Original Article

Comparison of Airtraq DL™ and Macintosh laryngoscope for double-lumen tube placement in simulated difficult airway: A randomised study

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Submitted: 02-Feb-2022
Revised: 15-Mar-2022
Accepted: 05-Jun-2022
Published: 21-Jun-2022

Access this article online

Website: www.ijaweb.org

DOI: 10.4103/ija.ija_119_22

Quick response code

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ABSTRACT

Background and Aims: The Airtraq DL™ is a prototype channeled video laryngoscope, designed specifically for endobronchial intubation with a double-lumen tube (DLT). Evidence on its superiority over Macintosh laryngoscope for DLT placement in the difficult airway is limited. This study compared the efficacy of both these laryngoscopes in the simulated difficult airway. **Methods:** A prospective randomised controlled study was conducted on 52 patients undergoing elective thoracic surgery with lung isolation using a left-sided DLT. The patients were randomised into Airtraq DL™ group (group A) and Macintosh group (group M). The primary objective was to compare the time required for intubation, and the secondary objectives were to evaluate time to best glottic view, Cormack–Lehane (CL) grading, intubation difficulty score (IDS), manoeuvres, attempts at intubation, haemodynamic response and complications. Operating anaesthesiologists were also asked to grade the ease of laryngoscopy and intubation for both devices on a 4-point Likert scale. **Results:** The mean time to intubation was found to be lesser in group A than in group M (18 ± 6.91 s vs 25.48 ± 9.47 s, $P = 0.003$). Group A showed better CL grading ($P \leq 0.001$), lesser requirement of manoeuvres ($P = 0.02$) and lower IDS ($P = 0.003$). Also, group A had significantly better Likert scale results as compared to group M. **Conclusion**: The Airtraq DL™ is superior to Macintosh laryngoscope as it requires lesser time for intubation and provides favourable intubating conditions (better CL grading, lesser manoeuvres, lower IDS and improved Likert scales) for double-lumen placement in the simulated difficult airway.

Key words: Airway management, laryngoscope, one-lung ventilation, simulation

INTRODUCTION

Thoracic surgeries often require one-lung ventilation (OLV) to achieve a quiet surgical field. Of all the available options for achieving OLV, the double-lumen tube (DLT) is the most popular and commonly used. The large size and complex structure of DLT make its insertion technically more difficult than the single lumen tube. The difficult airway may further add to the woes of the anaesthesiologist during DLT intubation. The efficacy of video laryngoscopes (VLs) with a single lumen tube in difficult intubation is well established and is often advocated.[1] However, evidence of the success of VL (both channeled and non-channeled) in DLT intubation is limited. The Airtraq DL™ (Prodol Meditec S.A, Vizcaya, Spain) is a prototype channeled VL specifically designed for DLT insertion. Its inbuilt channel can accommodate DLTs of sizes between28 and 41 French [Figure 1]. The specially designed curvature of this device enables the alignment of the glottic axis with the DLT in spite of the latter's preformed shape. Moreover, the design of the Airtraq DL™ obviates the need for the use of stylet

How to cite this article: Mounika K, Kar P, Padhy S, Pathy A, Durga P. Comparison of Airtraq DL™ and Macintosh laryngoscope for double-lumen tube placement in the simulated difficult airway: A randomised study. Indian J Anaesth 2022;66:442-8.

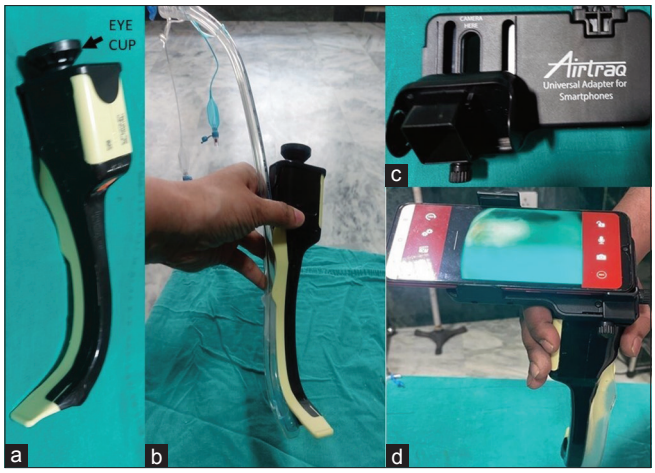

Figure 1: Airtraq DLTM (a) Airtraq DLTM with eye cup, (b) Airtraq DLTM with preloaded double lumen tube, (c) universal adaptor for smart phones. (d) Airtraq, universal adaptor and smart phone assembly

with DLT resulting in smooth manoeuvrability during advancement inside the Airtraq channel. This study compared the efficacy of the Airtraq DL™ and Macintosh laryngoscopes for DLT placement in a simulated difficult airway with the use of a Philadelphia neck collar. We hypothesised that Airtraq DL™ would require lesser time to intubation and provide a better glottic view, lower intubation difficulty score (IDS), ease of laryngoscopy and intubation, lesser haemodynamic response and fewer complications.

