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Comparison of Hemodynamic Responses to Orotracheal Intubation by Flexible Fibreoptic Bronchoscope, McCoy Laryngoscope and Airtraq in Presence of Rigid Cervical Collar for Traumatic Cervical Injury

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Abstract

Background: Orotracheal Intubation can lead to exaggerated hemodynamic response. In cases of unstable cervical spine placing rigid cervical collar for cervical immobilization to avoid neurological injury may cause hindrance in laryngoscopic view. The aim of our study was to analogize the hemodynamic responses to intubation by flexible Fiberoptic Bronchoscope (FOB), McCoy laryngoscope and airtraq in patients posted for surgery under general anesthesia with rigid collar simulating cervical spine stability in the cases of traumatic cervical injury.

Method: Ninety patients in the age group 20–50 years, of American Society of Anesthesiologist grade I II, posted for surgery under general anesthesia were randomly designated into three groups according to the aid used for intubation: Group A (flexible FOB), Group B (McCoy laryngoscope) and Group C(Airtraq). Systolic blood pressure, diastolic blood pressure, mean arterial blood pressure and Heart Rate (HR) were recorded at baseline, post induction, and shortly one min, three minutes and five minutes post intubation.

Statistical analysis: The categorical data was compared by Chi-square test and P value<0.05 was captured as statistically significant. To compare the quantitative data parametric test (unpaired t test) was done.

Results: The difference in mean arterial pressure with mc coy, airtraq and fiberoptic bronchoscope was significant at one min, three minutes and five minutes after intubation. Similarly there was significant difference in heart rate in intubation with mc coy, airtraq and fiberoptic bronchoscope. The mean duration of intubation was (40 ± 7.28 sec) in fiberoptic group which was statistically significant compared to mc coy (27.3 ± 4.47 sec) and airtraq (25.2 ± 5.11 sec).

Conclusion: Airtraq is better as an aid for orotracheal intubation in traumatic cervical injury with rigid collar as it consumes lesser time and provides stable hemodynamics compared to fiberoptic and mc coy.

Keywords: Hemodynamic response; Cervical spine injury; Intubation; McCoy laryngoscope; Fibreoptic bronchoscope; Airtraq; Cervical collar

Introduction

Somato–visceral reflexes are found to be the main mechanisms behind response to laryngoscopy and orotracheal intubation. At the time of laryngoscopy proprioceptors at the base of tongue get stimulated which induces an impulse-dependent rise in plasma catecholamine concentrations, systemic blood pressure and heart rate [1]. For prevention of this kind of circulatory response, different pharmacological and nonpharmacological interventions have been demonstrated in literature performing Intubation in patients with cervical spine instability is a challenging task as we need to avoid the calamitous neurological complications which can occur by movement of unstable cervical spine, at the same time we know that for adequate laryngeal exposure during intubation, movement of cervical vertebrae in form of cervical spine flexion and atlanto-occipital joint extension is required. Using a rigid collar during intubation might reduce movement of cervical spine, but there is significant diminution in mouth opening, making laryngoscopy difficult, it further lifts up the chin placing the larynx anteriorly thus making intubation cumbersome [2,3]. In cases of difficult intubation Flexible FOB is considered as gold standard [4]. The rotational movement of FOB and the flexion-deflexion movement of its distal flexible tip cause the operator to visualize the airway anatomy nearly at 360 degrees. Due to decrease mechanical stimulation of laryngeal surface it causes lesser stress response to intubation. Mccoy laryngoscope (Penlon Ltd., Abingdon, England) is a modification of Macintosh laryngoscope, which was introduced in 1993 as assistance for difficult tracheal intubations [5]. On pressing the lever on the back of the scope handle, the movement of hinged tip of McCoy blade elevates the epiglottis thereby improves the glottis view with so less force [6]. It was demonstrated as a very convenient aid for laryngoscopy in cases of restricted neck extension in previous studies [7-9]. Airtraq Laryngoscope is comparatively novel intubation tool that provides a high-quality view of glottis and surrounding structures even without alignment of all three oral, pharyngeal and tracheal axes [10,11]. The primary objective of our clinical study was to analyse for clinically significant difference in the hemodynamic response to orotracheal intubation, aided by any of the devices (flexible FOB, McCoy and airtraq laryngoscope) in surgical patients posted under general anesthesia with rigid cervical collar simulating cervical spine stabilization, in terms of: Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), and HR. The secondary objective was to investigate the time duration of intubation using either of the devices.

