Original Article

A comparative evaluation of Airtraq and Hansraj Video laryngoscopes in patients undergoing tracheal intubation with cervical spine immobilization - A randomized prospective study

Poojangi Varshney, Syed M. Ahmed, Obaid A. Siddiqui, Abu Nadeem, Ajmal PM

Dr Poojangi Varshney: Senior Resident, GTB, New Delhi Syed M. Ahmed: Professor in the Department of Anesthesiology JNMCH, AMU. Abu Nadeem: Associate Prof in the Department of Anesthesiology JNMCH, AMU. Obaid A. Siddiqui: Associate Prof in the Department of Anesthesiology JNMCH, AMU Ajmal PM: Assistant Professor GMC, Palakkad, Kerala

Abstract

Background and Aims: Airway management is a key concern in trauma patients with cervical spine fracture. Application of manual inline axial stabilization (MIAS) has become the standard of care in these patients. Indirect laryngoscopy only requires alignment of the pharyngeal and laryngeal axis. Hence the primary objective of the study was to compare two indirect laryngoscopes, Airtraq (with adaptor) and Hansraj Video laryngoscopes based on its Intubation Difficulty Score.

Material and Methods: Sixty anesthetized patients were divided into two groups using computer-based randomization, and tracheal intubation was performed using either Airtraq or Hansraj Videolaryngoscope with cervical spine immobilization.

Results: Both Airtraq and Hansraj groups were comparable in terms of percentage of glottic opening (POGO) scoring (92 ± 9.88% vs. 89.3 ± 10.4%.) and duration of intubation attempt (14.9 ± 4.36 sec vs. 16.97 ± 3.64 sec). Intubation difficulty scale (IDS) score was significantly shorter with Airtraq (1 ± 0.58 vs. 1.8 ± 0.805; $P < 0.0001$). The mean duration of time taken for laryngoscopy in Airtraq (12.9 ± 2.07 s vs. 19.06 ± 3.83 s; $P < 0.0001$)) was significantly shorter and also the duration of time taken to secure airway in Airtraq VL was significantly shorter (29.47 ± 4.75 s vs. 36.03 ± 5.80 sec; $P < 0.0001$). The heart rate and MABP changes were modest in both groups, but was significantly more in Hansraj VL as compared to Airtraq VL, post-intubation.

Conclusion: Both Airtraq and Hansraj videolaryngoscope can be used as first-hand device in the scenario of cervical spine stabilization. Airtraq videolaryngoscope is better than Hansraj videolaryngoscope due to shorter IDS and lessor hemodynamic changes.

Keywords: Airtraq, Hansraj videolaryngoscope, tracheal intubation

Introduction

Airway management is a key concern in trauma patients with cervical spine fracture. Application of manual inline axial stabilization (MIAS) has become the standard of care in these patients in order to reduce the risk of cord injury during tracheal intubation.[1] This can result in failure to successfully intubate the trachea and secure the airway, a complication that remains the leading cause of morbidity and mortality, in the operative and emergency settings, despite advances in airway management.[2] Almost 30% of the anesthesia-related deaths are induced by the complications of difficult airway management and more than 85% of all respiratory-related complications cause brain injury or death.[3] In recent years, indirect laryngoscopes have gained in popularity.

Address for correspondence: Dr. Abu Nadeem,
Associate Professor, Department of Anesthesiology, JNMCH, AMU.
E-mail: drabunadeem@gmail.com

Access this article online	
Quick Response Code:	Website: www.joacp.org
	DOI: 10.4103/joacp.JOACP_327_19

How to cite this article: Varshney P, Ahmed SM, Siddiqui OA, Nadeem A, Ajmal PM. A comparative evaluation of Airtraq and Hansraj Video laryngoscopes in patients undergoing tracheal intubation with cervical spine immobilization - A randomized prospective study. J Anaesthesiol Clin Pharmacol 2021;37:336-41.
Submitted: 04-Oct-2019 **Revised:** 23-Mar-2021
Accepted: 10-Apr-2021 **Published:** 12-Oct-2021

Tracheal intubation using a direct laryngoscope requires alignment of oral, pharyngeal, and laryngeal axis for visualization of the glottis and is a technical skill that is difficult to acquire in patients with MIAS[4-6] and in patients with restricted neck flexion extension. In contrast, indirect laryngoscopes only require alignment of the pharyngeal and laryngeal axis, which lie along much more similar angles when compared with the oral axis. This may make tracheal intubation easier to accomplish in these patients. It is a significant challenge even to the most experienced anesthesiologist to intubate patients in whom the movement of the cervical spine is not desirable or restricted. A number of studies have been conducted with different video laryngoscopes (VL) to determine their utility in unstable or limited mobility cervical spines. The results have been variable but promising.[7] Airtraq VL is an optical device with an exaggerated blade curvature, an internal arrangement of optical lenses and a mechanism to prevent fogging of the distal lens, when used along with adaptor that fits most Smartphones, allows real-time imaging of the glottis.

