Comparison of haemodynamic responses to orotracheal intubation in anaesthetised and paralysed patients with simulated cervical spine injury: Airtraq® video laryngoscope versus fibreoptic bronchoscope

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Background: Endotracheal intubation may produce haemodynamic fluctuations which may be deleterious in patients with cardiovascular and neurological disorders. This is further worsened in patients with difficult airway. This study was conducted to compare haemodynamic fluctuations produced when intubation was done using Airtraq and fibreoptic bronchoscopy which are used in patients with anticipated difficult airway.

Methodology: Prospective randomized study. Eighty patients, ASA PS 1 and 2 undergoing elective surgery were randomized into two groups – Group A and Group F. After routine induction and muscle relaxation, orotracheal intubation was done using Airtraq in Group A and fibreoptic bronchoscope in Group F. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP) were recorded at regular intervals. Duration and number of attempts for intubation were also noted

Results: There was no significant difference in the average of variation in HR (p=0.384), SBP (p=0.179), DBP (p=0.746) and MAP (p=0.057) from the baseline between the two groups. Duration of intubation in FOB group (mean value of 56.98 s) was more than Airtraq® video laryngoscope group (mean value of 37.38 s) which was statistically significant.

Conclusion: Use of fibreoptic bronchoscope offer no added advantage over Airtraq video laryngoscope in terms of haemodynamic response for intubation in difficult airway situation such as cervical spine injury.

Keywords: Airtraq; fibreoptic bronchoscope; haemodynamic stress response; intubation

Introduction

Sympathetic stimulation associated with endotracheal stimulation can be deleterious in patients with cardiovascular and neurological compromise.[1]

The major stimulus for this sympathetic response is the force applied by the laryngoscope blade on vallecula.[2]

The degree of cardiovascular response during endotracheal intubation depends on airway equipment used for intubation and this cardiovascular response can be increased in patients with difficult airway. Airtraq® is an indirect video laryngoscope which gives a high-quality wide-angle view of the glottis and surrounding structures and simultaneously facilitates insertion of the tracheal tube through a side channel.[3] Flexible fibreoptic bronchoscope (FOB) guided awake intubation is considered as the gold standard in an anticipated difficult airway situation. Many authors have extensively described the use of FOB in securing the airway in head and neck trauma, and cervical spine injuries, but mostly by awake intubation.[4] Compared to the studies on awake patients for nasal intubation using FOB, there are fewer studies on orotracheal intubation with the same, especially in anaesthetised and paralysed

patients. Many authors have studied the haemodynamic stress response (HSR) to different types of laryngoscope blade during endotracheal intubation.[5-10] There were no studies comparing Airtraq® and FOB in terms of HSR produced during endotracheal intubation. We compared these two techniques in terms of HSR produced by them when used for orotracheal intubation in anaesthetised and paralysed patients with simulated cervical spine injury.

Materials and methods

After obtaining clearance from institutional ethics committee, this prospective randomized study was carried out in 80 patients between age group 18 and 70 years and who fulfilled the criteria for ASA Physical status I and II, undergoing elective surgical procedures under general anaesthesia and endotracheal intubation. Patients with anticipated difficult airway, signs and symptoms of raised intracranial pressure, patients on drugs affecting blood pressure or heart rate were excluded from the study. Patients were randomised into 2 groups (Group A and Group F) of 40 each using computer generated random sequence and allocation concealment was ensured using sequentially numbered opaque sealed envelopes. There were three observers in our study. Observer 1 was the postgraduate in anaesthesiology, who performed the preoperative evaluation and enrolled the patients for the study and obtained informed written consent for participation. He also gave Manual in-line stabilisation (MILS). Observer 2 was the consultant anaesthesiologist experienced with the use of Airtraq® video laryngoscope and FOB who performed endotracheal intubation using one of the techniques. Observer 3 was another postgraduate in anaesthesiology who recorded the study parameters. Preoperative evaluation of the patients was done on the day prior to surgery, written informed consent obtained and anxiolytic premedication given according to their body weight on the night before and morning of the surgery. Patients were kept nil orally, 6 hours for solids and 2 hours for clear fluids. Inside the operating room, patients were monitored continuously with electrocardiogram, pulse oximeter, noninvasive blood pressure (NIBP) and capnograph (ETCO$_2$). After adequate preoxygenation patients were induced with propofol 2mg/kg and fentanyl 2mcg/kg. After checking the adequacy of mask

