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Research Article

The use of AIR-Q as conduit for fiberoptic endotracheal intubation in adult paralyzed patients

A.R. Elganzouri ^a, Sahar Marzouk ^b, Maha M.I. Youssef ^{b,*}, Nourhan Abdelalem ^b

^a Airway Management Training Program, Rush University, Chicago, USA

^b Kasr Einy Hospital, Cairo University, Egypt

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KEYWORDS

Air Q;
Intubating laryngeal mask;
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Airway management

Abstract *Background:* The AIR-Q Laryngeal Mask (Cookgas LLC; distributed by Mercury Medical) is a supraglottic device present in the market since 2004. It has different sizes for pediatric and adult use. This device proved to be of utmost importance in the management of difficult airway [1]. The study evaluates the different adult sizes of the Air Q when used for intubation regarding the ease of insertion, the laryngeal view grade, their efficacy as conduit for standard cuffed endotracheal tubes using fiberoptic bronchoscope. The study also records the time of intubation, the ease and time of removal of the AIRQ over a removal stylet without dislodgement of the tube from trachea. Any complications related to the use of AIRQ were also recorded such as laryngeal oedema, blood streaked mucous, trauma to the airway, laryngeal spasm or aspiration.

Methods: Sixty adult patients aged 20–50 years, ASA I, II undergoing elective surgeries requiring general anesthesia, were enrolled in the study. The patients were divided into 2 equal groups according to their body weight. The body weight of the first group ranged from 50 to 70 kg and used the Air Q 3.5 for intubation with an endotracheal tube (ETT) 7 mm ID, while the body weight of the second group ranges from 70 to 100 kg and used the Air Q 4.5 for intubation with a tube 7.5 mm ID. The number of attempts of insertion, the seal pressure, the laryngeal view grade, the time and the number of attempts of intubation, time of removal of the AIRQ over the tube without dislodgement, and any complications related to the use of AIRQ were recorded such as laryngeal oedema, blood streaked mucous, trauma to the airway, laryngeal spasm or aspiration.

Results: The insertion and removal of the AIRQ were easy and successful in all patients of both groups. The endotracheal intubation by fiberoptic bronchoscope through the Air Q was successful

* Corresponding author. Address: Lecturer of Anesthesia, Cairo University, Egypt. Tel.: +20 1220002205.

E-mail address: mahal1youssef@yahoo.com (M.M.I. Youssef).

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and easy in both groups. Grade 5 laryngeal view was seen with AIRQ 4.5 in some patients with higher body weight.

Conclusion: The insertion of AIRQ in adult patients is easy and provides an effective conduit for the standard cuffed endotracheal tubes using fiberoptic bronchoscope. The removal of the AIRQ over the removal stylet is easy without dislodgement of the tube. Because of higher incidence of down folding of the epiglottis in some obese patients, they are better intubated under direct vision with the use of fiberoptic bronchoscope.

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1. Introduction

The AIRQ is a supra glottic device used as conduit for intubation in the last few years. In contrast to Intubating (fastrach) LMA (ILMA), it allows the passage of standard cuffed endotracheal tubes. The maximum size ETT is 7.5 mm ID for Air Q 3.5, and 8.5 mm ID for Air Q 4.5. The ILMA has three sizes; 3, 4, 5. It allows for passage of five different sizes of special endotracheal tubes (6–6.5–7–7.5 and 8 mm ID) [1]. The commonly used classic LMA number 3 allows for passage of 5 mm ID ETT, and the maximum size LMA number 6 allows passage of ETT 7 mm ID [2].

The AIR-Q Laryngeal Mask (Cookgas LLC; distributed by Mercury Medical) is a c pre-shaped intubating laryngeal airway easy to use, with a rapid learning curve. The inner diameter of the airway is wide and oval allowing easy passage of the standard endotracheal tube. The keyhole opening present within the opening guides the tube into the larynx. The AIR-Q is then removed over removal stylet. Reusable and disposable AIR-Qs are available in the market [1].