Hansraj VL is a new portable VL The image can be seen on the screen of the device. It is ergonomically designed to avoid the intubation injury caused to laryngeal structure enabling the clinicians to improve the success of tracheal intubation.

We therefore hypothesized that Hansraj VL reduces intubation difficulty in comparison with Airtraq VL

The primary objective was to determine the relative efficacy of the Hansraj VL in comparison to Airtraq VL based on Intubation Difficulty Score (IDS) in patients undergoing tracheal intubation with cervical spine immobilization.

Secondary objectives were to assess the incidence of postoperative blood staining on endotracheal tube, and the effect of laryngoscopy and intubation on mean arterial pressure (MAP) and heart rate in between the two groups.

Material and Methods

After obtaining approval from the board of Studies of the department, ethical clearance from the institutional ethical committee (certificate uploaded separately) and written informed consent from the patients, 60 patients undergoing elective surgery under general anesthesia requiring endotracheal intubation were enrolled in this study over a period of 2 years. The trial was registered with Clinical Trials Registry India (CTRI/2019/01/017042). Learning curve on each equipment was achieved by doing intubation 20 different times on manikin and in 10 different patients. The person intubating the patients was same in all the cases to eliminate observer bias.

Inclusion criteria were American Society of Anesthesiologists grade I and II, 20–50 years of age of both sex, body mass index ≤30, and Mallampati Class 1 and 2. Exclusion criteria included presence of any of the mentioned predictors of difficult intubation like decreased inter-incisor distance (<3 cm), short thyromental distance (<6 cm), any facial anomaly, fixed flexion deformity, patient at risk of pulmonary aspiration

Patients were randomly divided into two groups. Randomization was done using a computer-based random number generator and the allocation concealed in sealed envelopes, which was not opened until patient consent was obtained.

Patients' demographic characteristics were recorded. Mallampati class, neck movements, and mouth opening were also recorded.

All patients in both the groups were uniformly pre-medicated as per the institutional protocol i.e., with inj. midazolam 0.03 mg/kg IV, ondansetron 0.10 mg/kg IV and fentanyl 1 μg/kg IV. In the operating room, patients were monitored with ECG, pulse rate, SpO_2, NIBP, and $EtCO_2$ through the multichannel monitor (Nihon Kohden). The baseline ECG, pulse rate, SpO_2, NIBP was recorded before induction of anesthesia. After preoxygenation, anesthesia was induced with inj. propofol (2-2.5 mg/kg). neuromuscular blockade was achieved with inj. vecuronium 0.08- 0.12 mg/kg. After the onset of neuromuscular block, the neck was immobilized using MIAS, which was applied by an experienced anesthetist holding both the sides of the neck and the mastoid processes, preventing extension/flexion or rotational movements of the neck.[8] Two-handed jaw thrust maneuver was applied starting from insertion of device till securing the airway. This was done with both the devices so as to make a clear passage. The patients were then intubated with Airtraq VL (Group A) or Hansraj VL (Group H) according to the allocated group. The study ended after confirmation of tube placement.

The primary endpoint was the intubation difficulty scale (IDS) score as described by Adnet and colleagues.[9] The IDS is a seven-point scoring system that describes the difficulty of intubation based on several parameters including number of attempts, the Cormack and Lehane view, lifting force required, and the position of the vocal cords. Ideal intubation conditions yield an IDS of 0 while progressively more difficult tracheal intubations result in higher scores.

Secondary endpoints were the duration of the laryngoscopy attempt, duration of the tracheal intubation procedure, the total time required to secure the airway, and the rate of successful placement of the ETT in the trachea.

The duration of the laryngoscopy attempt was defined as the time taken from insertion of the blade between the teeth until the researcher had obtained the best possible view of the vocal cords.

