

## Comparison of haemodynamic responses to tracheal intubation using Macintosh and Airtraq® laryngoscope in patients with simulated cervical spine injury

*Nithin Mathew<sup>1</sup>, Yogesh Kanta Gaude<sup>2\*</sup>, Tim Thomas Joseph<sup>3</sup>, K Gurudas Kini<sup>4</sup>*  
*Consultant Anaesthesiologist<sup>1</sup>, St. Thomas Hospital, Chethipuzha, Changanassery, Kerala, India*  
*Assistant Professor<sup>2\*</sup>, Professor<sup>4</sup>, Kasturba Medical College, Manipal Academy of Higher Education,*  
*Manipal, India. Specialist<sup>3</sup>, Department of Anaesthesia and Perioperative Medicine, Goulburn Base*  
*Hospital, NSW, Australia.*

**Background:** Mechanical stimulation of airway structures occurs during laryngoscopy. The magnitude of cardiovascular response is related to the force and duration of laryngoscopy. Video laryngoscopes like Airtraq® will help us to intubate patients with restricted neck movements without much manipulation but are bulkier than conventional Macintosh laryngoscope. We compared Airtraq® and Macintosh laryngoscopes in patients with simulated cervical spine injury with respect to haemodynamic fluctuations.

**Methodology:** A prospective, randomized study involving patients who are undergoing elective surgical procedures under GA. After routine preoperative preparation and monitoring, patients were administered conventional general anaesthesia. Preloaded Airtraq® or Macintosh laryngoscope was used for intubation. The outcome variables of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP) were recorded at regular intervals. Duration for intubation, manoeuvres required to optimize laryngeal view, glottic view, number of attempts taken and complications if any, were noted down as secondary objectives.

**Results:** We observed that there is no significant difference in the average of variation in HR ( $p=0.078$ ), SBP ( $p=0.515$ ) and MAP ( $p=0.057$ ) from the baseline between the two groups. We performed independent sample t test to know whether there is any significant difference for average duration of intubation, glottic view, ease of intubation and complications and we observed that there is significant difference in average duration of intubation ( $p=0.002$ ) between two groups.

**Conclusion:** Haemodynamic response caused by intubation with Airtraq® and Macintosh laryngoscopes in simulated cervical spine injury were comparable.

**Keywords:** Haemodynamic fluctuations; simulated cervical spine injury; Airtraq® video laryngoscope; Macintosh laryngoscope.

### Introduction

Laryngoscopy and tracheal intubation are associated with varied levels of sympathetic stimulation. Patients with cardiovascular compromise, neurological insult requires measures

to curb these changes. The magnitude of cardiovascular response is related to the force and duration of laryngoscopy. The choice of airway equipment can play a role in the severity of sympathetic stimulation. However not many studies have compared the difference with respect to haemodynamic changes among various airway equipment.

Airtraq® (Prodol Ltd., Vizcaya, Spain) is a novel video laryngoscope that has been developed to facilitate tracheal intubation in patients with normal or difficult airways as it does not require alignment of oral, pharyngeal and laryngeal axes. Macintosh laryngoscope blade is still the most

\*Correspondence: Yogesh Kanta Gaude

E mail: [yogeshgaude@gmail.com](mailto:yogeshgaude@gmail.com)

 <https://orcid.org/0000-0001-9749-9597>

Received: 06/04/2018

Accepted: 31/05/2018

DOI: <http://doi.org/10.4038/slja.v26i2.8331>



widely used airway device even in patients with cervical injury. More manipulations are required when Macintosh laryngoscope is used especially when Manual Inline Stabilisation (MILS) is applied. Various studies have proved that the application of MILS can increase Intubation Difficulty Score (IDS).<sup>1-3</sup> This will further aggravate haemodynamic variations.

Therefore, we compared these two devices for use in patients with simulated cervical spine injury. The primary outcome measure was to compare haemodynamic changes: Heart rate (HR), Systolic blood pressure (SBP), Diastolic blood pressure (DBP) and Mean arterial blood pressure (MAP) to laryngoscopy and intubation with Macintosh and Airtraq<sup>®</sup> laryngoscopes in patients with simulated cervical spine injury. The secondary outcome measures were to compare duration of intubation and intubation attempts required, glottic view, requirement of Optimal External Laryngeal Manipulations (OELM) and complications in such scenarios.