METHODS

This prospective randomised controlled study was conducted in a tertiary teaching hospital between November 2020 and March 2021 on 52 consenting American Society of Anesthesiologists (ASA) I and II patients of either gender. Institutional ethics committee approval (EC/NIMS/2439/2019) in accordance with the Declaration of Helsinki and Clinical Trial Registry of India (CTRI) registration (CTRI/2020/11/028984) was obtained before the initiation of the study. Patients scheduled for elective thoracic surgery under general anaesthesia, requiring lung isolation with left-sided DLT placement were recruited in the study. Demographic data (height, weight, gender) and clinical airway data such as inter-incisor distance (IID), mentohyoid distance (MHD), thyromental distance (TMD), sternomental distance (SMD), and Mallampati grading (MPG) were recorded preoperatively. Patients having bleeding disorders, actively secreting adrenal tumours, body mass index >30 and anticipated difficult airways were excluded from the study. The patients were also excluded from the study if the study team was not available on the day of surgery or if the surgical plan was changed or if surgery was deferred.

The recruited patients received routine preoperative premedication and followed standard fasting orders. After shifting the patients to the operating room, ASA standard monitoring and entropy were connected, and intravenous access was secured. An arterial line was placed prior to induction, and baseline mean arterial pressure (MAP), heart rate (HR) and peripheral oxygen saturation values were noted. Epidural space was identified in T4–5/T5–6 interspace using an 18-gauge Tuohy needle with the loss of resistance to air technique, and a catheter was inserted. A test dose of 3 mL of 2% lignocaine was given to rule out intrathecal/intravenous placement.

The patients were made to lie down in a supine position with the neck placed neutrally using a pad under the occiput. Tynor Philadelphia rigid cervical collar of appropriate size (available in S, M, L, XL sizes) was applied to simulate a difficult airway. The patients were excluded from the study if their IID was <2 cm after collar application (as Airtraq DL™ requires an IID of a minimum of 19 mm for its insertion).

The patients were preoxygenated with 100% oxygen for 3 min and premedicated with intravenous fentanyl 2 μg/kg. Induction was achieved with a graded dose of propofol to attain an entropy of 40–60. After confirming the ability to ventilate, an injection of rocuronium 1 mg/kg was administered to facilitate intubation. At this point, the sealed envelope containing the group allocation as per computer-generated randomisation chart was opened, and the allocated laryngoscope was kept ready. In the case of group A (Airtraq DL™ group), the stylet of DLT was removed, and the DLT was preloaded into the integrated channel of an Airtraq DL™ as per manufacturer instructions. A universal phone adaptor for smartphones® (Prodol Meditec, Vizcaya, Spain) was attached to the Airtraq DL™ after removing the eye cup. A smartphone enabled with Airtraq mobile app was then attached to the adaptor [Figure 1]. Glottic visualisation was done during intubation using the above assembly. In group M, a Macintosh laryngoscope was used for intubation under direct vision using DLT with stylet *in situ*. The decision on the size of DLT to be used was at the discretion of the attending anaesthesiologist. The size of DLT used was noted.

The intubations were performed by anaesthesiologists who had an experience of at least 8 years in thoracic