The duration of the intubation attempt was defined as the time taken to obtain the best view by the researcher after laryngoscopy till the ETT is placed through the vocal cords, the ETT was then connected to the anesthesia circuit and 6 $EtCO_2$ graph was obtained in the multichannel monitor as an evidence of presence of carbon dioxide in the exhaled breath.

The total time taken to secure the airway was the sum of all laryngoscopy and intubation times over the entire procedure.

A maximum of three attempts were permitted after which the anesthetist either used an alternative technique (SAD) or abandon the case. The study ended at this point and was considered as failed intubation.

A failed intubation attempt was defined as an attempt in which the trachea is not intubated, or where the device is abandoned and another device utilized.

Additional endpoints were the number of intubation attempts and the number of optimization maneuvers required (use of a bougie, external laryngeal pressure, and second assistant) to aid tracheal intubation the POGO (percentage of glottic opening)[10] score at laryngoscopy, and the total number of passes of the ETT in the direction of the vocal cords. Heart rate and SpO2 were recorded from the pulse oximeter while BP was recorded using non-invasive manual blood pressure measuring instrument. Immediate preinduction value was recorded and was considered as control value. Subsequently, the parameters were recorded after 3 & 5 minutes of intubation. Immediate postoperative complications as blood on laryngoscope, dental trauma, airway trauma, soreness of throat, etc., was also recorded

At the end of the intubation attempt, the researcher rated the degree of difficulty of use of the device on a 100 mm visual analog scale (VAS).

The appropriate method is usually governed by the design of the study, the type of data collected and the type of relationship being evaluated. In this study statistical analysis was performed using R-software latest version. The results were presented in number, percentage, mean and standard deviation as appropriate.

The sample size estimation was based on our primary outcome measure, namely the IDS score. Based on previous studies,[11] we considered that a clinically important between-group change in the mean IDS score for tracheal intubation was 2.0. Given an expected standard deviation (SD) of 2.25 from prior studies,[12] and using an $\alpha = 0.05$ and a $\beta = 0.2$, for an experimental design incorporating two equal-sized groups, we estimated number of patients required will be 25 patients per group. However, to have safety margin we enrolled 30 patients in each group.

Nonparametric data like gender, Mallampati grade were analyzed using the Fisher´s exact test. Parametric data like age, BMI were analyzed using the unpaired t-test.

Data for time taken for laryngoscopy, time taken for intubation attempt, total time taken to secure airway and POGO score were analyzed using unpaired t test. Number of attempts, number of optimization maneuvers and VAS were analyzed using Fisher's exact test. Hemodynamic changes were analyzed using paired *t* test between the two groups. Postoperative complications like blood on endotracheal tube, sore throat 24 hours postoperatively and hoarseness of voice 24 hours postoperatively were analyzed using Fisher's exact test.

All data are expressed as the number of patients or mean +/- SD. A P value < 0.05 was considered significant.

Results

This study enrolled 60 patients of either sex, age ranging between 20 and 50 years. The patients were randomly allocated using computer-generated random numbers into two groups with 30 patients in each group.

The demographic profile of the patients in both the groups were comparable [Table 1]. All the patients could be intubated successfully.

Mean IDS in Group A (Airtraq VL) was 1 ± 0.58 and 1.8 ± 0.805 in Group H (Hansraj VL). The difference was statistically highly significant ($P < 0.001$). All the patients in both the groups were intubated in first attempt. However, 5 patients in Group A did not require any optimizing maneuver, while 25 patients needed only once to facilitate intubation. Whereas in Group H, 24 patients needed optimization maneuver once and 6 patients required optimization twice during intubation.

Though in 50% of patients the POGO score was >90 in Group A as compared to 36.67% of patients intubated in Group H but the difference in mean POGO score between the two groups did not achieve statistical significance [p > 0.05, Table 2].

The mean time taken for laryngoscopy in Group A was 12.9 ± 2.07 sec and Group H was 19.06 ± 3.83 sec, the difference was statistically highly significant ($P < 0.0001$). The mean duration of intubation attempt in Group A was 14.9 ± 4.36 sec and Group H was 16.97 ± 3.64 sec, the difference was not significant statistically. The mean time taken to secure airway in Group A was 29.47 ± 4.75 sec as compared to 36.03 ± 5.80 sec in Group H, the difference was statistically highly significant ($P < 0.0001$). The blood on endotracheal tube (ETT) was only present in 5 cases in each group. There was no statistical difference among the groups.