Compared to classic LMA, the AIR-Q has a removable international connection, bite block, short airway tube for easy manipulation during removal of the AIR-Q over the removal stylet, and a smaller air volume for cuff inflation. There are three internal ridges located in anterior part of the cup to create airway stability. When the cuff is inflated, these ridges move against the posterior larynx and improve the anterior mask seal, isolate the esophagus and reduce the incidence of aspiration. The semi inflated anterior part of the wide cup minimizes the folding back of the cup tip during insertion. The presence of a hole on the top of the keyhole opening allows ventilation if the main airway opening is blocked by the long epiglottis.

Comparing the AIR-Q to the ILMA, it is made of silicone with no metal parts in it. So it is used as ventilatory device as well as a conduit for ETT, in contrast to ILMA, which is used only for intubation [3].

The ILMA has only three sizes for single or reusable use (3, 4, 5), and cannot be used for patients below 30 kg. AIRQ has six different disposable sizes (1–1.5–2–2.5–3.5–4.5), and 4 reusable sizes which are present in the market now (1.5–2.5–3.5–4.5) [3–5].

2. Objectives

The main objectives of work first to assess the ease of insertion of the different adult AIRQ sizes 3.5 and 4.5 in patients according to their body weight, second to record the laryngeal view grade, third is to assess the ability to intubate through it by fibroscope, fourth to assess the ease and success rate of its

removal over the removal stylet without dislodgement of the endotracheal tube. Lastly to record the presence of any complications related to the use of AIRQ in the oral cavity as laryngeal oedema, blood streaked mucous, trauma to the airway, laryngeal spasm or aspiration.

3. Materials and methods

The study was performed in kasr Einy learning hospital, Cairo University, Egypt from 1/10/2011 to 1/4/2012. All patients were intubated by experienced personnel proficient with fiberoptic and AIR-Q insertion.

After approval of ethical committee and written informed consent from the patients, 60 adult patients, were enrolled in the study.

Exclusion criteria were ASA > II, airway score ≥ 5 (Ganzouri airway scoring system) [6,7]. Patients < 20 or > 50 years, body weight < 50 or > 100 kg, any anatomical abnormalities in the head and neck that affect the airway, any active chest or cardiac condition, or any gastric problems increasing incidence of regurgitation and aspiration.

Inclusion criteria include patient's age 20–50 years, body weight 50–100 kg, ASA I, II and AWS < 5 evaluated by Ganzouri AWSS. No anatomical abnormalities in the head and neck, No active chest or cardiac condition preventing safe general anesthesia, and no gastric problems that may increase the incidence of regurgitation and aspiration.

All patients included in the study were intubated using fiberoptic bronchoscope through the intubating AIR-Q. The size of the AIRQ was used according to body weight referred to manufacture's guidelines.

The patients were divided into 2 groups according to the body weight. Group 3.5 Includes patients with body weight 50–70 kg, and group 4.5 includes patients 70–100 kg body weight. In the pre-anesthetic room, the AWS was calculated for each patient according to Ganzouri AWSS described in Table 1.

An intravenous (IV) cannula was inserted in a peripheral vein, 1 mg atropine, and 2 mg midazolam were given IV 5 min prior to induction of general anesthesia. In the operating room, all standard monitors were connected to the patient including pulse oxymeter, electrocardiogram, and non-invasive blood pressure. 100% oxygen mask was given to patient by face mask. Anesthesia was started by IV Fentanyl 1 $\mu\text{g}/\text{kg}$, propofol 2 mg/kg, and atracurium 0.5 mg/kg. Mechanical ventilation was allowed for at least 3 min together with inhalation of isoflurane at 1 MAC. Adequate muscle relaxation was tested by peripheral nerve stimulator with Train Of Four (TOF) stimuli. When TOF ratio is 0; the proper size semi inflated AIR-Q was inserted by classical method, the cuff was inflated according the manufacture's recommendations.

Table 1 Ganzouri Airway Scoring System (AWSS).