anaesthesia and who had performed at least 20 DLT intubations with an Airtraq DL™ prior to the study. During laryngoscopy, Cormack Lehane (CL) grade and time to best glottic view were noted. This was defined as the time from passage of the designated laryngoscope's blade between the incisors to achieve the best view of the vocal cords. In group A, after visualisation of the glottis, the DLT was negotiated into the glottic opening and advanced without any further rotation. For the Macintosh laryngoscope, the DLT was rotated 90° to the left after the bronchial cuff entered the glottis and was advanced further. The advancement of DLT was stopped in both groups when the pre-decided length of the tube reached the angle of mouth. This was decided based on the height-based formula [(height in cm/10) + 12] being approximated to the nearest whole number. After tracheal cuff inflation and connection of the circuit, the end-tidal carbon dioxide ($EtCO_2$) curve was checked. Total time for intubation was defined as the time from the beginning of laryngoscopy till the appearance of the first deflection in $EtCO_2$ trace. Later, the bronchial cuff was inflated, and the adequacy of isolation was checked by auscultation and fibreoptic bronchoscopy (FOB). Minor adjustments in the form of slight pulling or pushing of the tube (<1 cm) were done if required. If a patient could not be intubated or isolation could not be achieved (with <1 cm adjustment), the DLT was removed, and reintubation was attempted with the same allocated laryngoscope. It was considered a failure after three unsuccessful attempts. These patients were excluded from the final analysis, but the numbers of failures were noted in each group. If failure to intubate or achieve isolation was encountered, the Philadelphia collar was removed, and routine intubation practice was followed along with FOB-guided confirmation of DLT position. Other parameters such as the number of attempts, manoeuvres required and IDS were noted. The haemodynamic response to intubation (MAP and HR) at 1, 2 and 5 min after intubation were recorded. Complications like oropharyngeal trauma, cuff rupture and desaturation were also noted. The patients were followed up for the incidence of postoperative hoarseness. The patients with serious airway trauma or continuous bleeding interfering with the vision even after suctioning, significant haemodynamic instability requiring the initiation of vasopressors or vasodilators, desaturation <90% not improving with ventilation with 100% oxygen were also excluded from the analysis. After the intubation, the operating anaesthesiologists were asked to grade the ease of laryngoscopy and intubation on a 4-point Likert scale (very easy/easy/difficult/very difficult)

The sample size was determined (using free online software G power) based on our pilot study of 10 patients, where the time to intubation was 18 ± 5.4 s and 24.5 ± 6.3 s in the Airtraq and Macintosh groups, respectively. With an alpha error of 5% and power of 95%, a sample size of 23 in each group was required to detect a time difference of 6.5 s between the two groups for intubation. However, a total of 52 patients (26 in each group) were recruited to account for possible exclusions. The statistical analysis was done using Statistical Package for Social Sciences software version 20 (2011, International Business Machines, Armonk, United States of America). Continuous variables were expressed as mean and standard deviation. Categorical variables were expressed as frequency and percentage. Unpaired Student's t-test was applied to compare continuous variables between the two groups. Analysis of variance (ANOVA) of repeated measures with post-hoc analysis using the Tukey test was done to compare haemodynamic variables within the group. Categorical variables were analysed using Chi-square test when the expected number in any cell of the contingency table was >5. If not, Fisher's exact t-test was applied. A two-tailed *P* value of <0.05 was considered significant.

RESULTS

Out of the 52 recruited patients, 1 in each group was excluded. Thus, 50 patients were included in the final analysis [Figure 2]. The demographic variables and airway parameters were comparable in both groups [Table 1]. The mean time to intubation was shorter in group A than in group M. However, the time

Table 1: Demographic and airway parameters

Parameter	Group A (Mean±S. D)	Group M (Mean±S. D)	*P*
Age (years)	38.28±12.23	44.48±13.42	0.09
Gender (Male/female)	17/8	13/12	0.24
Height (in cm)	164.64±7.64	160.24±9.95	0.08
Weight (in kg)	57.36±12.81	55.64±10.61	0.60
IID (in cm)	5.08±0.68	4.88±0.67	0.40
MHD (in cm)	5.46±0.76	5.12±0.84	0.16
TMD (in cm)	8.56±1.42	8.64±1.59	0.85
SMD (in cm)	14.3±1.58	14.24±1.98	0.82
MP Grade (I/II)	15/10	17/8	0.55