Discussion

We compared Airtraq VL and Hansraj VL in terms of IDS, hemodynamic response and complications. The demographic parameters like age, gender, BMI, and the Mallampati class were comparable in both the groups [Table 1]. Thus, these parameters probably did not influence our results.

Table 1: Distribution of age, sex, body mass index (BMI) and Mallampati (MP) grading of patients between the two groups

Parameter	Group		*P*
	Group A (Airtraq VL)	Group H (Hansraj VL)	
Age (years mean±SD)	30.77±8.81	33.76±9.33	0.062
Sex (Male: Female)	9:21	9:21	1.000
BMI (Kg/m^2 mean±SD)	24.66±3.59	23.87±3.11	0.367
MP Grade (I: II)	12:18	13:17	1.000

Table 1 shows distribution of age, sex, body mass index (BMI) and MP grading of patients between the two groups. These parameters were comparable and there was no statistical difference between the groups

All the patients could be successfully intubated in single attempt. However, the IDS was significantly less in Airtraq VL as compared to Hansraj VL. This could be probably because Hansraj VL being a non-channeled required stylet to intubate in all the intubations. In addition, it also required more maneuvers during laryngoscopy resulting to increase in overall IDS. This was in agreement with the findings of previous authors[13] where Airtraq also showed better performance as compared to other VLs in terms of IDS

With Airtraq VL, duration of laryngoscopy was significantly less than Hansraj VL. This could be probably due to two reasons. First, the Hansraj VL often required certain adjustment with the equipment The laryngoscope blade had to be inserted into the oral cavity, with the concavity facing the right angle of the mouth and subsequently rotated anticlockwise the gradually inserted till the vallecula is reached. This was done to avoid the monitor attached to the handle get obstructed with anterior chest wall. This problem was encountered particularly in female patients with large breasts. Secondly, visualization of larynx and intubation with Hansraj VL required more maneuvers. However, we could not support our findings with any other studies because no literature was available based on this equipment.

The duration of intubation attempt was less in Airtraq VL but was not statistically significant. However, with Airtraq VL total time to secure airway was significantly less than Hansraj VL. This was in accordance with previous studies

Table 2: Comparing the various intubation parameters

Intubation parameters	No. of cases	Group A (Airtraq VL) (*n*=30)	Group H (Hansraj VL) (*n*=30)	*P*
POGO SCORE				
>90	26	15	11	
≤90	34	15	19	0.308
IDS Score	60	1±0.58	1.8±0.805	0.0000531
ATTEMPTS				
1	60	30	30	1.000
NUMBER OF OPTIMISATION MANEAUVERS				
0	5	5	0	
1	49	25	24	0.0009
2	6	0	6	
Duration of laryngoscopy (in sec)	60	12.9±2.07	19.06±3.83	0.00000078
Duration of tracheal intubation (in sec)	60	14.9±4.36	16.97±3.64	0.208
Time required to secure airway (n sec)	60	29.47±4.75	36.03±5.80	0.000018
BLOOD ON ETT				
No	50	25	25	1.000
Yes	10	5	5	

Table 2 compares the various intubation parameters, 1) POGO score, 2) IDS score, 3) Number of intubation attempts, 4) Number of optimization maneuvers, 5) Duration of laryngoscopy, 6) Duration of tracheal intubation, 7) Time required to secure airway, 8) Blood on ETT

Table 3: Distribution of patients according to VAS, instrument difficulty scale in both the groups

VAS	No of Patients		P
	Group A (Airtraq VL)	Group H (Hansraj VL)	
≤20	9	4	0.001
20-30	15	9	
30-40	4	8	
40-50	2	7	
>50	0	2	
TOTAL	30	30	
MEAN±SD	28.3±10.11	38±11.56	

Table 3 shows difference in VAS (Instrument difficulty scale) between two groups. The above distribution of VAS was statistically significant by using Fisher's exact test. (p=0.001). Intubation of patients with Airtraq VL was significantly easier than in patients intubated with Hansraj VL

Table 4: Distribution of heart rate changes before and after intubation

Heart rate	Group A (AIRTRAQ VL)	Group H (HANSRAJ VL)	P
Pre-induction (Tpi)	92.86±7.16	87.83±10.18	
Post-intubation (t0)	103.67±7.57	101.73±8.13	
3 min post intubation (t3)	100.33±8.40	100.7±8.97	
5 min post intubation (t5)	93.3±7.18	92.2±6.69	
T0-Tpi	10.7±10.6	14.37±9.85	0.0000066
T3-Tpi	6.3±11.73	12.63±15.51	0.06
T5-Tpi	3.36±9.35	4.5±7.15	0.3