Assessment	0 Points	1 Point	2 Points
Interincisor gap	> 4 cm	< 4 cm	Cannot open mouth
Mallampati classification	Class I	Class II	Class III
Head/neck movement	> 90°	= 90°	< 90°
Buck teeth	Can prognath or edentulous	Can approximate teeth only	Cannot approximate teeth
Thyromental distance	> 6.5 cm	6.0–6.5 cm	< 6.0 cm
Body weight	< 90 kg	90–110 kg	> 110 kg
History of difficult intubation	None	Questionable	Definite
Airway Score (AS) range 0–14	0	7	14

AS 0 – Proceed with routine management, AS 1–2 – Check fiberoptic scope availability, then proceed with routine management. AS 3–4 – Have standby fiberoptic scope in room, AS ≥ 5 – Awake intubation. Conditions invalidating the airway score: Cervical spine pathology, upper airway pathology, Craniofacial anomalies, gastro-oesophageal reflux (GERD).

The number of attempts of insertion was recorded until it became fit around the larynx without air leak. If the Air Q was not fitting in place, it was manipulated from the neck to put it in best position to allow adequate tidal volume 5–6 ml/kg, without air leak. The AIR-Q was then connected to the ventilator. The peak airway pressure was not allowed to increase more than 25 cm H₂O. The leak pressure was calculated by closing the expiratory valve, stopping ventilation and keeping the patient apneic, with the oxygen flow at 5 L/min. The gradual rise in the pressure gauge was observed until an audible noise was heard from the AIRQ due to release of pressure. This pressure point is recorded as the leak test pressure [8].

After adequate oxygenation, the patient was disconnected from the ventilator, then the fiberoptic bronchoscope (Storz 3.7 mm) loaded with the tube was inserted through the AIRQ to detect the laryngeal view grade that may ranged from 1 to 5 as follows; grade 1 = only larynx was seen, grade 2 = larynx plus the posterior surface of epiglottis were seen, grade

3 = larynx and anterior tip of epiglottis were seen with < 50% visual obstruction of larynx, grade 4 = epiglottis downfolded and its anterior surface were seen with > 50% visual field obstruction, and grade 5 = complete down folding of epiglottis and the larynx could not be seen directly [9,10] Figure 1.

After viewing the laryngeal grade, the bronchoscope was advanced into the trachea, followed by insertion of the endotracheal tube 3–5 cm away from carina. The bronchoscope was removed, the correct position of ETT was confirmed by exhaled CO₂ capnography, chest movement and auscultation.

The time of tracheal intubation was recorded from the insertion of bronchoscope through the AIRQ to reconnection of the AIRQ to circuit and appearance of capnogram's waveform. The number of attempts of endotracheal intubations was recorded. Then, the AIRQ and the tube's cuff were deflated and the device was removed over the removal stylet. The tube cuff was re-inflated and the tube was reconnected to the ventilator's circuit.

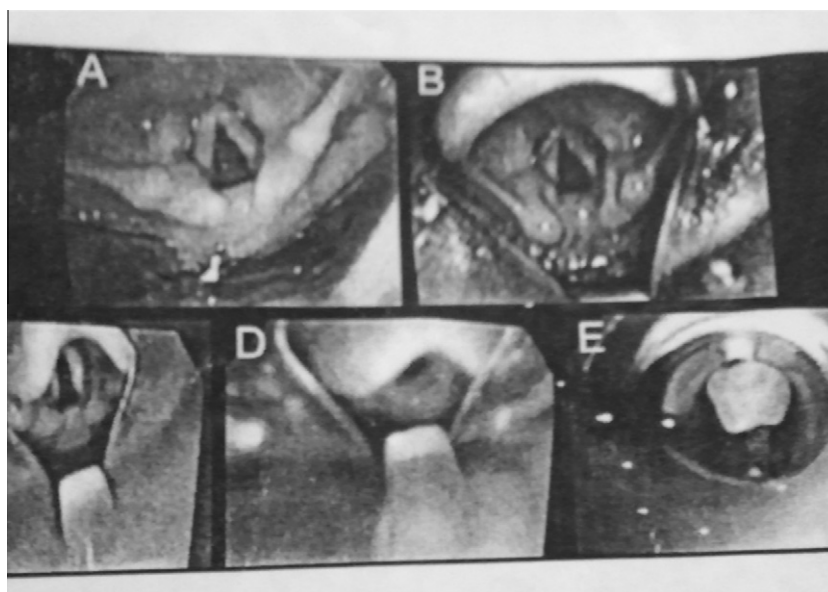


Figure 1 The laryngeal view grades are as such Grade 1: whole vocal cords are seen, the epiglottis is not seen at all. Grade 2: larynx plus the posterior surface of epiglottis are seen. Grade 3: the anterior tip of the epiglottis is seen. Grade 4: the anterior tip of the epiglottis is seen and encroaching on the view of vocal cords obstructing < 50% of view. Grade 5: the epiglottis is completely obstructing the AQ opening, no view is seen.