IID- Inter incisor distance, MHD- Mentohyoid distance, TMD- Thyromental distance, SMD- Sternomental distance, MP grade- Mallampati grade. Group A- Airtraq DL™ Group, Group M- MacIntosh Group. S. D - Standard Deviation

to best glottic view was not statistically different in both the groups. The other intubation parameters (CL grade, IDS and manoeuvres required) were also significantly different in both groups and were suggestive of better intubating conditions in group A [Table 2]. Both the groups did not differ in the number of attempts required to intubate. However, in the Airtraq DL™ group, lesser number of second attempts were observed. The size of DLT used ranged between 28 and 37 French. There was no statistical difference between the sizes of the tubes used in the two groups ($P = 0.516$). The 4-point Likert scale showed that group A was statistically better than group M both for the ease of laryngoscopy and ease of intubation (*P*-value 0.03 and 0.018 for laryngoscopy and intubation, respectively) [Figure 3]. The MAP and HR in both the groups were comparable at the baseline and at 1, 2 and 5 min after intubation [Table 3]. Although the MAP and HR increased at 1, 2 and 5 minutes from the baseline, the change was not of statistical significance. Only three patients had oropharyngeal trauma in the entire study (one in group A and two in group M). A case of cuff rupture was encountered in group A after the first failed attempt. The DLT was changed for the second attempt, and successful intubation was done. The complications were comparable in both groups. Six cases complained of sore throat in the post-operative period (four in the Airtraq group and two in the Macintosh group). The incidences of complications in both groups were not different statistically. There was no incidence of desaturation in the study.

Table 2: Intubation parameters

Parameter	Group A	Group M	*P*
Continuous Variables			
Expressed as (Mean±S.D)			
Time to Best glottic view (seconds)	7.08±4.41	9.5±4.34	0.06
Total time to Intubation (seconds)	18±6.92	25.48±9.47	0.003
Categorical Variables			
Expressed as Number of patients			
CL grade			
1	23	7	0.001
2	2	16	
3	0	2	
Attempts			
1	23	17	0.07
2	2	8	
3	0	0	
Manoeuvres required (no/yes)	20/5	11/14	0.02
IDS			
0-1	22	12	0.003
2-3	3	10	
≥4	0	3	

CL- Cormack Lehane, IDS- Intubation difficulty score. Group A- Airtraq DL™ Group, Group M- MacIntosh Group. S.D- standard deviation

DISCUSSION

The present study suggests that the Airtraq DL™ requires a shorter time to intubation and provides better intubating conditions as compared to the conventional Macintosh laryngoscope during

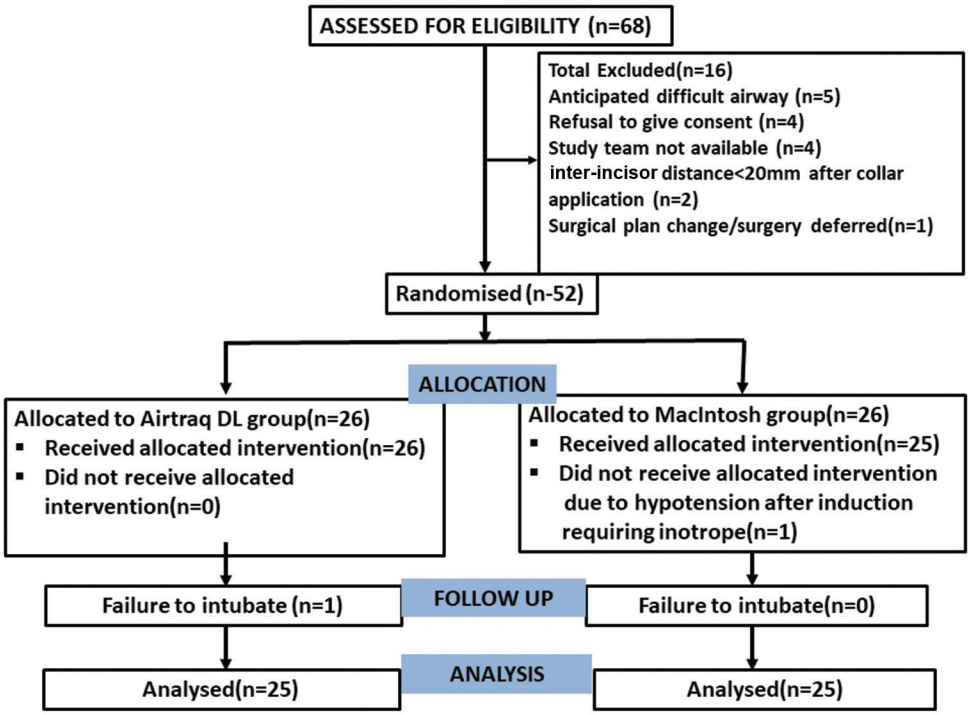

Figure 2: Consolidated Standards of Reporting Trial(CONSORT)flow chart for patient recruitment