### Methodology

After obtaining the Institutional Ethics Committee approval, this prospective randomised study was conducted on 60 patients. Patients between age group 18 to 60yrs and BMI <30kg/m<sup>2</sup> belonging to ASA PS 1 or 2 scheduled for elective surgery under general anaesthesia requiring tracheal intubation were enrolled. Patients with hypertension/hypotension, ischaemic heart disease, anticipated difficult airway, signs and symptoms of raised intracranial pressure, patients on drugs affecting blood pressure or heart rate were excluded.

After obtaining informed written consent patients were randomly allocated to one of two groups (Group M or Group A) with the help of a computer-generated table of random numbers and group allocation concealment was ensured using sequentially numbered, opaque sealed envelopes. In Group M: Macintosh laryngoscope blade size 3 was used for females and size 4 for males. In Group A: Airtraq<sup>®</sup> laryngoscope size 3 was used for 8.0 – 8.5 ID ET tubes and size 2 for 7.0 – 7.5 ID ET tubes.

In the operating room, monitoring of ECG, non-invasive blood pressure (NIBP), pulse oximetry and end tidal carbon dioxide were established. NIBP was cycled at every 1 minute for measuring blood pressure. Patients were preoxygenated for 3mins using 100% oxygen. Pre-induction baseline values were recorded. Patients were induced with fentanyl 2mcg/kg and propofol (titrated to loss of response to verbal command). After confirmation of ability to ventilate, vecuronium 0.12mg/kg was administered. Patient's ventilation was manually assisted with 1.5% isoflurane in 100% oxygen maintaining an end tidal isoflurane of 1 - 1.25%. Just prior to laryngoscopy, MILS was applied by the co-investigator simulating suspected cervical spine injury.

After 3mins, laryngoscopy and tracheal intubation was done with instrument depending on randomisation. Anaesthesia was maintained with isoflurane (with ET 1 - 1.25%) with 33%O<sub>2</sub> and 66% N<sub>2</sub>O. All data were recorded by the observer not involved in the study. All intubations were performed by anaesthesiologists with more than 2 years of experience with the Macintosh and Airtraq<sup>®</sup>. Mechanical ventilation was continued for the duration of surgery, maintaining an EtCO<sub>2</sub> of 35±5mmHg. During the entire course of observations, manipulations (movement of head and neck) or preparation of operative field were avoided.

The outcome variables of HR, SBP, DBP and MAP were recorded at the following time intervals:

1. T1=Pre-induction, immediately before IV induction
2. T2=1 minute before intubation
3. T3=At intubation (after the tube is inserted properly in place and capnogram shows traces)
4. Every minute for five minutes after intubation-T4, T5, T6, T7, T8.

The duration for intubation was recorded as the time in seconds from the time point anaesthesiologist inserts laryngoscope into the mouth, to the appearance of capnographic trace.

A failed attempt was defined as the failure to get capnographic trace within 120 seconds of introduction of laryngoscope blade or a decrease in O<sub>2</sub> saturation ≤ 94%. If an intubation attempt failed, the patient was mask ventilated with 100% oxygen and isoflurane 2%. A second attempt of intubation was done. If a second attempt was required, then case was excluded from analysis of haemodynamic parameters and duration of intubation, and only other data were analysed. Any patient with two unsuccessful attempts at tracheal intubation was completely excluded from the study.

Ease of intubation was subjectively classified

**Very Easy:** Smooth insertion of instrument into position in the vallecula allowing a good glottic view *AND* smooth passage of ETT into glottis without hinging against arytenoids.

**Easy:** Difficulty in inserting instrument and obtaining a good glottic view *OR* hinging of ETT against arytenoids.

**Difficult:** Difficulty in inserting instrument and obtaining a good glottic view *AND* hinging of ETT against arytenoids.

The Cook's modification of Cormack and Lehane (C/L) grading system<sup>4</sup> was used to compare the direct and indirect laryngoscopic view.

