Haemodynamic response to endotracheal intubation in coronary artery disease: Direct versus video laryngoscopy

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ABSTRACT

Endotracheal intubation involving conventional laryngoscopy elicits a haemodynamic response associated with increased heart and blood pressure. The study was aimed to see if video laryngoscopy and endotracheal intubation has any advantages over conventional laryngoscopy and endotracheal intubation in patients with coronary artery disease. Thirty patients suffering from coronary artery disease scheduled for elective coronary artery bypass grafting (CABG) were studied. The patients were randomly allocated to undergo either conventional laryngoscopy (group A) or video laryngoscopy (group B). The time taken to perform endotracheal intubation and haemodynamic changes associated with intubation were noted in both the groups at different time points. The duration of laryngoscopy and intubation was significantly longer in group B (video laryngoscopy) when compared to group A patients. However, haemodynamic changes were no different between the groups. There were no events of myocardial ischaemia as monitored by surface electrocardiography during the study period in either of the groups. In conclusion, video laryngoscopy did not provide any benefit in terms of haemodynamic response to laryngoscopy and intubation in patients undergoing primary CABG with a Mallampatti grade of <2.

Key words: Coronary artery disease, haemodynamic response, video laryngoscopy

INTRODUCTION

Laryngoscopy and endotracheal intubation is an integral part of general anaesthesia for cardiac surgery. Direct laryngoscopy and passage of endotracheal tube through the larynx is a noxious stimulus, which can provoke untoward response in the cardiovascular, respiratory and other physiological systems.[1] Significant tachycardia and hypertension can occur with tracheal intubation under light anaesthesia. The magnitude of cardiovascular response is directly related to the force and duration of laryngoscopy.[2] The sympathetic response and the resulting haemodynamic response have been extensively studied and documented in different patient groups, both with and without cardiac illness.[3] Hypertension, tachycardia and arrhythmia caused by endotracheal intubation can be deleterious in patients with poor cardiovascular reserve. Such haemodynamic changes that occur during intubation may alter the delicate balance between myocardial oxygen demand and supply and precipitate myocardial ischaemia in patients with coronary artery disease. Methods to attenuate these responses, both pharmacological and otherwise, have also been studied.[4-6]

The video laryngoscope [Figures 1 and 2] is a new airway tool, which was developed to address difficult airway. The Pentax Airway Scope (AWS), (AWS-S100; Pentax Medical Company, New Jersey, USA) is a battery-operated video laryngoscope, first described in 2006, which has shown promising results in patients with difficult airways. It consists of a handle with a 2.4-inch (6-cm) LCD screen, a disposable, polycarbonate. rigid blade called PBLADE®, a light source and camera system mounted 3 cm from the tip of the blade. The monitor screen can be tilted (0°–120°) to facilitate viewing of the images from the cranial, lateral and

Figure 1: Assembled pentax video laryngoscope

Figure 2: Pentax video laryngoscope with blade datached

caudal ends of the patient. The AWS is operated by two AA batteries which allow almost 1 hour of operating time. It is not known if this device offers any particular advantage in terms of haemodynamic stability when compared to conventional direct laryngoscopy in patients with ischaemic heart disease. This study was undertaken to compare the haemodynamic changes that occur during and after endotracheal intubation with either a conventional (Macintosh) laryngoscope or a video laryngoscope in patients with documented coronary artery disease who did not have anticipated intubation difficulty.

METHODS

After getting approval from the institutional review board (IRB) and informed consent from the patients, 30 consecutive patients scheduled for elective coronary artery bypass grafting (CABG) were enrolled for the study. Patients were excluded if risk factors for gastric aspiration, difficult intubation, or both (Mallampatti class III or IV; thyromental distance <6 cm; and inter-incisor distance <3.5 cm) were present. Patients with left main coronary artery disease, poor left ventricular (LV) function, conduction abnormality and those on a permanent pacemaker were excluded too. All data were collected by an independent unblinded observer. Patients were randomised into two groups: tracheal intubation done with the Macintosh blade (group A) (size 3 blade in females; size 4 in males) or with AWS (Pentax) video laryngoscope (group B). The allocation sequence was generated by random number tables. Tracheal intubation was performed in each patient by one of the three consultant anaesthesiologists who learnt and performed at least 20 intubations with the new device in the clinical setting, prior to the study. All the patients received standard premedication of diazepam (10 mg) orally the previous night and on the morning of surgery. All antihypertensive and

antianginal medications were continued till the morning of surgery with the exception of angiotensin-converting enzyme inhibitors and angiotensin-receptor blockers. Electrocardiogram and pulse oximeter were used for monitoring the patients during induction of anaesthesia in addition to direct intra-arterial pressure monitoring placed under local anaesthesia with the patient breathing O_2 with face mask. Baseline parameters, namely, heart rate (HR), systolic, diastolic and mean blood pressure (SBP, DBP and MBP, respectively), and arterial oxygen saturation (SPO_2) were recorded. Electrocardiographic (ECG) monitoring for myocardial ischaemia and arrhythmia was instituted during the study period using automated system with Solar, Marquett monitoring system. Myocardial ischaemia was defined as ST-segment depression or elevation exceeding 1 mm, 60 ms after the J point.