The time to removal of AIRQ is finally recorded from time of disconnection of the tube from the circuit to the time of reconnection again to the ventilator and capnogram after removal of the AIRQ. At the end of operation, the patients were extubated after complete recovery from muscle relaxant shown by TOF ratio 0.7. Any complications as blood streaked mucous, sore throat, laryngeal spasm, laryngeal oedema were recorded postoperatively.

4. Statistical data

Data were analyzed using the statistical software PASW statistics 19 (SPSS Inc., Chicago). Data is represented as Mean \pm SD. Statistical comparison between the groups using student *t* test for continuous data, χ^2 test for categorical data, and Mann Whitney *U* test for ordinal data, a spearman *p* correlation coefficient was calculated for the relationship between the patient's body weight and the fiberoptic laryngeal view grade. The Pearson correlation coefficient was calculated for the relationship between the patient's body weight and the time for intubation.

5. Results

Sixty patients ASA I, II were enrolled in the study. No one was excluded from it. We studied 22 females and 38 males with a mean age of 37.3 ± 12.2 years and mean body weight of 77 ± 12.5 kg. There was significant difference in the body weight within both groups ($p < 0.001$). The patients were divided into two equal groups according to body weight. The demographic and descriptive characteristics were included in Table 2

The airway score (AWS) was calculated for each patient. 21 patients had AWS 0 (35%), 7(11.7%) patients had AWS 1, 13(21.7%) patients had AWS 2, 10(16.7%) patients had AWS 3, 9(15%) patients had AWS 4 Table 1.

In the group 3.5, the AIRQ was inserted easily from the first time in all patients, while in 2 patients of group 4.5, there was some difficulties in insertion of the AIRQ that needed its reinsertion again until it became fit around the airway without any air leak, and this difference was significant between groups ($p < 0.001$).

For group 3.5 the mean leak pressure was 24 ± 2 cm H₂O, while that for group 4.5 was 24.2 ± 1.9 cm H₂O and this difference was non-significant.

The laryngeal view grades were as such:

- **Grade 1:** for group 3.5 22(73.3%) patients had grade 1 and 16(53.3%) patients in group 4.5.
- **Grade 2:** 4(13.3%) patients in each group.
- **Grade 3:** 2(6.7%) in group 3.5 and 3(10%) in group 4.5.
- **Grade 4:** 1(3.3%) patient in group 3.5, and 4(13.3%) patients in group 4.5.
- **Grade 5:** 1(3.3%) patient in group 3.5 and 3(10%) in group 4.5.

There was statistical and clinical significances between groups ($p < 0.01$)

The number of attempts of endotracheal intubation was recorded. At the beginning of the study, 2(6.7%) patients were

intubated from the second time in group 3.5. In group 4.5 all patients (100%) were intubated from the first time.

The time of intubation was recorded from the time of introduction of the fibroscope through the AIRQ to the appearance of ETCO₂ wave form after successful intubation. In group 3.5 the mean intubation time was 19.7 ± 3.8 s while for group 4.5 it was 22.2 ± 6.4 s and this difference was not statistically significant.

The time of removal of the AIR-Q was recorded from the time of attachment of the stylet to the tube till capnogram waveform reading after reconnection of the tube to the ventilator. For group 3.5 the mean time of removal was 21 ± 2.7 s and for group 4.5 was 20.3 ± 3 s and these findings were non-significant.

After removal of the AIR-Q, it was examined for blood stained mucous as a result of mucosal injury. Only one patient in group 4.5 (3.3%) showed blood stained mucous. However in both groups there were no other complications recorded.