When increase in any parameters (HR ≥ 120bpm or SBP ≥ 180 or DBP ≥ 110 mmHg) was observed then intravenous propofol in increments of 10mg up to 1mg/kg was administered to control the same. Bradycardia (heart rate ≤ 50bpm) was treated by administration of intravenous atropine. Hypotension was treated by administration of intravenous fluids and mephenteramine. All patients were followed up to 24hours postoperatively for any complications from intubation like sore throat, cough, stridor, dysphonia or dysphagia.

Sample size was calculated based on the pilot study done on 10 patients, for a clinically significant difference of 20% variation in haemodynamics from the baseline time point between the groups, a sample size of 25 was

required ( $\alpha = 0.05$ ) ( $\beta = 0.2$ ). We recruited 66 patients in our study, 33 in each group. Statistical analysis was done using SPSS version 20 for Windows. Repeated measure ANOVA was used for HR, SBP and MAP and independent sample t test for duration of intubation, glottic view, ease of intubation and complications.

## Results

The demographics in both the groups were comparable (Table 1).

**Table 1:** Patient characteristics

	GROUP A	GROUP M	p value
Age in years (Mean ± SD)	39.40±10.92	39.33±13.24	0.380*
Gender (Male/Female)	12/21	13/18	0.256*
Weight in kg (Mean ± SD)	58.03±9.52	61.4±1.33	0.222*
Height in cm (Mean ± SD)	158.5±10.54	160.9±8.22	0.268*
BMI in kg/m <sup>2</sup> (Mean ± SD)	23.03±2.53	23.55±2.72	0.08*
ASA PS (1/2)	31/2	28/5	0.75*
Mallampati Class (1/2)	14/19	18/15	0.19*

\*Independent samples t-test

Three patients from Airtraq<sup>®</sup> group and one from Macintosh group were excluded from the analysis of haemodynamic parameters and duration of intubation as they required a second attempt for intubation and other data were analysed. None of the patients required more than two intubation attempts nor had a failed intubation.

Macintosh group showed a clinically significant rise in HR at T3 (27.26 ± 12.91 %) and T4 (23.45 ± 14.93 %). But there is no statistical (p = 0.078) or clinical significance in the *variation of HR from T2* between the two groups at any time point. (Table 2)

**Table 2:** Percentage variation in heart rate compared to T2

Time points	% Variation compared to T2		p value
	Group A (n = 30) [Mean ± SD]	Group M (n = 30) [Mean ± SD]	
T3	17.87 ± 15.22	27.26 ± 12.91	0.078*
T4	14.72 ± 15.46	23.45 ± 14.93	
T5	12.62 ± 10.49	19.84 ± 14.55	
T6	9.36 ± 9.55	13.57 ± 11.39	
T7	7.54 ± 12.19	8.40 ± 10.16	
T8	3.45 ± 10.08	4.61 ± 8.46	

\*Repeated measure ANOVA

Group A showed a mean percentage variation of 43.65 ± 25.11%, while in Group M it was 32.08 ± 16.70% at T3. Airtraq® showed a higher variation compared to Macintosh in all time points. But this is not statistically (p = 0.515) or clinically significant (Table 3).

**Table 3:** Percentage variation in systolic blood pressure compared to T2

Time point	% Variation compared to T2		p value
	Group A (n = 30) [Mean ± SD]	Group M (n = 30) [Mean ± SD]	
T3	43.65 ± 25.11	32.08 ± 16.70	0.515*
T4	29.07 ± 20.94	25.08 ± 12.94	
T5	20.60 ± 18.02	18.79 ± 10.52	
T6	16.56 ± 17.62	11.69 ± 9.32	
T7	12.62 ± 16.21	7.09 ± 8.78	
T8	9.14 ± 13.42	3.77 ± 9.91	

\*Repeated measure ANOVA

Group A showed a higher variation of DBP

compared to baseline at all time points. At T3 with the maximum variation, Group A showed 62.19 ± 34.26% variation while Group M showed 47.90 ± 35.38%. There was no statistical (p = 0.08) or clinical significance in the variation of DBP between the two groups at any particular time point (Table 4).