ventilation neuromuscular blockade was achieved with iv vecuronium and anaesthesia was deepened with 1.5% - 2% isoflurane in oxygen to achieve a MAC of 1.2. A peripheral nerve stimulator was used to stimulate the ulnar nerve and to deliver a train of four (TOF) stimulus at 40 mA. Ventilation was continued until the TOF count of zero was achieved. Prior to laryngoscopy MILS was applied by observer 1 to prevent any movement at the cervical spine. Endotracheal intubation with appropriate size endotracheal tube (ETT) was done by observer 2 using either Airtraq® video laryngoscope or FOB depending on the group allocated.

In Group F an appropriate size ETT was rail loaded over the FOB during the preparation of the scope. FOB was introduced through the ovassapian airway which was placed just after removing mask, into the oropharynx using the midline approach. After visualising the glottis, the FOB was further advanced to the trachea till visualisation of carina. The ETT was then advanced gently over the FOB and FOB removed. The ETT was connected to the breathing circuit.

In Group A appropriate size ETT was preloaded in the guiding channel of the Airtraq® video laryngoscope chosen for the patient with the tip of the tube just visible through the device camera. Airtraq® video laryngoscope was then introduced orally in the midline till optimal glottic opening was visualised on the wireless camera display placed beside the patient. The ETT was then advanced into the trachea under vision and device was taken out. ETT was moved laterally, connected to the breathing circuit.

Correct placement of ETT in both the groups were confirmed by the appearance of a normal capnogram. The ETT was secured after confirming bilateral equal air entry over the chest.

An attempt was defined as introduction of Airtraq® video laryngoscope or FOB between the teeth to the appearance of capnographic trace following intubation. An attempt was considered failed if the time exceeded 120 seconds or saturation dropped below 95%. In a failed attempt situation, patient would have been ventilated using face mask with 100% oxygen and isoflurane 1.5 – 2% and patient intubated using conventional direct laryngoscopy without MILS and excluded from the study.

External laryngeal manipulation (ELM) was used if intubation using Airtraq was found to be difficult and jaw thrust was used if intubation using FOB was found to be difficult.

The outcome variables of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP) were recorded at the following time intervals:

1. T_0= Pre-induction baseline value before induction.
2. T_1 = After completion of induction and paralysis but before instrumentation of airway.
3. T_{2A} = After introduction of Airtraq® video laryngoscope and optimum glottic view obtained in group A patients.
4. T_{2F} = After passing of FOB and visualisation of carina in group F patients.
   5. T_{int} = After the confirmation of ETT placement by the appearance of capnographic trace.
6. T_{int1}, T_{int2}, T_{int3}- After intubation every minute for 3 minutes.

For a clinically significant difference of 20% variation of haemodynamic variables from the baseline time point between the groups, a sample size of 35 in each group was required ($\alpha = 0.05$) ($\beta = 0.2$) based on the pilot studies done in 10 patients. We recruited 40 patients in each group. Statistical analysis was done using SPSS version 20 for windows. Statistical test used was repeated measure ANOVA which was used for analysis of haemodynamic variation.

Results
All patients from both groups completed the prospective study and were comparable with respect to age, body mass index (BMI) and gender (Table 1).
In Group A the maximal rise in HR was at T_2A compared to baseline at T1. At T_{2A}, Group A showed a mean percentage variation 33.35 ± 9.88 from T_1, while Group F showed 22.11 ± 10.61.