After pre-oxygenation, anaesthesia was induced with titrated doses of fentanyl (5–10 μg/kg) and midazolam (0.1–0.2 mg/kg) till loss of consciousness, and pancuronium bromide (0.1 μg/kg) was used for neuromuscular blockade in standard dosage. Patients were ventilated manually with isoflurane (1% end-tidal) in oxygen using facemask and laryngoscopy was done at the end of 3 min. In group A patients, trachea was intubated orally with an 8.5 mm ID endotracheal tube (Portex, Kent, UK) using conventional laryngoscopy (Macintosh blade) by one of the three consultant anaesthesiologists. No local anaesthetic (lignocaine) was utilised either as laryngotracheal spray or by intravenous route. The time (in seconds) to intubation was calculated from the time of picking up of the laryngoscopy to the time the blade was removed from the month after successful intubation, using a stop-watch. In group B patients, video laryngoscopy was used in the following manner. An 8.0-mm ID

polyvinyl chloride tracheal tube (Portex, Kent, UK) (for males) or a 7.0-mm ID tube (for females) was attached to the groove of the video laryngoscope blade and the tip of the tracheal tube was positioned just beyond the charge-coupled device (CCD) camera. After induction of anaesthesia and neuromuscular blockade, one of the three senior anaesthesiologists introduced the Pentax-AWS into the mouth, and advanced the tip of the blade towards the glottic side of the epiglottis [Figure 3]. Tracheal intubation was performed after ensuring that the glottis was in the center of the green target symbol using the video laryngoscope. Time (in seconds) to intubate the trachea, starting from picking up the Pentax-AWS to removal of the scope after successful tracheal intubation, was measured. The heart rate, arterial blood pressure (systolic, diastolic and mean), SPO_2, end tidal carbondioxide ($EtCO_2$) were recorded at eight specified intervals, namely, T_1 = baseline, prior to anaesthetic induction; T_2 = after anaesthetic induction, prior to relaxant administration; T_3 = after administration of muscle relaxant and just before intubation attempt; T_4 = 1 min after endotracheal intubation; T_5 = 2 min after endotracheal intubation; T_6 = 3 min after endotracheal intubation; T_7 = 4 min after endotracheal intubation; T_8 = 5 min after endotracheal intubation. $EtCO_2$ was maintained within 40 ± 5 mmHg to avoid the effects of hypercarbia or hyperventilation on the haemodynamic variables. The ECG was monitored continuously for arrhythmia and ischaemic episodes, if any. After successful tracheal intubation, in all patients, the lungs were mechanically ventilated for the duration of the surgical procedure and anaesthesia was maintained with isoflurane (end-tidal 1–1.25%) in oxygen. No other medications were administered or procedures performed during the 5-min data collection period after tracheal intubation. Subsequent management was left to the discretion of the anaesthesiologist providing care for the patient. CVP, pulmonary artery (PA) and urinary catheterization were done after of data collection. If the patient needed intervention on account of brady cardia or tachycardia, hypertension or hypertension, was treated appropriately as follows. Bradycardia with a heart rate of <50 beats/min was treated with 0.6 mg atropine intravenous (IV); hypotension with systolic BP of <90 mm Hg was treated with 50–100 μg of phenylephrine IV; hypertension with a systolic BP of ≥180 mmHg was treated by increasing the anaesthetic depth followed by nitroglycerine infusion. Data were expressed as mean ± SD and statistically analysed using analysis of variance (ANOVA) and paired "*t*"-test over time and software SPSS-17.00.