**Table 4:** Percentage variation in diastolic blood pressure compared to T2

Time point	% Variation compared to T2		p value
	Group A (n = 30) [Mean ± SD]	Group M (n = 30) [Mean ± SD]	
T3	62.19 ± 34.26	47.90 ± 35.38	0.08*
T4	35.49 ± 27.30	34.98 ± 31.28	
T5	28.99 ± 26.69	28.32 ± 31.40	
T6	19.96 ± 19.11	17.40 ± 22.17	
T7	16.68 ± 18.51	12.87 ± 21.51	
T8	10.77 ± 18.39	5.80 ± 18.30	

\*Repeated measure ANOVA

When variations in MAP were compared Group A showed a higher variation than Group M. At T3, Group A showed a variation of 50.06% (SD = 22.94) compared to 39.47% (SD = 22.70) in Group M. But variations between the two groups is not statistically (p = 0.057) or clinically significant (Table 5).

**Table 5:** Percentage variation in mean arterial pressure compared to T2

Time point	% Variation compared to T2		P value
	Group A (n = 30) [Mean ± SD]	Group M (n = 30) [Mean ± SD]	
T3	50.06 ± 22.94	39.47 ± 22.70	0.057*
T4	29.32 ± 19.29	28.46 ± 18.17	
T5	22.64 ± 18.40	22.70 ± 16.75	
T6	16.86 ± 14.68	13.84 ± 14.59	
T7	12.47 ± 14.98	9.91 ± 13.42	
T8	9.75 ± 13.95	3.92 ± 12.02	

\*Repeated measure ANOVA

Duration of intubation in Airtraq® group (mean value of 42.47sec) was more than Macintosh group (mean value of 28.50) which is statistically (p value = 0.02) and clinically significant. Three subjects required a second intubation attempt in Group A while in Group M one subject required a second attempt. Thus, intubation attempts needed for Airtraq® and Macintosh laryngoscopes is clinically and statistically (p value = 0.245) not significant. Sixteen out of 33 subjects required Optimal External Laryngeal Manipulations (OELM) in Group A and 15 out of 33 in Group M. Requirement for OELM is clinically and statistically (p = 0.182) insignificant between the groups. In Airtraq® group, out of 33 subjects grade 1 view was obtained in 15 subjects, grade 2a in 5 and grade 2b in 9. In Macintosh group out of 33 subjects grade 1 view was obtained in 20, grade 2a in 8 and grade 2b in 5. Thus, glottic view is comparable in both groups statistically (p = 0.269) and clinically. (Table 6)

In Group A, out of 33 subjects, 8 cases had difficult, 7 had easy and 18 had very easy intubations, while in Group M out of 33 subjects, 4 had difficult, 5 had easy and 24 had very easy intubations. But this is not clinically or statistically (p value = 0.193) significant. Adverse effects in both groups are comparable with dysphonia in 2 subjects in each group and sore throat in 3 patients in Group A and 4 in Group M (p value = 0.543).

**Table 6:** Intubation parameters

		Group A (n = 30)	Group M (n = 30)	p value
Duration of intubation (seconds) [Mean ± SD]		42.47 ± 20.54	28.50 ± 10.15	0.02*
Intubation attempts	1	30	32	0.245#
	2	3	1	
OELM	Required	16	15	0.182#
	Not Required	17	18	

\* Independent t test

# Chi - square test

## Discussion

Several studies have evaluated the efficiency of intubation with different kinds of video laryngoscopes in non-emergent circumstances with anticipated difficult airway.<sup>5-14</sup> There are not many researches which compare the haemodynamic variations occurring while using video laryngoscopes. This is worth a study when situations where patients with anticipated difficult airway cannot tolerate much haemodynamic variations as in head injury patients.

Maharaj et al compared Airtraq® and Macintosh laryngoscope in routine airway management and concluded that Airtraq® reduced the difficulty of tracheal intubation and the degree of haemodynamic stimulation.<sup>5</sup> D Ranieri Jr. et al demonstrated that Airtraq® provided an improved glottic view and faster intubation in obese patients.<sup>6</sup> Y. Hirabayashi et al demonstrated that Airtraq® caused less movement of the cervical spine compared to Macintosh laryngoscope.<sup>7</sup>

With this background, we hypothesized that Airtraq® will cause a lesser change in haemodynamic parameters in case of anticipated difficult airway, as it is demonstrated to have more ease of intubation, better glottic view and lesser cervical spine movements.