Materials and Methods

This is a hospital-based randomized prospective double blind comparative interventional type of study which was conducted between April 1, 2017 and December 31, 2018. After obtaining approval of the Institution Ethics Committee and written informed consent from the patients, 90 American Society of Anesthesiologists (ASA) physical status I and II patients of either gender between 20 and 50 years of age scheduled for elective surgery under general anesthesia requiring orotracheal intubation were included in this study. Exclusion criteria included patient's refusal, anticipated difficult intubation (Mallampatti grade 4, thyromental distance 42 cm), a history of reactive airway disease, hyperthyroid, neck swelling, gastro-esophageal reflux, hypertension, dysrhythmia, cervical spine pathology, airway distortion or trauma, morbid obesity, and use of medications that affect blood pressure and Heart Rate. Patients were distributed randomly into three groups of 30 each using computer generated random number table and then the random numbers were kept in an opaque envelope. The pre anaestehtic check-up was done a day before surgery under the institutional protocols. In the operation theater, after confirming patients fasting status, identity and consent, the rigid cervical collar was applied, and intravenous (IV) lines with 18 gauge cannula were secured. Standard monitoring with noninvasive arterial pressure, electrocardiography, oxygen saturation, end tidal carbon dioxide (etco2 was done. Baseline readings of HR, SBP, DBP, and MAP were recorded. Premedication with glycopyrrolate (0.005 mg/kg iv), midazolam (0.02 mg/kg iv) and fentanyl citrate (2 μg/kg iv) was given along with preoxygenation for 5 min. Induction was done with propofol 2 mg/kg i.v. Given slowly over 1 min, followed by injection rocuronium (0.9 mg/kg). Patients were ventilated by mask with 100% oxygen for 90 seconds. In case of any difficulty in mask ventilation, the patient was excluded from the study. After completion of 90 seconds of i.v. Rocuronium, orotracheal intubation was performed with appropriate sized Endotracheal Tube (ETT) (male-8.5 mm ID, female-7.5 mm ID) either by flexible FOB or McCoy or airtraq laryngoscope according to the group allotted. Modified Berman's airway was used as an aid for fiberoptic orotracheal intubation. Tube position was checked by five point auscultation technique and fixed after confirmation by capnography tracing after which the lungs were mechanically ventilated and anesthesia was maintained with sevoflurane in a mixture of N_2O (60%) and O_2 (40%). Incremental dose of fentanyl was given when we observed increase in HR and MAP by 10% from baseline. All values of HR and BP (SBP, DBP, and MAP) were recorded, immediately after induction, just after intubation, 1 minute, 3 minutes and 5 minutes after intubation. During the 5 min data collection period after tracheal intubation any other medication and head and neck movement was avoided. The duration of the tracheal intubation procedure was also noted. The duration of the intubation attempt is defined as the time taken from insertion of the blade/fiberoptic cord between the teeth and connecting endotracheal tube to the circuit. All the intubations were performed by a single anesthesiologist who was familiar and trained with intubation using FOB, Mc coy and airtraq. Any patient who required more than one attempt to achieve successful intubation was excluded from the study. The person recording the hemodynamic parameters and duration of intubation was different from the person doing intubation so it was a double blinded study.

Statistical analysis

The results were analyzed with the aid of a statistician, and a sample size of 30 in each group was calculated with alpha error 0.05 and power 80%. Analysis of the statistical data obtained from the study was carried out by statistical programming software Statistical Package for the Social Sciences-SPSS Statistics version 17.0.0 (SPSS Inc., Chicago, Illinois, USA). Categorical data are presented as numbers and intergroup comparison of these was done by Chi-square test. $p<0.05$ was considered statistically significant. Quantitative data [age, weight, airway parameters, intubation duration, and hemodynamic variables (HR, SBP, DBP, and MAP)] are presented as mean value and standard deviation. Intergroup comparison of continuous data was done by the parametric test (unpaired t-test), and statistical significance was considered at $p<0.05$ (Table 1).