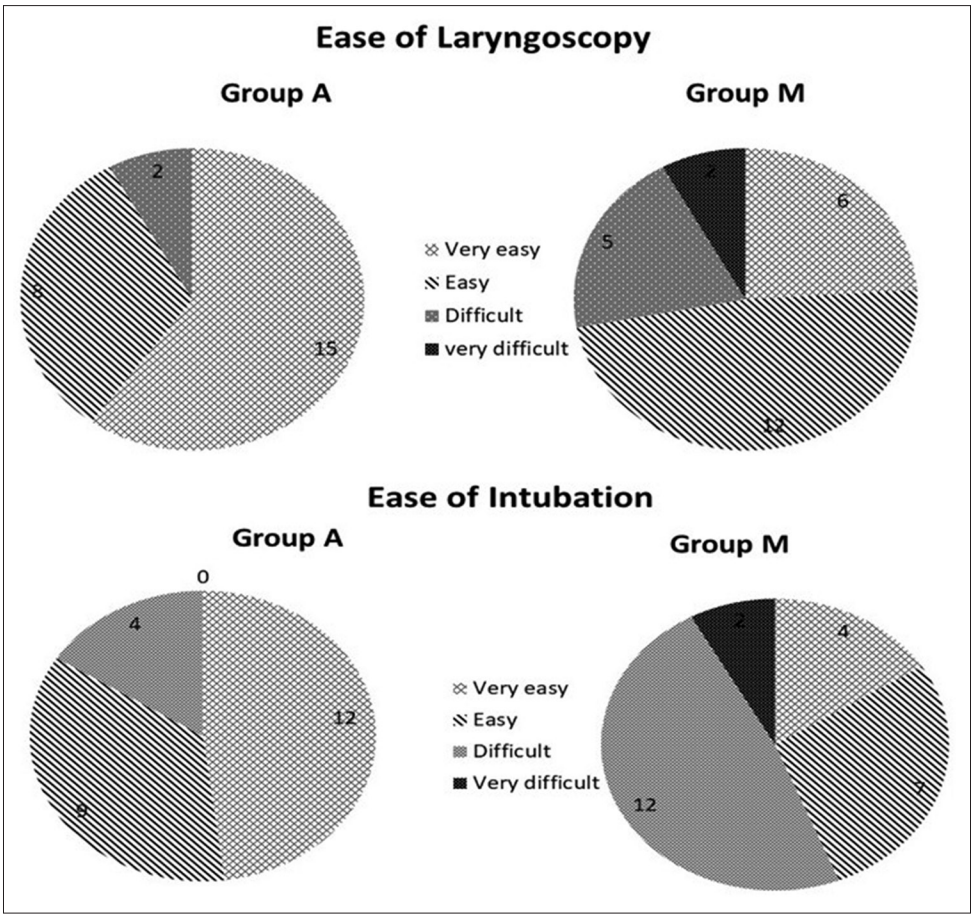

Figure 3: Likert scale for ease of laryngoscopy and intubation

Table 3: Haemodynamic response to intubation

Parameters	Group A (Mean±S.D)	Group M (Mean±S.D)	*P*
MAP (T0) (mm Hg)	92.20±20.86	96.32±16.01	0.43
MAP (T1) (mm Hg)	101.60±16.71	105.60±20.66	0.45
MAP (T2) (mm Hg)	100.92±17.83	99.12±18.45	0.72
MAP (T5) (mm Hg)	102.16±17.01	100.60±21.34	0.77
HR (T0)	97.12±18.34	95.04±15.86	0.67
HR (T1)	98.20±12.31	96±15.74	0.58
HR (T2)	99.12±16.16	96.44±14.60	0.54
HR (T5)	98.76±15.86	97.20±14.07	0.7

T0- baseline, T1-1 min after intubation, T2-2 min after intubation, T5-5 minu after intubation. MAP- mean arterial pressure, HR- heart rate. Group A- Airtraq DL™ Group, Group M- MacIntosh Group. S.D- standard deviation

left-sided DLT placement in the simulated difficult airway.