In our study, time point T2 was taken as the pre-intubation baseline; as at T1 patients' anxiety was found to influence the haemodynamic parameters. A significant rise in the values occurred in both the groups after the intubation especially at T3.

In our study, variation in heart rate was comparatively higher in Macintosh group whereas systolic, diastolic and mean arterial pressures were higher in Airtraq® group although clinically and statistically insignificant. J. McElwain et al stated that there were no differences in success rates or haemodynamic profiles post-intubation between C-MAC, Airtraq® and Macintosh laryngoscopes.<sup>8</sup> Our results were similar to this study although it had conflicting results with the findings of Maharaj et al with respect to mean arterial and diastolic blood pressures.<sup>9</sup> Even though Airtraq® doesn't require oral, pharyngeal and laryngeal axes alignment, its blade is bulkier (with 1.8cm

thickness and 2.8cm width) causing a greater stretch of tissues. Longer duration of intubation and hinging of the endotracheal tube against arytenoids while using Airtraq® also would have caused a higher sympathetic response.

Duration of intubation was comparatively more in Airtraq® group (42.47 secs) than that in Macintosh group (28.5secs). Duration of 42.47secs is clinically significant in cardiac and neurosurgical patients. The factor which increased the duration of intubation in Airtraq® could be due to the fact that longer handle of Airtraq® pressed against chest wall while insertion into the oral cavity. Also, the removal of endotracheal tube from the Airtraq® channel added to the time between insertion of blade and appearance of capnographic trace. Airtraq® provides a better laryngoscopic view but this does not always mean that the intubation will be easy.

In three cases, Airtraq® required a second intubation attempt while in Macintosh, one needed a second attempt. This is clinically and statistically not significant. Certain factors, including poor vision due to secretions, accidental extubation upon the retraction of the device and the inability to introduce the blade into the oral cavity of a patient with a rather limited mouth opening can contribute to the failure of intubation by Airtraq®. OELM can be helpful while using Airtraq® also as in Macintosh laryngoscope. Hinging of endotracheal tube against arytenoid cartilage was a problem faced in some of the cases when Airtraq® was used even though a good view could be obtained. OELM along with some manipulations in handling the Airtraq® helped in dealing with this situation.

In Airtraq® group, 8 were found to be difficult, 7 were easy and 18 very easy intubations. While in Macintosh 4 were difficult, 5 easy and 24 very easy intubations. This was statistically insignificant ( $p = 0.193$ ). Difficulty with Airtraq® was because of (1) the restricted mouth opening associated with application of MILS caused difficulty in insertion of bulkier Airtraq® blade, (2) longer blade of Airtraq® touching the chest and (3) hinging of endotracheal tube against the arytenoids in some cases. No significant adverse effect occurred in both groups.

In our study NIBP measurement was used rather than IBP monitoring which would have given more accurate values. But considering the cost factor and invasive nature we have resorted to use noninvasive method.

In our study we used regular size handle in Macintosh group. But short handle provides easier introduction of laryngoscope in obese patients, patients with large breasts, restricted cervical spine extension etc. We preferred using regular handle as the length was comparable to that of Airtraq®.

Due to the nature of the study, blinding was not practical. However, recording of parameters was done by observer (blinded to the equipment) not involved in the study and only numerical recording exist avoiding possible bias. More studies in this area with preferably more sample size and multicenter analysis is required.

### Conclusion

Haemodynamic response caused by intubation with Airtraq® and Macintosh laryngoscopes in simulated cervical spine injury were comparable. More duration was required for intubation with Airtraq® in comparison with Macintosh laryngoscope. Both Airtraq® and Macintosh laryngoscopes have comparable results in terms of glottic view, requirement of OELM, intubation attempts and complications.

Clinical Trials Registry, India  
(CTRI/2017/10/010157).