RESULTS

There were 30 patients in the study (15 in each group). The demographic data, incidence of hypertension, serum creatinine, LV ejection fraction, and Mallampatti score were similar in both the groups. The time taken for endotracheal intubation was significantly longer in group B (Pentax video laryngoscopy) patients as compared to group A (conventional laryngoscopy) patients (i.e., 36.4 ± 2 vs. 22.08 ± 8 seconds) [Table 1]. However, there were no differences in the haemodynamic response between the groups, i.e., cardiovascular changes were comparable in between the two groups [Table 2]. Both the groups showed a reduction in arterial pressure after anaesthetic induction but prior to laryngoscopy, as a result of haemodynamic effects of the anaesthetic induction and loss of consciousness. There were no significant

Figure 3: Insertion of pentax laryngoscope for endotracheal intubation

Table 1: Patient demographic and other details (mean ± SD)		
	Control (conventional) Group A (*n* = 15)	**Test (Pentax) Group B (*n* = 15)**
Age (years)	55 ± 8	59 ± 8
Weight (kg)	65 ± 10	62 ± 5
Hypertension	5	5
Diabetes mellitus	3	7
Serum creatinine (mg%)	0.87 ± 0.14	0.88 ± 0.15
LV ejection fraction (%)	57.3 ± 5	53.2 ± 9
Mallampatti score	1.01 ± 0.8	1.57 ± 0.5
Teeth abnormality	None	None
Anticipated difficulty	None	None
Time taken for endotracheal intubation (seconds)	22.08 ± 8	36.43 ± 2*

*$P \leq 0.05$

	HR		BP sys		BP dia		Mean BP		SPO₂		EtCO₂	
	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B
T_1	62.5 ± 9	70.1 ± 15	148 ± 30	137 ± 22	68 ± 12	70 ± 11	100 ± 14	94 ± 13	99 ± 1	99 ± 1		
T_2	57 ± 10	73.6 ± 22	133 ± 27	121 ± 24	65 ± 15	63 ± 15	88 ± 19	84 ± 15	99.5 ± 0.6	99.6 ± 1		
T_3	69 ± 13	70 ± 14	119 ± 25*	102 ± 23*	64 ± 13	52 ± 12*	84 ± 16	70.6 ± 16*	99.5 ± 0.6	87 ± 24		
T_4	73 ± 12	75 ± 12	124 ± 26*	115 ± 27*	64 ± 13	61 ± 14*	87.6 ± 13.2	80.7 ± 20*	99.3 ± 0.6	99.8 ± 0.5	35 ± 6	36.8 ± 16
T_5	72 ± 11	72 ± 12	117 ± 27*	105 ± 23*	61 ± 12	54 ± 13*	81 ± 18	73 ± 17*	99.3 ± 05	98.9 ± 0.53	34 ± 6	31 ± 5
T_6	69 ± 11	71 ± 13	110 ± 26*	95 ± 17*	56 ± 12	50 ± 9*	75 ± 15	66 ± 13*	99.8 ± 0.5	99 ± 0.2	33.9 ± 4	31 ± 5
T_7	68 ± 11	71 ± 13	104 ± 27*	92 ± 5*	54 ± 13	48 ± 9*	71 ± 16	69 ± 12*	99.7 ± 0.5	99.9 ± 0.2	32 ± 5	30 ± 5
T_8	68 ± 10	70 ± 13	100 ± 27*	88 ± 15*	53 ± 13	47 ± 9*	69.5 ± 17	62 ± 12*	99 ± 0.5	99.9 ± 0.2	32 ± 5	29 ± 5

Table 2: Haemodynamic data (mean ± SD) with video (group B) and conventional (group A) laryngoscopy in patients with coronary artery disease

T_1 = Baseline, prior to anaesthetic induction; T_2 = after anaesthetic induction, prior to relaxant administration; T_3 = prior to endotracheal intubation but after relaxant administration; T_4 = 1 min after endotracheal intubation; T_5 = 2 min after endotracheal intubation; T_6 = 3 min after endotracheal intubation; T_7 = 4 min after endotracheal intubation; T_8 = 5 min after endotracheal intubation; *Significant change P <0.05 for within group comparison; HR = heart rate; BP = blood pressure; SPO₂ = oxygen saturation; EtCO₂ = end tidal carbon dioxide

differences between the groups with respect to SAP, MAP and DAP, but within the group, SAP, MAP and DAP decreased significantly during the 5-min observation period, indicating anaesthetised state with no surgical stimulation. This did not warrant any treatment. There were no incidences of arrhythmia or new myocardial ischaemia during the study period in either of the groups.

