AIRWAY MANAGEMENT AND HEMODYNAMIC RESPONSE TO LARYNGOSCOPY AND INTUBATION IN SUPINE AND LEFT LATERAL POSITIONS

Muhamad Faisal Khan*, Fawzia Anis Khan**
and Fawzia Nasim Minai***

Abstract

Introduction: Intubation in the lateral position is desirable in several conditions. We compared the technical ease and hemodynamic response to laryngoscopy and intubation in the lateral (group L) and supine (group S) positions in 120 patients with normal airway in a prospective randomized controlled study.

Methods: This was a randomized, controlled observational study. All intubations were performed by a single investigator experienced in lateral intubation. Ventilation score with bag and mask ventilation, laryngoscopy duration and attempts, application of external pressure and Cormac & Lehane grade were measured. Blood pressure and heart rate were observed before and after induction of anesthesia, after laryngoscopy/intubation and then at one minute interval for 6 minutes.

Results: 90% of patients in group S were ventilated by a single operator compared to 17% in group L. Duration of laryngoscopy was significantly longer in group L (32 seconds) compared to group S (12 seconds) [$p<0.001$]. 78% of the patients in group S had Cormack and Lehane grade 1 versus nil in group L. External pressure was required in 58% patients in group L and 5% in group S. In intra-group comparison at specified time lines no difference was observed in HR but the changes in BP were significantly higher in the lateral position (P-value <0.001).

Conclusion: Ventilation and intubation in lateral position was more difficult technically than in the suprine position, and the BP response was exaggerated in the lateral position.

Keywords: Laryngoscopy; intubation; supine; lateral; hemodynamic response.

* FCPS (Pak), Senior Instructor, Department of Anaesthesia, Aga Khan University, P.O. Box 3500, Karachi 74800, Pakistan.
** FRCA (UK), Professor, Department of Anaesthesia, Aga Khan University, P.O. Box 3500, Karachi 74800, Pakistan.
*** FCPS (Pak), Assistant Professor, Department of Anaesthesia, Aga Khan University, P.O. Box 3500, Karachi 74800, Pakistan.

Author for Correspondence: Dr. Muhammad Faisal Khan, Senior Instructor, Department of Anaesthesia, Aga Khan University, Stadium Road, P.O. Box 3500, Karachi-74800, Pakistan. Telephone: (92) 21 486-4639, Fax: (92) 21 493-4294, 493-2095, E-mail: mfkdr.icu@gmail.com

Introduction

Anaesthesiologists should be able to performs tracheal intubations in the lateral position as this position may be encountered in trauma, accidental airway loss during surgery, in posteriorly located pathology, or in patients with oral bleed.

The published literature on this topic is deficient. A recent randomized control trial has looked at the technical ease of tracheal intubation in the lateral position[1], others have compared the use of different airway devices other than tracheal tube in supine versus lateral positions[2,3]. The aim of this study was to compare the technical ease and hemodynamic response of laryngoscopy and intubation in lateral and supine position in patients undergoing elective surgery under general anesthesia. All of these patients had a low predictive risk of difficult airway. Our rationale was that in the lateral position gravity will aid the laryngoscopist by displacing the tongue and this less force may be require thus altering the hemodynamic response.

Methods

After institutional ethical committee approval, written informed consent was obtained from 120 surgical patients scheduled to undergo general anesthesia for elective surgery for this prospective randomized controlled trial. The sealed opaque envelope technique was used to divide the patients into two groups of 60 patients each; a control group, where tracheal intubation was carried out in the supine position (S) and the study group in whom the tracheal intubation was performed in the lateral position (L). The inclusion criteria was American Society of Anesthesiology (ASA) class 1 and 2, adults of either sex 18 to 55 years of age with no predictors of difficult mask ventilation or difficult intubation.

Detailed airway assessment was conducted on each enrolled patient by one of the primary investigators. The preoperative difficult airway predictors used were Langeron's criteria of difficult mask ventilation[4], Mallampati class, Wilson score[5], and sub mandibular space assessment. Patients who had Langeron Difficult Mask Ventilation (DMV) score more than or equal to 2, Mallampatti class 2, 3 or 4, Wilsons score more than 4, thyromental distance less than 6 cm, mentohyoid distance less than 4 cm, or inadequate jaw protrusion, were excluded. Other patients who were excluded were those with facial trauma, emergency surgery, history of gastro-esophageal reflux, pregnancy, raised intracranial pressure, cervical spine disease, dental abnormalities, and obesity. Patients with hypertension, cardiovascular disease or atherosclerotic disease were also excluded.

All patients were premedicated with 0.15 $mgkg^{-1}$ of oral midazolam one hour before surgery. On arrival to the operating room patients were monitored with CM 5 lead for measuring the heart rate (HR) and ST segment changes. An 18 gauge iv catheter was inserted in an upper extremity vein. Blood pressure (BP) was measured at preset intervals by oscillotonometry using Datex Ohmeda monitor (AS 3; Datex, Helsinki Finland). Oxygen saturation using a finger pulse oximeter and $EtCO_2$ were measured continuously. The BP and HR readings were taken preinduction (baseline), after a rest period of five minutes, one minute after induction and then every minute following laryngoscopy and intubation for six minutes by an anesthesiologist unconnected with the study.