Tracheal intubation consists of three critical sequential steps. These include achieving an optimal glottic view, delivering the tip of the tube to the glottis and the advancement of the tube.[2] The procedure is more challenging during the placement of DLT because of its large external diameter, peculiar shape and more rigid configuration. Difficult airway further adds to the glitches during DLT use. The recent ASA guidelines for the management of the difficult airway suggest the use of VLs as a choice for tracheal intubation in patients with predicted and unpredicted difficult airways.[1] In the survey by Shruthi A *et al*.[3] on the role of VLs in the difficult airway, VL was voted as the first choice in the unanticipated difficult airway. The VLs have an advantage as they do not require aligning airway axes (oral-pharyngeal-laryngeal) for optimal glottic visualisation. The role of non-channeled VLs in DLT placement has been studied more extensively than channeled VLs.[4,5] As per our knowledge, there are no previous studies comparing the efficacy of Airtraq DL™ and Macintosh laryngoscopes for DLT placement in human subjects with simulated difficult airways (with Philadelphia cervical collar). The only similar study on Airtraq DL™ in the simulated difficult airway was conducted by El Tahan and colleagues in a randomised, controlled, crossover mannequin study using prone head rest and adhesive head tape for difficult airway simulation.[6]

Airtraq DL™ offers various options for the visualisation of glottic view, which include a direct view through

the eyepiece, a video system, a universal smartphone adaptor and an endocam connection. The new universal smartphone adaptor used in conjunction with Airtraq is cheap, efficient and easy to use and is thus gaining popularity. Ajimi *et al*.[7] reported smooth and successful DLT intubation with the use of a combination of an Airtraq DL™ and a smartphone adaptor in a patient with a difficult airway. A mannequin study conducted by the same authors also concluded that the use of a universal smartphone adaptor with Airtraq DL™ significantly reduced intubation time.[8] In the present study, we also found the universal phone adaptor useful in improving the vision and convenience during the procedure.

The average time to intubation of DLT using Airtraq DL™ varies between 20.1 and 81 s across various studies.[6,9-12] This variation could be due to differences in definitions used for time to intubation or different inclusion criteria for the study sample (predicted easy airway, predicted difficult airway, or simulated difficult airway). In the present study, CL Grade 1 was visualised in 92% of the patients in the Airtraq DL™ group as compared to 68% in the Macintosh group. Other investigators also reported a higher incidence of CL grade 1 visualisation with Airtraq DL™ (86%–100%).[9,11-13] Better laryngoscopic view due to universal phone adaptor, improved CL grade and prior training of the operators might explain the shorter intubation time of the Airtraq group in the present study. Our study had a first attempt success rate of 92% in the Airtraq group similar to previous studies.[6,9,12,14]

The intubation difficulty scale was proposed by Adnet *et al*. in 1997.[15] Although it remains controversial whether the IDS is suitable for the evaluation of VLs, many authors have used IDS for grading the difficulty of intubation with various VLs.[16,17] In the present study, lower IDSs were noticed in the Airtraq DL™ group.

Apart from the use of quantitative objective scores, subjective assessment of ease of laryngoscopy and intubation was also done by interviewing the operators on a 4-point Likert scale. The operators seemed to find laryngoscopy and intubation easier with Airtraq in a simulated difficult airway. El-Tahan and colleagues compared four laryngoscopes and found Airtraq to be the easiest to manipulate with a mean score of 1.1 on a 5-point Likert scale.[14] DLT insertion per se is more likely to be associated with a higher incidence of sore throat, hoarseness and trauma due to its larger size. Furthermore, Airtraq for DLT is larger than the Airtraq for a conventional endotracheal tube. This may be the reason for the high incidence (16%) of sore throat in the Airtraq group in our study. Previous studies report a sore throat incidence of between 17% and 24%.[9,10,12] Only one out of 25 patients in the Airtraq group had trauma in our study. An incidence of 27% and 37.7% has been reported by Wasem *et al*.[9] and El-Tahan *et al*.,[14] respectively.

In the present study, both the groups recorded an increase in MAP and HR from the baseline after intubation, which is a normal laryngoscopy and intubation response. Similar results were reported by Hamp *et al*.[18]

Our study has several limitations. First, these two laryngoscopes are completely different in terms of shape and size. Thus, it was impossible to blind the investigator in this study. The use of a solo operator versus multiple operators always poses a dilemma. Our study had two operators for intubation, thus introducing some bias. Airtraq DL™ requires a minimum of 19 mm mouth opening for its insertion. Thus, the results of the study do not apply to patients with severe restrictions in mouth opening.

CONCLUSION

The Airtraq DL™ is superior to the Macintosh laryngoscope for DLT insertion in the simulated difficult airway as it requires lesser time for intubation and provides favourable conditions for intubation.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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