Variable	Group A (FOB)	Group B (MC COY)	Group C (AIRTRAQ)	p Value
Age (yrs)	37.41 ± 8.871	38.27 ± 7.362	41.23 ± 13.22	0.314 (NS)
Sex (M/F)	19/11	18/12	16/14	0.725 (NS)
Weight (kg)	66.34 ± 8.582	63.53 ± 7.86	62.5 ± 8.35	0.183 (NS)
ASA grade (1/2)	17/13	16/14	18/12	0.873 (NS)
Mallapatti (1/2/3)	19/10/1	19/8/3	17/10/3	0.813 (NS)
Thyromental Distance	8.2 ± 1.04	7.85 ± 0.692	7.6 ± 0.77	0.438 (NS)
Mentohyoid Distance	6.69 ± 0.77	5.25 ± 0.99	4.92 ± 0.63	0.076 (NS)
Sternomental Distance	16.2 ± 2.55	17.34 ± 2.80	17.06 ± 0.89	0.129 (NS)

Neck Circumference	35.8 ± 2.87	35.16 ± 2.81	34.30 ± 2.06	0.088 (NS)

Table 1: Demographic data and Airway characteristics of patients.

Variables	Baseline	Post induction	Post intubation	1 min	3 min	5 min
HR (FOB)	85.76 ± 17.31	91.22 ± 13.67	94.84 ± 12.97	95.63 ± 14.14	91.91 ± 13.34	87.16 ± 13.43
HR (MCCOY)	89.7 ± 20.17	88.03 ± 18.12	108 ± 17.22	104.5 ± 15.08	98.43 ± 13.62	94.23 ± 13.31
HR (AIRTRAQ)	81.1 ± 17	82.1 ± 16.2	91.9 ± 16.3	93.8 ± 13.1	89.1 ± 13.1	84.4 ± 14.1
p VALUE	0.193 (NS)	0.09 (NS)	<0.001(S)	0.009 (S)	0.025 (S)	0.019 (S)

Table 2a: Hemodynamic variable: Heart Rate at different time.

Variables	Baseline	Post induction	Post intubation	1 min	3 min	5 min
SBP (FOB)	126.03 ± 9.88	101.94 ± 8.86	111.1 ± 14.21	110.44 ± 13.12	109.97 ± 10.59	108.97 ± 9.5
SBP (MCCOY)	129.23 ± 9.79	106.7 ± 9.10	133.2 ± 18.72	134.1 ± 22.40	126.93 ± 14.26	118.3 ± 12.23
SBP (AIRTRAQ)	127.4 ± 20.89	104.43 ± 8.81	122.43 ± 18.55	115.73 ± 15.69	111.47 ± 15.18	109.2 ± 8.2
P VALUE	0.693(NS)	0.124(NS)	<0.001(S)	<0.001(S)	<0.001(S)	<0.001(S)

Table 2b: Hemodynamic variable: Systolic Blood Pressure (SBP) at different time.

Variables	Baseline	Post induction	Post intubation	1 min	3 min	5 min
DBP (FOB)	87.75 ± 7.79	72.72 ± 9.37	77.72 ± 11.34	76.38 ± 9.69	75.94 ± 7.3	74.22 ± 5.9
DBP (MCCOY)	85.36 ± 8.61	71.73 ± 9.53	93.06 ± 16.11	90.53 ± 15.21	85.86 ± 11.51	82.36 ± 9.77
DBP (airtraq)	82.16 ± 10.38	75.8 ± 11.97	84.1 ± 16.73	79.36 ± 12.30	76.23 ± 11.30	75.86 ± 12.42
p Value	0.059 (NS)	0.289 (NS)	<0.001 (S)	<0.001 (S)	<0.001 (S)	0.002 (S)

Table 2c: Hemodynamic variable: Diastolic Blood Pressure (DBP) at different time.

Variables	Baseline	Post induction	Post intubation	1 min	3 min	5 min
MAP (FOB)	100.78 ± 7.58	83.25 ± 9.06	89.47 ± 11.26	88.84 ± 10.71	88.06 ± 7.65	86.81 ± 5.6
MAP (MCCOY)	100.53 ± 7.46	82.36 ± 8.63	106.5 ± 16.38	105.6 ± 17.216	101.33 ± 10.83	98.63 ± 9.93
MAP (airtraq)	97.46 ± 12.55	87.7 ± 12.26	97.23 ± 16.62	91.83 ± 13.04	89.82 ± 12.62	88.26 ± 10.58
p value	0.329 (NS)	0.097 (NS)	<0.001 (S)	<0.001 (S)	<0.001 (S)	<0.001 (S)

Table 2d: Hemodynamic variable: Mean Arterial Pressure (MAP) at different time.