Prior to induction patients in group L were placed in the left lateral position with a pillow under the head and the head and neck in the sniffing position. Baseline readings were obtained. Those in group S stayed supine with a pillow under the occiput. The height of the table was adjusted so that the top of patients head was at the xiphisternum of the anesthesiologist in both groups.

All patients were pre oxygenated with 4 liters of oxygen/min. Fentanyl 1.5 μgkg^{-1} was administered intravenously over a period of 5 sec. Anesthsia was induced with thiopentone 4mg kg^{-1} administered over a period of 30 seconds, and muscle relaxation was achieved with atracurium 0.6 $mgkg^{-1}$ administered over a period of 10 secs. The lungs of all patients were ventilated with N_2O/O_2 60:40 mixture and 1% isoflurane. Hand ventilation was assessed by a ventilation score. This score looked at how the airway was maintained before tracheal tube insertion. A note was made whether a single operator could maintain the airway without insertion of oropharangeal airway, single operator along with insertion of oropharangeal airway, two operators without insertion of oral airway, or two operators with insertion of oral airway. All induction and tracheal intubations were performed by a single investigator with anesthesia experience of seven years who underwent a learning curve for lateral intubation. Intubating conditions were assessed by ulnar nerve stimulation. Laryngoscopy was performed at train of four count zero with a size 3 Macintosh laryngoscope blade.

Difficulty of intubation was graded I-IV according to Cormac and Lehane classification. A note was also made of the number of intubation attempts and application of any external pressure. Pressure was be applied at the level of cricoid cartilage. A size 7.5mm polyvinyl chloride tracheal tube was used in females and size 8.5mm in male patients. The time from insertion of laryngoscope to successful insertion of tracheal tube (appearance of capnograph on manual ventilation) was monitored by a stop watch by another anesthesiologist not connected to the study. Mucosal trauma and lip or dental injuries were also recorded. In case of failure of appearance of capnograph for three consecutive manual breaths, the tube was withdrawn and reinserted. Number of attempts of laryngoscopy for correct tracheal tube placement were noted. Any disturbance of cardiac rhythm, rate, inability to maintain the oxygen saturation of 95% or more, any ST segment depression of more than 1mm during the study period was also noted. In case of failure to intubate in the lateral position, with more than 3 attempts or more than five minutes, or desaturation to less than 92% the protocol required the patients to be turned supine and intubation performed in the supine position.

For intubation in the left lateral position the laryngoscope was held in the left hand and inserted from the right side of the mouth, and the tracheal tube was held in the right hand. The duration of laryngoscopy was defined as the time from insertion of the laryngoscope to the time of appearance of capnograph trace with positive pressure ventilation. The end point of the study was six minutes after intubation.

Results

Demograhphic characteristics and baseline hemodynamic parameters

There were 60 patients in each group. The demographic characteristics of the two groups are shown in Table 1.

Table 1
Demographic characteristics and baseline haemodynamic parameters of the two groups Mean (SD)

	Group S	Group L	P value
Age: years	35.8 (12.8)	35.0 (11.3)	0.71
Weight: kg	69.0 (9.8)	66.7 (10.5)	0.22
Gender: m/f	38/22	38/22	1.0
SAP	126.6 (14.6)	119.8 (13.8)	0.009
DAP	78.9 (8.3)	72.5 (10.3)	<0.001
MAP	64.4 (9.4)	86.6 (9.8)	<0.001
HR	80.5 (16.4)	77.03 (12)	0.32

SD: Standard deviation; SAP: Systolic arterial pressure; DAP: Diastolic blood pressure; MAP: Mean arterial pressure; HR: Heart rate
No significant difference was observed in age (p = 0.71), weight (p = 0.22) and gender (p = 1.0). Significant difference was observed between baseline systolic blood pressure (p = 0.009), diastolic (p <0.001), and mean arterial pressure (p <0.001) between the two groups. No difference was observed in heart rate (p = 0.32).

Preoperative Airway Assessment

The comparison is shown in Table 2.

Table 2
Comparison of preoperative airway assessment between the two groups (SD deviation)

Airway assessment	Groups S	Groups L	p value
DMV Score			
0	45	45	
1	11	13	0.65
2	4	2	
Wilson's Score			
0	58	55	0.41
1	2	5	
Mean TM distance	9.86 (2.25)	10.13 (2.02)	0.49
Mean MH distance	7.50 (1.46)	7.27 (1.50)	0.39

DMV : Difficult mask ventilation
TM distance : Temperomandibular distance
MH distance : Mentohyoid distance
No significant difference was observed between the two groups.

Ease of mask ventilation

54 patients (90%) in group S were ventilated by a single operator, versus 10 (17%) in group L.