By correlating the body weight of the patients to the laryngeal view grades; the study found that with increase body weight the incidence of high laryngeal view grade was also increased. This correlation was strongly significant ($p < 0.05$) Fig. 2.

After correlation of the body weight with the time of insertion of the endotracheal tube through the AIRQ into the trachea, it showed that the higher the body weight, the longer time for intubation of the patient. This correlation was statistically significant ($p < 0.01$) Fig. 3.

But clinically, this difference did not exceed few seconds and did not affect ventilation and oxygenation.

6. Discussion

The invention of AIRQ in the near last years had helped easy control of difficult airway together with increasing incidence of successful intubation. Many studies showed the efficiency of the device as ventilating as well as a conduit for endotracheal intubation. These studies also recorded any complications related to the use of the AIRQ [11]. The AIRQ allows the insertion of different tube sizes up to 8.5 mm ID comparing with classic LMA that allows maximally the insertion of 7 mm ID tubes. The supraglottic devices are now used in emergency medicine to secure airway [12].

After the induction of anesthesia and adequate muscle relaxation, the AIRQ 3.5 was easily inserted in all patients of the group from the first time compared with the group 4.5; the AIRQ was inserted from the second time in 2 patients of the group. The repeated trial of insertion was due to unfitting of the AIRQ on the laryngeal opening and inadequate ventilation of the patients. The difference was statistically and clinically significant among the groups [13–15].

The seal pressure values in the study are consistent with other studies on different supraglottic devices [16]. The fiberoptic bronchoscope was introduced to evaluate the laryngeal view grade followed by intubation of the patients. For group 3.5, grade 1 was recorded in 22 patients compared with 16 patients in group 4.5, while grade 5 was recorded in only 1(3.3%) patients of group 3.5 compared with 3(10%) patients in group 4.5.

The study found that in some patients, the greater the body weight, the higher the laryngeal view grade. By clinical

Table 2 Demographic and descriptive statistics.

	All patients (n = 60)	Group 3.5 (n = 30)	Group 4.5 (n = 30)	P value
Age (y)	37.3 ± 12.2	34.7 ± 13.7	39.8 ± 10	
Sex, f:m	22:38	14:16	8:22	
f n(%)	22(36.7%)	14(46.7%)	8(26.7%)	
m n(%)	38(63.3%)	16(53.3%)	22(73.3%)	
Weight (kg)	77 ± 12.5	67 ± 5.4	87.2 ± 8.5	(<0.01)*
AWS	1.65 ± 1.48	1.3 ± 1.4	1.9 ± 1.5	(0.01)*
0	21(35%)	13(43.3%)	8(26.7%)	
1	7(11.7%)	3(10%)	4(13%)	
2	13(21.7%)	8(26.7%)	5(16.7%)	
3	10(16.7%)	3(10%)	7(23.3%)	
4	9(15%)	3(10%)	6(20%)	
AIR Q attempts	1 ± 0.2	1 ± 0	1.07 ± 0.2	
1st	58(93.3%)	30(100%)	28(93.3%)	
2nd	2(6.7%)	0(0%)	2(6.7%)	
Leak pre cm H ₂ O	24.3 ± 1.8	24.2 ± 2	24.4 ± 1.8	
Laryngeal v. grade	1.8 ± 1.3	1.5 ± 1	2.13 ± 1.4	(<0.01)*
Grade 1	38(63.3%)	22(73.3%)	16(53.3%)	
Grade 2	8(13.3%)	4(13.3%)	4(13.3%)	
Grade 3	5(8.3%)	2(6.7%)	3(10%)	
Grade 4	5(8.3%)	1(3.3%)	4(13.3%)	
Grade 5	4(6.7%)	1(3.3%)	3(10%)	
ETT Atmp				
1st	58(96.7%)	28(93.3%)	30(100%)	
2nd	2(3.3%)	2(6.7%)	0(0%)	
ETT insertime (s)	20.1 ± 5.4	19.7 ± 3.8	22.2 ± 6.4	
AIRQ rmv time (s)	20.7 ± 3	21 ± 2.7	20.3 ± 3	
Complications	1/60	0/30	1/30	
Laryngospasm				
Laryngeal oedema				
Blood stained mucous	1(3.3%)	0	1(3.3%)	
Aspiration				
Hypoxemia				

Data are presented as mean ± SD. Frequencies are presented as number (%). $P < 0.05$ is considered significant v: view, atmp: attempt, inser: insertion, rmv: removal, S: seconds, pre: pressure, y: years, n: number.