Results

There is no significant difference in demographic data and airway characteristics of patients ($p>0.05$) between Group A (FOB), Group B (McCoy) and Group C (Airtraq) (Table 1). The Hemodynamic variables like Heart Rate and blood pressure (SBP, DBP and MAP) were comparable at baseline in both groups ($p>0.05$) (Tables 2a-2d), but are increased significantly ($p<0.05$) post intubation and lasts upto 5 minutes thereafter in McCoy group as compared to airtraq and fiberoptic group as shown in Figure 1. The rise in HR was statistically significant ($p<0.05$) in McCoy group as compared to airtraq and FOB group up to 5 min post intubation. But the duration of Intubation was significantly ($p<0.05$) higher in Group A in comparison to Group B and Group C (Table 3).

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	Group A (FOB)	Group B (MC COY)	Group C (AIRTRAQ)	p Value
Duration of Intubation	40 ± 7.28	27.3 ± 4.47	25.2 ± 5.11	<0.001

Table 3: Duration of Intubation in three different groups.

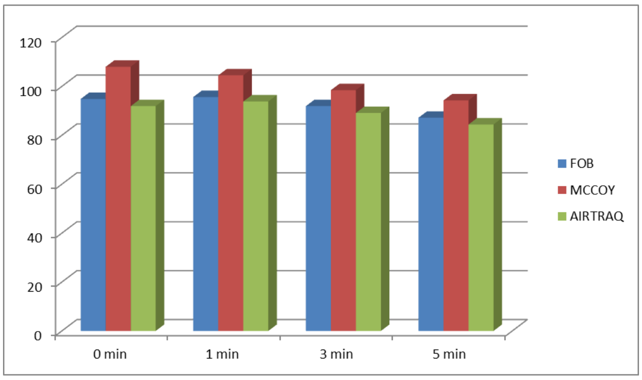

Figure 1: Effect on heart rate post intubation.

All the endotracheal intubations with any of the devices were smooth without any injury to surrounding airway structures or any other complication and were performed in a single attempt successfully in all the patients without any failure (Figure 2).

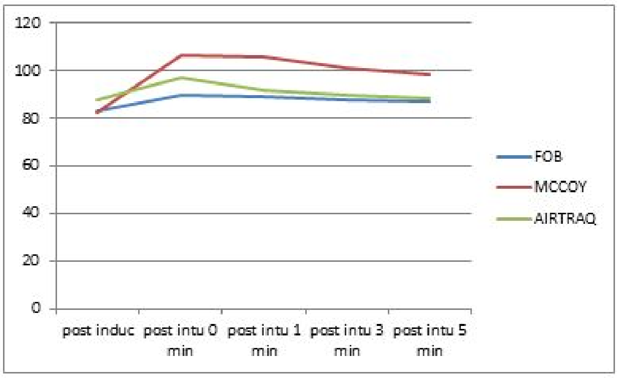

Figure 2: Effect on mean arterial pressure after induction and intubation.

Discussion

Intubation in unstable cervical spine carries risk of cord injury which can be avoided by minimal cervical motion either by manual inline stabilization, cervical collar, pin traction or combination of maneuvers. Both laryngoscopy and tracheal tube insertion are responsible for the pressure response and intubation causes more rise in MAP and HR compared to laryngoscopy. Laryngoscopy and tracheal intubation often leads to tachycardia, hypertension and cardiac arrhythmias. The transient pressure response to laryngoscopy and orotracheal intubation is very commonly studied and various pharmacological means to suppress the response like beta blockers, calcium channel blockers,lignocaine,gabapentine,nitroglycerine,clonidine,dexmedetomidine,inhalational agents have been studied in literature but research on non-pharmacological methods is limited. The site of airway stimulation, total duration of airway stimulation and type of laryngoscope blade affects the degree of pressure response. The glossopharyngeal nerve responses on giving stimulus superior to anterior surface of epiglottis and the vagus nerve responses on giving stimulus below posterior epiglottis down into lower airway both of which are responsible for the cardiovascular response of intubation. There is widespread autonomic response resulting in neither far-flung release of nor epinephrine from adrenergic nerve terminals and secretion of epinephrine from adrenal medulla along with activation of the rennin angiotensin system [12].