DISCUSSION

Laryngoscopy and endotracheal intubation results in sympathetic stimulation that leads to hypertension and tachycardia. These haemodynamic changes in cardiac patients can cause instability in the crucial period of anaesthetic induction before the cardiac disease is addressed. Heart rate is an important determinant of myocardial oxygen demand, and tachycardia in patients with ischaemic heart disease is a risk factor for the development of perioperative myocardial ischaemia and infarction.[7] Hence, the need to attenuate the sympathetic response to laryngoscopy and endotracheal intubation is important in patients with coronary artery disease undergoing coronary revascularisation. Direct laryngoscopy involves stretching the oropharyngeal tissues in an attempt to straighten the angle between the mouth and the glottic opening, and this stretch can cause pain and trigger a stress response.[8] Since tracheal intubation is unavoidable for major surgical procedures like cardiac surgery, the attempt to reduce the sympathetic stimulation is now directed towards minimising the stretching of tissues in the epipharynx and laryngo-pharynx. Blind nasal intubation by avoiding laryngoscopy altogether was able to achieve this.[9] Performing blind nasal intubation has a steep learning curve and may not be recommended in patients soon to be heparinised for fear of nasopharyngeal bleeding.

Both laryngoscopy and intubation separately result in sympathetic stimulation, but the catecholamine rise with intubation exceeds that with laryngoscopy alone.[10] Various anaesthetic agents, adjuvants and analgesics have been used to blunt the level of stimulation and the stress response to the manipulation and stimulation of airway during laryngoscopy and intubation. Fentanyl, beta-adrenergic receptors blockers, and lignocaine have all been used with varying results.[11,12]

Newer airway aids have always been a part of the evolution of anaesthetic equipment and have been used either to facilitate laryngoscopy and intubation so as to avoid major sympathetic stimulation or to aid in a scenario of difficult intubation. These airway aids are compared with the current standard practice of using a direct laryngoscopy and endotracheal intubation. The fibreoptic bronchoscope, McCoy laryngoscope, and more recently the stylescope have been studied and the haemodynamic changes have been found to be lesser with these than with direct laryngoscopy. The patients studied in these groups were non-cardiac patients. Another airway adjunct, laryngeal mask airway (LMA), was used in 27 patients coming for CABG and it was found to cause lesser tachycardia than direct laryngoscopy.[13] Koyama *et al*. developed an airwayscope which was used in orotracheal intubation in neurosurgical patients needing general anaesthesia.[14]

The Pentax-AWS is a new video laryngoscope consisting of a disposable transparent blade (PBLADE®), a 12 cm cable with a CCD camera, and a 2.4-inch liquid crystal device monitor display.[15,16] The main unit is water-proof, facilitating cleaning with water or a disinfectant, such as ethanol. The device is light (it weights 290 g without batteries). The image is displayed on a full-colour screen. A tracheal tube

can be attached to the right side of the blade. There is a green target symbol on the monitor display, which indicates the direction of the tracheal tube tip. The PBLADE has a port through which a suction catheter can be passed. The distal aperture of the suction port is near the CCD camera, so that the tip of the suction catheter will come into view. The Pentax-AWS has been commercially available in Japan since July 2006, and its use has been described in a limited number of patients.[17]

The video laryngoscope is a new airway tool, which by virtue of the fiberoptic bundle incorporated in it, can reduce the amount of stretch on the airways and gives a good view in the LCD display. The ease of use of this laryngoscope has already been demonstrated in 100 patients, where 98 patients were uneventfully intubated, without any adverse effects.[17] Recent studies indicate that this device may have advantages over the Macintosh in patients undergoing cervical spine immobilisation.[18-21] There is evidence to show that the AWS caused less haemodynamic stimulation than the other laryngoscopes. Heart rate was not altered significantly with this device during intubation attempts. These findings may reflect the fact this device provides a view of the glottis without the need to align the oral, pharyngeal, and tracheal axes, reducing cervical movement thereby reducing the potential for haemodynamic stimulation.[20]

There are three important limitations regarding this study. First, we acknowledge that the potential for bias exists, as it is impossible to blind the anaesthesiologist to the device being used. Secondly, the relative efficacies of these devices in comparison with other promising devices such as the Airtraq, McCoy, McGrathw, Bonfils, intubating LMA or Bullard laryngoscopes have not been determined.

CONCLUSION

The present study did not demonstrate benefit with the use of Pentax video laryngoscope in terms of obtundation of cardiovascular responses to laryngoscopy and endotracheal intubation in patients with ischemic heart disease who did not have intubation difficulty. It is worthwhile to evaluate the utility of the device in patients with ischaemic heat disease with a Mallampatti score of ≥2, both form the point of view of ease of endotracheal intubation and haemodynamic response. The time taken for intubation was significantly longer in the Pentax video

laryngoscope group and it is postulated that if the time taken for laryngoscopy/intubation could be reduced, we might be able to realise the benefit of video laryngoscope in terms of haemodynamic response. The mean time taken to achieve endotracheal intubation with video laryngoscopy was longer in this study probably because of two reasons, namely, extra time taken in (i) centering the green target symbol and (ii) sliding the endotracheal tube though the grove of the video laryngoscope.

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