Table 4 shows mean heart rates at different times in both the groups. Intra-Group comparison showed statistically significant difference in immediately post-intubation heart rate compared to pre-induction values (P<0.05) for both the group but after 3 and 5 minutes from the baseline the values were comparable and the statistically significant difference was not there

Table 5: Distribution of mean arterial blood pressure (MABP) changes after intubation

MABP	Group A (Airtraq VL)	Group H (Hansraj VL)	P
Pre-induction (Tpi)	88.06±8.86	91.5±6.99	
Post-intubation (t0)	94.43±13.05	97.80±8.50	
3 min post intubation (t3)	91.7±7.06	92.96±8.46	
5 min post intubation (t5)	90.43±7.73	90.83±6.84	
Tpi-T0	6.5±10.7	6.63±8.76	0.049
Tpi-T3	2.08±9.88	1.40±9.57	0.885
Tpi-T5	2.17±9.22	-0.76±5.43	0.485

Table 5 shows mean arterial blood pressure at different times in both the groups. Intra-Group comparison showed statistically significant difference in rise in MABP value at immediately post-intubation using paired t-test for both groups (P=0.04), but not significant at 3 min and 5 min post intubation compared to pre-induction values

where Airtraq VL showed better performance as compared to other non-channeled VLs.[14-16]

All the patients had a POGO score of >70. Although the mean POGO score obtained by Airtraq VL was more than with Hansraj VL, but was not enough to achieve significant level. Better POGO score with Aitraq VL have also been reported earlier by various author.[17]

Incidence of successful intubation in first attempt was 100% in both groups. The reason for higher success rate and easier grade of intubation was probably because we studied in patients with MP I and II and also excluded all cases of anticipated difficult intubation. Our finding was similar to the studies based on Airtraq VL by the previous authors.[15-17]

Intubation of patients with Airtraq VL was significantly easier than in patients intubated with Hansraj VL as evident by VAS score (Instrument difficulty scale) [Table 3]. Previous authors also observed similar findings when Airtraq VL has been compared with other VLs.[18] In addition, the increased number of optimization maneuvers required to intubate with Hansraj VL could also be a cause.

The effects of laryngoscopy and tracheal intubation on the mean arterial pressure and on heart rate were relatively modest. Heart rate and blood pressure were significantly high during the first minute of intubation with Hansraj VL. This could be due to increased duration of laryngoscopy time and more maneuvers required with Hansraj VL. However, in both the groups MABP and HR reached the baseline value by the 5th min [Tables 4 and 5].

The incidence of post-operative blood staining on ETT and the incidence of postoperative sore throat with both the groups were comparable. The occurrence of blood-stained ETT in both the groups may be attributed to minor trauma due to suctioning of oropharynx which was done prior to the removal of ETT in all the cases.[19]

As with all studies on intubating aid, our study also had certain limitations and bias. Though the patients were blinded, it was not possible to blind the anesthesiologist due to entirely different size and shape of two devices. So some element of bias could be there. The sample size was decided based on the power of the study but a larger sample size including all categories of patients (all age groups, emergency/elective, ASA all classes, MP I-IV, etc.) may give a different picture. The study was conducted on patients undergoing elective operations with no predictors of difficult intubation so the results cannot be extrapolated in trauma patients with cervical spine fracture associated with predictors of difficult intubation.

The Airtraq has been a standard device to be used in case of difficult intubation and various studies have been conducted comparing it with the other VL. Whereas, Hansraj VL has been recently launched device so there has been no literature on this device comparing with other VLs. Therefore, numerous studies should be conducted comparing Hansraj VL with other VLs to prove its utility in cervical spine fracture and also in predicted difficult intubation.

Conclusion

Both Airtraq and HansrajVL can be used as first-hand device in the scenario of cervical spine stabilization. Airtraq VL is better than Hansraj VL due to shorter IDS, less duration of laryngoscopy attempt, tracheal intubation time to secure airway, and also showed better POGO and VAS scoring and with lessor hemodynamic changes.

Financial support and sponsorship
Nil.

Conflicts of interest
We cannot provide any document which will prove there was no conflict of interest. However, since the equipment was purchased by the researcher so there was no obligations towards the company. Accordingly, there was no conflict of interest.

There are no conflicts of interest.

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