The main aim of our study was blunting cardiovascular response to laryngoscopy and intubation along with cervical spine immobilization in traumatic spine injury by using rigid cervical collar. However, placing the collar limits mouth opening thus decrease interincisor distance making laryngoscopy difficult and its anterior strap that comes under the chin lifts up the larynx anteriorly making intubation difficult further. With rigid collar *in situ* we have compared hemodynamic response of intubation by fiberoptic, mc coy and airtraq laryngoscopes.

Nishiyama et al. [13] Tewari et al. [14] and Haidry and Khan [15] compared Mc coy and Mac intosh blades and showed that the use of Mc coy blade resulted in minor change in HR and MAP. In study by Mc coy et al. [6] no change in HR was noted as it decreases the force required for better glottic view by elevating the epiglottis thereby diminishes the pressor response to laryngoscopy but, in our study we have observed significant rise in HR post intubation in Mc coy blade group, this could be attributed to the response to laryngoscopy only and not tracheal intubation in study by mc coy. Tracheal intubation has been shown to affect HR more than laryngoscopy [16].

The fiberoptic bronchoscope enables glottis visualization with minimum force. Adachi et al. [17] and Barak et al. [18] compared fiberoptic intubation with conventional direct laryngoscopy and found stable hemodynamics with the fiberoptic group which is coinciding with our study where we found a significantly lower change in heart rates and all kind of pressure readings (SBP, DBP, MAP) due to fiberoptic intubation. We can reduce the stimulation of nerves over the laryngeal surface by proper positioning the distal flexi tip of fiberscope which can result in negligible changes in cardiovascular variables. Lesser sympathetic stimulation with FOB can be of utmost benefit as it reduces the doses of drugs required to diminish this hemodynamic response and thus decreasing the side effects associated with them. In our study, we also found that intubation duration was significantly more in fiberoptic group (40 s ± 7.28) as compared to McCoy group (27.3 s ± 4.47) and airtraq group (25.2 ± 5.11). This is also in concordance with previous studies showing duration of intubation also affects stress response. However the intubation duration may vary as it depends on the skill of anesthesiologist as mentioned in previous studies [14,18-21].

Airtraq optical laryngoscope is a novel intubation device with exaggerated curvature of blade that embody fiberoptic imaging providing better glottis view even without alignment of oral, pharyngeal and laryngeal axes. It resulted in minor rise in HR while BP was not affected [22]. It also produces a better laryngeal view over the mac intosh laryngoscope in patients with collar with no difference in hemodynamics or intubation duration [23]. Hirbayashi demonstrated that the airtraq decreases both the time to intubate and the incidence of unsuccessful endotracheal intubation by novice laryngoscopists [24]. Our results are confirmed by previously published data showing less hemodynamic alteration when endotracheal intubation was done with the Mc intosh laryngoscope [25].

Durga et al. Compared Airtraq with McCoy in patients stabilized with collar and manual in-line stabilization imitating cervical spine injury and observed that the process of intubation is much easier with airtraq in these conditions [20]. According to Arino et al. and sherren et al. airtraq require minimal force for intubation for best glottis view in both normal and difficult airway situations compared to other airway aids [26,27]. Studies have reported minimal cervical motion with airtraq which was comparable with mc coy laryngoscope [28]. In our study we found that mean duration of intubation was significantly lower in airtraq. Our study has also shown statistically significant results in hemodynamic parameters in mc coy group. Minimal manipulation with airtraq leads to decrease fluctuations in cardiovascular parameters with a good glottic view. Although Ali et al. have compared airtraq and McCoy using collar in patients with imitated difficult laryngoscopy showing comparable number of attempts and overall intubation success rate but lesser duration of intubation with airtraq [29]. There are very few studies where Airtraq was compared with other intubation devices in cases of actual cervical spine injury. Srilata et al. in their study also concluded that airtraq provides better glottis visualization with stable hemodynamics and lesser time for intubation with comfort and minimal assistance [30]. Direct laryngoscopy was not required with the airtraq. However, limitation of the Airtraq for routine use is that it is a single time use device and expensive.

Conclusion

We conclude that for conditions requiring faster intubation mc coy laryngoscope is better than fiberscope but if strict cervical spine immobilization and stable hemodynamics is mandatory fiberscope is preferable over McCoy laryngoscope. However, since FOB consumes more time and needs skilled personal for intubation, Airtraq laryngoscope is superior to it being faster, feasible as well as provides relatively stable hemodynamics for orotracheal intubation.

Limitation

Numbers of cases for study were less in this study.

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