### References

1. Smith CE, Pinchak AB, Sidhu TS, Radesic BP, Pinchak AC, Hagen JF. Evaluation of tracheal intubation difficulty in patients with cervical spine immobilisation: fiberoptic (WuScope) versus conventional laryngoscopy. *Anesthesiology* 1999; **91**: 1253–9.  
<https://doi.org/10.1097/00000542-199911000-00015>  
PMid:10551574
2. Nolan JP, Wilson ME. Orotracheal intubation in patients with potential cervical spine injuries. An indication for the gum elastic bougie. *Anaesthesia* 1993; **48**: 630–3.  
<https://doi.org/10.1111/j.1365-2044.1993.tb07133.x>  
PMid:8155112

3. Heath KJ. The effect on laryngoscopy of different cervical spine immobilisation techniques. *Anaesthesia* 1994; **49**: 843–5.  
<https://doi.org/10.1111/j.1365-2044.1994.tb04254.x>  
PMid:7802175
4. Cook TM. A new practical classification of laryngeal view. *Anaesthesia*. 2000 Mar; **55**(3):274–9.  
<https://doi.org/10.1046/j.1365-2044.2000.01270.x>  
PMid:10671848
5. Maharaj CH, O'Croinin D, Curley G, Harte BH, Laffey JG. A comparison of tracheal intubation using the Airtraq® or the Macintosh laryngoscope in routine airway management: A randomised controlled clinical trial. *Anaesthesia* 2006 Nov; **61**(11):1093–9.  
<https://doi.org/10.1111/j.1365-2044.2006.04819.x>  
PMid:17042849
6. Ranieri Jr D, Filho SM, Batista S and Nascimento Jr P. Comparison of Macintosh and Airtraq® laryngoscopes in obese patients placed in the ramped position. *Anaesthesia* 2012; **67**: 980–85.  
<https://doi.org/10.1111/j.1365-2044.2012.07200.x>  
PMid:22670846
7. Hirabayashi Y, Fujita A, Seo N and Sugimoto H. A comparison of cervical spine movement during laryngoscopy using the Airtraq® or Macintosh laryngoscopes. *Anaesthesia* 2008; **63**: 635–40.  
<https://doi.org/10.1111/j.1365-2044.2008.05480.x>  
PMid:18477276
8. McElwain J and Laffey JG. Comparison of the C-MAC®, Airtraq® and Macintosh laryngoscopes in patients undergoing tracheal intubation with cervical spine immobilisation. *Br. J. Anaesth* 2011; **107**:258–64.  
<https://doi.org/10.1093/bja/aer099>  
PMid:21586444
9. Maharaj CH, Costello JF, Harte BH and Laffey JG. Evaluation of the Airtraq® and Macintosh laryngoscopes in patients at increased risk for difficult tracheal intubation. *Anaesthesia* 2008; **63**: 182–88.  
<https://doi.org/10.1111/j.1365-2044.2007.05316.x>  
PMid:18211450
10. Maharaj CH, Ni Chonghaile M, Higgins B, Harte BH, Laffey JG. Tracheal intubation by inexperienced medical residents using the Airtraq® and Macintosh laryngoscope –A manikin study. *American Journal of Emergency Medicine* 2006; **24**: 769–74.  
<https://doi.org/10.1016/j.ajem.2006.03.014>  
PMid:17098095
11. Maharaj CH, Costello JF, McDonnell JG, Harte BH, Laffey JG. The Airtraq® as a rescue airway device following failed direct laryngoscopy: a case series. *Anaesthesia* 2007; **62**: 598–601.  
<https://doi.org/10.1111/j.1365-2044.2007.05036.x>  
PMid:17506739
12. Norman A, Date A. Use of the Airtraq® laryngoscope for anticipated difficult laryngoscopy. *Anaesthesia* 2007; **62**: 533–4.  
<https://doi.org/10.1111/j.1365-2044.2007.05075.12.x>  
PMid:17448079
13. Ndoko SK, Amathieu R, Tual L, Polliand C, Kamoun W, El Housseini L. Tracheal intubation of morbidly obese patients: a randomised trial comparing performance of Macintosh and Airtraq® laryngoscopes. *Br J Anaesth* 2008; **100**: 263–8.  
<https://doi.org/10.1093/bja/aem346>  
PMid:18211999
14. White MC, Marsh CJ, Beringer RM, Nolan JA, Choi AYS, Medlock KE and Mason DG. A randomized, controlled trial comparing the Airtraq® optical laryngoscope with conventional laryngoscopy in infants and children. *Anaesthesia* 2012; **67**: 226–31.  
<https://doi.org/10.1111/j.1365-2044.2011.06978.x>  
PMid:22321076