Table 1: Patient characteristics

	Group A (n=40)	Group F (n=40)	P value
Age in years (Mean ± SD)	35.08 ± 7.63	34.43 ± 7.13	*0.66
Gender (Male/Female)	22/18	24/16	# 0.65
BMI in kg/m² (Mean ± SD)	23.99 ± 2.13	24.18 ± 2.68	*0.72

*Independent samples t-test, # Chi - square test

In Group F the maximal rise was at T_{int} compared to baseline at T_1. At T_{int}, Group F showed a mean percentage variation 26.78 ± 11.20 from T_1, while Group A showed 26.03 ± 9.98, which were comparable. After this, the heart rate slowly fell towards baseline in both groups. (Table 2)

Table 2: Percentage variation in HR compared to T_1

	% Variation compared to T_1		
	Group A (n = 40) [Mean ± SD]	Group F (n = 40) [Mean ± SD]	P value
$T_{2A/2F}$	33.35 ± 9.88	22.11 ± 10.61	0.384*
T_{int}	26.03 ± 9.98	26.78 ± 11.20	
T_{int1}	17.06 ± 8.10	21.44 ± 10.02	
T_{int2}	9.80 ± 7.18	14.92 ± 11.01	
T_{int3}	5.28 ± 5.71	9.71 ± 8.24	

*Repeated measure ANOVA

In Group A the maximal rise in SBP was at T_{2A} compared to baseline at T_1. At T_{2A}, Group A showed a mean percentage variation of 41.18 ± 14.93 from T_1, while Group F showed 28.18 ± 11.06. In Group F the maximal rise was at T_{int} compared to baseline at T_1. At T_{int}, Group F showed a mean percentage variation of 30.44 ± 10.06 from T_1, while Group A showed 35.01 ± 14.01 which were comparable. After this, the SBP slowly declined towards baseline in both groups, rate of fall being more in Group A. (Table 3)

Table 3: Percentage variation in SBP compared to T_1

| Time points | % Variation compared to T_1 | | P value |
	Group A (n = 40) [Mean ± SD]	Group F (n = 40) [Mean ± SD]	
$T_{2A/2F}$	41.18 ± 14.93	28.18 ± 11.06	
T_{int}	35.01 ± 14.01	30.44 ± 10.06	0.179*
T_{int1}	24.60 ± 11.67	22.53 ± 8.90	
T_{int2}	13.89 ± 10.52	15.68 ± 8.67	
T_{int3}	9.35 ± 8.20	10.83 ± 7.34	

*Repeated measure ANOVA

The maximal rise in DBP was at $T_{2A/2F}$ compared to baseline at T_1. At T_{2A}, Group A showed a mean percentage variation of 40.24 ± 14.82 from T_1, while Group F (T_{2F}) showed 35.28 ± 21.36, which is comparable. After this, the DBP slowly declined towards baseline in both groups, rate of fall being more in Group A. (Table 4)

Table 4: Percentage variation in DBP compared to T_1

| Time points | % Variation compared to T_1 | | P value |
	Group A (n = 40) [Mean ± SD]	Group F (n = 40) [Mean ± SD]	
$T_{2A/2F}$	40.24 ± 14.82	35.28 ± 21.36	
T_{int}	32.72 ± 13.58	33.54 ± 20.15	
T_{int1}	21.65 ± 9.00	22.86 ± 13.80	0.746*
T_{int2}	13.45 ± 8.98	17.83 ± 12.28	
T_{int3}	9.42 ± 7.57	12.43 ± 10.00	

*Repeated measure ANOVA

In Group A the maximal rise in MAP was at T_{2A} compared to baseline at T_1. At T_{2A}, Group A showed a mean variation of 41.10 ± 11.96 from T_1, while Group F showed 29.97 ± 13.57. In Group F the maximal rise was at T_{int} compared to baseline at T_1. At T_{int}, Group F showed a mean variation of 30.35 ± 12.50 from T_1, while Group A showed 31.36 ± 11.38, which was comparable. After this, the MAP slowly declined towards baseline in both groups, rate of decline being more in Group A. (Table 5)

Table 5: Percentage variation in MAP compared to T_1

| Time points | % Variation compared to T_1 | | P value |
	Group A (n = 40) [Mean ± SD]	Group F (n = 40) [Mean ± SD]	
$T_{2A/2F}$	41.10 ± 11.96	29.97 ± 13.57	
T_{int}	31.36 ± 11.38	30.35 ± 12.50	
T_{int1}	20.55 ± 9.22	22.29 ± 9.51	0.508*
T_{int2}	12.73 ± 8.07	14.31 ± 9.26	
T_{int3}	8.63 ± 6.42	9.85 ± 7.29	

*Repeated measure ANOVA

All the patients were intubated orally in single attempt in both the groups. Six patients in Group A required ELM and 4 patients in Group F required jaw trust for intubation which was neither statistically and clinically significant. Duration of intubation in FOB group (mean value of 56.98 s) was more than Airtraq® video laryngoscope group (mean value of 37.38 s) which was statistically significant.