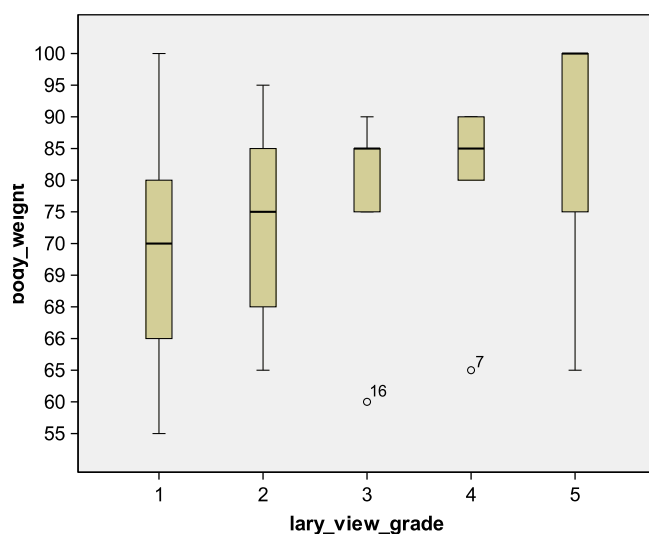


Figure 2 Correlation between laryngeal grade (lary_view_grade) and body weight (body_weight in kg). The more the body weight, the higher the laryngeal view grade ($P < 0.05$).

practice, the AIRQ 4.5 does not fit properly in a small percentage of patients compared to AIRQ 3.5 and this needs more manipulation to improve laryngeal view for intubation. The increased incidence of higher laryngeal view grades in obese patients is also consistent with the increased incidence of the long epiglottis, snoring and sleep apnea syndrome with obesity [17–21].

Also by correlating the body weight to the time of intubation we found that with increasing body weight the time of endotracheal intubation is also increased. This finding may be secondary to the higher laryngeal view grade.

The study showed that the leak pressure in all patients was 24 ± 1.7 cm H₂O which is also consistent with previous studies [22,23]. All patients were easily and properly ventilated after insertion of the AIRQ, which was confirmed with ETCO₂ waveform, chest expansion, chest auscultation and the absence of air leak from the mouth opening.

The insertion of the AIRQ 3.5 is easier than 4.5. This may be due to the large cup of the AIRQ 4.5. Our study showed that the time of insertion of the tube is increased with increasing body weight, and this may be explained by the increased incidence of higher laryngeal grade, manipulation to improve the view grade and the more time needed to bypass and “dive”

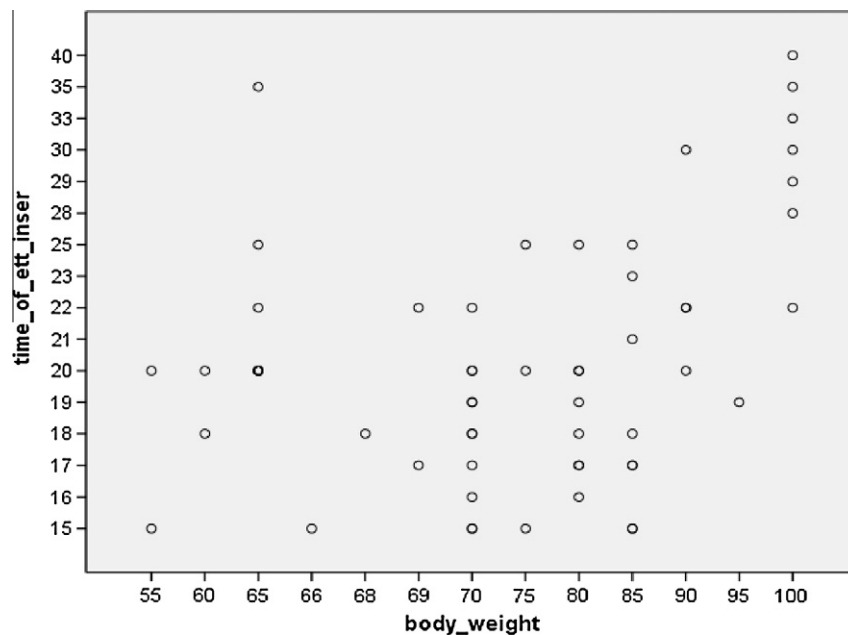


Figure 3 Correlation between body weight (in kg) and insertion time (s). The more the body weight, the more time for intubation ($P < 0.001$).

