqslant 0.05$ compared with the baseline values in the same group.

both via ILMA and via DLS. Suggesting that ILMA has no advantage over laryngoscopy in attenuating the hemodynamic responses to endotracheal intubation [10].

The Air-Q™ is a relatively new modification of ILMA intended for use as a primary airway allowing for positive pressure ventilation as well as blind tracheal intubation in situations of anticipated or unanticipated difficult airways. The Air-Q has several structural differences from other intubating supraglottic devices; so, it has the potential to overcome their limitations.

Air-Q design includes a shorter airway tube, a larger inner diameter (ID) and a tethered, removable standard 15-mm circuit adapter. These features enable direct insertion of larger standard cuffed tracheal tubes (up to 7.5 and 8.5 mm IDs) through the airway tube and ensure regular tracheal tube cuff placement below the level of the vocal cords in the midtrachea [11]. Such feature also allows safer and easier removal of the Air-Q after successful blind tracheal intubation. Furthermore; unlike the ILMA Fastrach, Air-Q devices are available in sizes small enough to allow its use in small children (< 30 kg)[12].

In our present study we are postulating that the Air-Q structural modifications are the reason for the lesser hemodynamic stress responses in comparison to DLS. Air-Q allow for using a regular PVC tracheal tubes which are disposable, more readily accessible, and less expensive than the reusable silicone tracheal tubes used in case of ILMA. Both Joo et al. and Kihara et al. used the regular PVC tube not the manufacturer's soft tipped one for blind intubation via fastrach. Joo et al. found lesser hemodynamic stress responses after blind intubation via ILMA group compared with the DLS group [13], Kihara et al. found the same effect only in hypertensive patients [6]. This supports our findings of suppressed stress response while using regular PVC tube in case of Air-Q.

Unlike ILMA, the Air-Q has no epiglottic elevating bar. During tracheal tube insertion via ILMA, epiglottic elevating bar elevate the epiglottis that results in stimuli to the epiglottis and periepiglottic structures [10]. Accordingly in our study we expected lesser stimulation and lesser hemodynamic stress responses.

Laryngeal mask airways with low airway seal pressure are not an ideal airway devices because it may be inadequate for positive pressure ventilation and it does not protect the lungs from regurgitated gastric contents into the pharynx [14]. The airway seal pressure of the Air-Q was comparable with the ProSeal; a device which has been demonstrated by clinical evidence to be able to provide a superior airway seal pressure than other devices [11]. Air-Q was also found to have higher airway seal pressures compared with the LMA Unique™ in children weighing 10–15 kg [15]. Design features unique to the Air-Q that are likely to improve its airway seal pressure include: an anterior curve of the airway tube that better approximates the upper oropharyngeal airway and may provide a more stable end-to-end coupling with the glottis; mask ridges that may improve the transverse stability of the bowl and support the lateral cuff seal; and a higher posterior heel height, which may improve the seal at the base of the tongue. Furthermore; reusable Air-Q is constructed from silicone, which may conform to the supraglottic structures better than PVC single used one [11]. Galgon and colleagues have chosen to fill the Air-Q cuff after insertion with 15–20 ml air in accordance with the device labeling, which may have resulted in over-inflation. Accordingly they postulated that the mean airway seal pressure for the Air-Q observed in their study might be an underestimate [11]. Previously it was also demonstrated that the LMA classic functions better at submaximal cuff volumes as regard seal pressure and fiberoptic view [16]. If this holds true for the Air-Q, there will be less pressure on the pharyngeal mucosa, less pharyngeal stimulation and thus less hemodynamic stress responses.

5. Conclusion

We concluded that the Air-Q is a safe device can be used for both ventilation of the lungs and blind intubation without significant harmful hemodynamic stress responses. Further studies are required to compare stress responses due to tracheal intubation via Air-Q and ILMA.

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