Discussion
The primary objective of this study was to investigate whether there is clinically significant difference between the haemodynamic response to orotracheal intubation by either of the devices (FOB and Airtraq® video laryngoscope) in patients undergoing elective surgery under general anaesthesia with MILS (used to simulate a cervical spine injury situation). Nahid Aghdaii *et al* compared FOB and direct laryngoscope with respect to haemodynamic response to orotracheal intubation in anaesthetised patients undergoing CABG surgery. This study was based on the hypothesis that intubation using FOB can avoid mechanical stimulation of the oropharyngo laryngeal structures and thereby reduce the HDSR. But surprisingly this study failed to show any significant difference in HDSR between the two groups with respect to BP and HR.[11] We had a similar hypothesis as that of the above study. We hypothesised that by application of MILS the difficulty in intubating with Airtraq® video laryngoscope will increase compared to FOB, and hence the chance for increased force on laryngeal

structures during Airtraq® video laryngoscope assisted laryngoscopy may lead to further increase in HDSR.

Time point T_1 (post induction of anaesthesia and paralysis, but just before instrumentation of airway) was taken as the baseline; as at time point T_0 anxiety was found to influence the HR and BP. During laryngoscopy/bronchoscopy, the mean (SD) percentage increase in HR from T1 in group A was 33.35 (9.88), and that in group F was 22.11 (10.61). But once the intubation was done the mean increase in HR became almost similar in the two groups as evident in the graph. A probable explanation could be that the FOB might not have produced much haemodynamic variation as laryngoscopy since the laryngeal structures were not much manipulated. We noted a slight increase in haemodynamic response just after the intubation in group F, which can be attributed to the rubbing of the highly innervated airway structures while advancement of the ETT in this group. This is in par with the results shown by Katsnelson *et al*, who found that it is during tracheal tube advancement over FOB that maximum change in HR and BP is seen.[12] Maximum change in HDSR is seen during laryngoscopy in Group A, as the maximum pressure on laryngeal structures occurs during this moment. Post intubation this pressure is withdrawn, and the mean increase in variables starts to fall, slowly reaching the baseline values.

A similar pattern of mean percentage variation was seen between the groups with respect to SBP, DBP and MAP. It should be noted that the percentage variation between T_{2F} and T_{int} in group F (though it is still less at T_{2F}) is less in blood pressure measurements value compared to HR. This could be because of the longer duration of recording the NIBP readings.

Advancement of the ETT over the FOB is often impeded when the Murphy's tip catches on the downward sagging epiglottis, arytenoid cartilage, vocal cords and anterior tracheal wall. On such occasions, the successful intubation often requires some specific manoeuvres e.g. rotating the tracheal tube, further lifting jaw upward and adjusting the patient's head-neck position which can result in hypertension and tachycardia. All these procedures may further stimulate pharyngolaryngeal structures and the trachea.[11] In our study number of cases which required additional manoeuvres in both the groups were comparable.

Though the time taken is more with FOB and the difference is statistically significant; clinically it was not significant since it reflected the additional distance ETT needed to pass from the railroaded FOB to trachea in Group F.

There were few limitations in our study. Use of real time arterial blood pressure monitoring in our study would have given a better picture of the haemodynamics. The time taken by the non-invasive blood pressure monitoring device in measurement might have missed the actual point of maximum blood pressure change. Use of MILS to simulate the difficult intubation in our study might not be uniform for every patient and acknowledge the potential for existence of bias.

Conclusion

Use of fibreoptic bronchoscope offer no added advantage over Airtraq video laryngoscope in terms of haemodynamic response for intubation in difficult airway situation such as cervical spine injury

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