under the epiglottis to find the way to the larynx. However no previous studies have been done to oppose or support our findings, so we recommend further studies. We succeeded to intubate all patients without any desaturation or hypoxemia. From our results, the longest time till intubation is within the accepted range of apnea time and without recording any case of desaturation [10].

In contrast to this study, a previous study showed desaturation during endotracheal intubation through supraglottic devices in 6 of 34 cases [23].

Our study recorded the number of attempts of intubation. At the beginning of the study, 2(6.7%) patients were intubated from the second time in group 3.5. This was due to inability to slide the tube through AIR-Q secondary to dryness of lubricating gel. So k-y gel “Jhonson and Jhonson” was used instead, producing better lubrication of the AIR-Q and the tube, and allowing easy sliding of the ETT through the AIRQ. However for group 4.5 all patients (100%) were intubated from the first time. This may be secondary to its wider internal diameter in relation to the used 7.5 mm ID ETT.

Similar study has been done on pediatrics and found that the higher laryngeal view grade was found in younger children with lower body weight. This finding was explained by the different anatomical considerations in children from adults [10].

From our study we concluded that there is a proportional relationship between the body weight, laryngeal view grade and time of endotracheal intubation.

The time of removal of the AIRQ over the stylet is (20.7 ± 3) s. During this period, the patients were apneic, but no case showed desaturation. The removal of the AIRQ may result in dislodgement of the tube with it. In the present study, this complication was not recorded [24].

After removal of the AIRQ, it was examined for any blood streaked secretions that may be present due to rough manipulation or injury to the oral mucosa. Only one patient of group 4.5 has blood streaked mucous over the removed AIR-Q.

These findings were consistent with previous studies on different supraglottic devices [25].

Post operatively, there were no other complications recorded in both groups, and this was consistent with previous researches [26]. This can be explained by the amount of air injected in the AIR-Q cuff (15–20 ml) max compared with the classic LMA that may reach up to 40 ml and may result in oedema of the airway, ischemia to the mucosa, or laryngospasm [11,25]. On the contrary, another study showed the occurrence of coughing, laryngospasm, and bronchospasm secondary to airway activation, sore throat, and blood staining on removal of the device. These complications were present in only 4% of cases separately [23,27].

7. Conclusion and recommendations

1. The AIRQ 4.5 has a larger and wider cup, making its insertion little bit difficult and more traumatic compared to AIR-Q 3.5.
2. Not only the body weight that may determine the size of the AIRQ, but also the oral cavity's inner volume. Some obese patients may have a small oral cavity making it difficult to properly insert the AIRQ 4.5.
3. The international connector becomes loose after certain time of use. It must be tighter (recommendations to the manufacturer).
4. Improving the laryngeal view grades through the AIRQ may be done by different manipulations as cricoid pressure, right or left device rotation, slightly inwards and outwards movement to optimize the laryngeal view grade and improve ventilation.
5. The AIRQ is easy to use, whether as a supraglottic ventilating device to secure airway or as a conduit for intubation through it.

6. In obese patients, the best supraglottic device to ventilate them is the AIRQ as it ventilates the patients through the auxiliary hole present above the keyhole opening even with complete occlusion of the keyhole opening by the down folded epiglottis.
7. In laryngeal view grade > 3 it is not advised to blindly intubate the patients as it may result in trauma to the airway but it is better to intubate the trachea under direct vision using fiberoptic bronchoscope, however blind intubation is not included in our research and further studies are recommended.
8. Adequate lubrication of the tube and AIRQ prior to use preferably by k-y gel *Jhonson and Jhonson or lidocaine gel*.

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