One patient in each group required two operators to ventilate. Five patients in group S needed one operator + oropharangeal airway versus 42 in group L. None of the patients in group S needed 2 operator + oropharangeal airway versus 7 in group L (p = <0.001).

Number of intubation attempts and applications of external pressure

All patients in group S were intubated by a single attempt versus 41 in group L (68%). Nineteen patients in group L required two attempts. (CI 1.2, 1.44). In three (5%) patients in group S and, 35 (58%) in group L external laryngeal pressure was required to bring vocal cords in view.

Duration of laryngoscopy

Mean duration of laryngoscopy in group S was 12.9 seconds, SD 4.2 (95% CI 11.8 – 14.0), compared to 32 seconds, SD 12.7 (95% CI: 28.7-35.3) in group L. This difference was significant (p <0.001).

Grade of intubation

Forty seven patients (78%) in group S had Cormack and Lehane (C & L) grade 1 versus none in group L. Eleven patients in group S had C & L grade 2a and two were grade 2b. Eighteen patients in group L were C&L2a, and 39 were 2b. Three patients in group L were grade 3 C&L compared to none in group S.

None of the patients required turning from lateral to supine position.

Hemodynamic Changes

Blood pressure

A significant difference in SAP, DAP and MAP was seen in the baseline parameters inspite of randomization. Average percentage change from baseline was therefore calculated in both groups for comparison. The trend was initial decrease from baseline blood pressures after induction, then increase after laryngoscopy and intubation, remaining high for three minutes and thereafter decreasing to baseline values. This difference was significant (p <0.001) when the percentage change from baseline was compared at different timelines in the same group. A significant difference was observed between the two groups with the values being higher in the lateral group (p <0.001). Similar changes were observed for SAP, DAP and MAP (Figures 1, 2 and 3).

Heart rate

There was no difference in baseline heart rate between the two groups. A significant difference was observed compared to baseline in both groups within intra group comparison (p <0.001). On inter group comparison the difference was significant at all time points with the readings being higher in the L group (Figure 4).

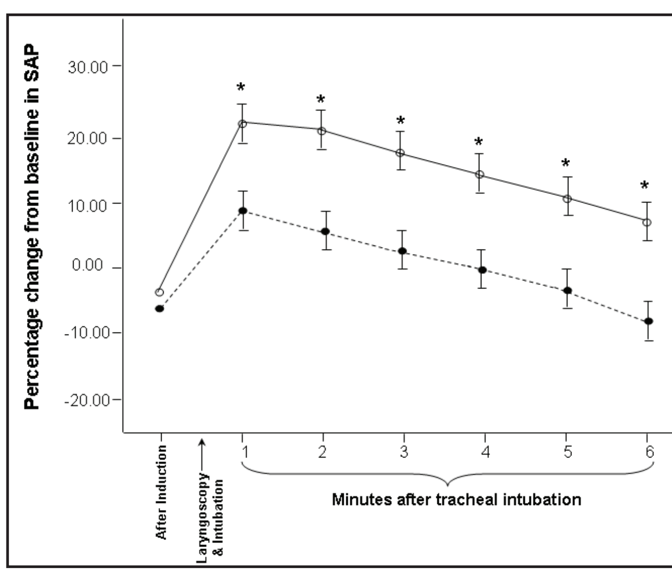

Fig. 1
Mean percentage change in systolic blood pressure associated with tracheal intubation at specified time points in the supine (●) and lateral (o) groups, with 95% confidence intervals.
**P<0.05 between groups*

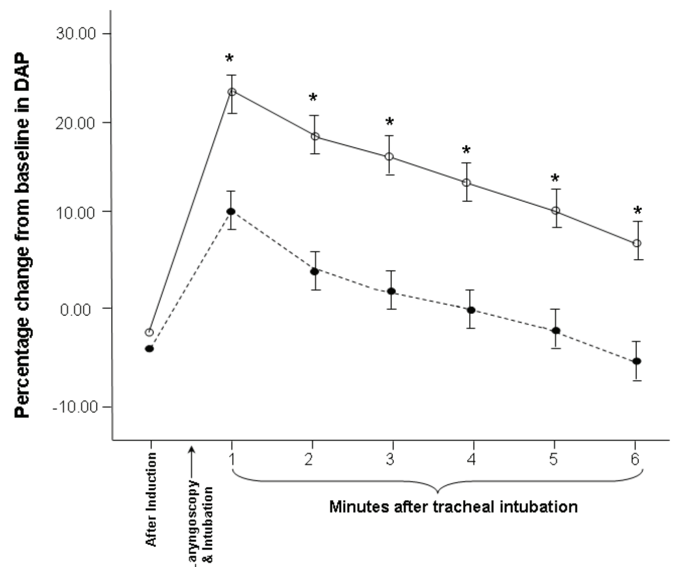

Fig. 2
*Mean percentage change in diastolic blood pressure associated with tracheal intubation at specified time points in the supine (●) and lateral (o) groups with 95% confidence intervals. *P<0.05 between groups*

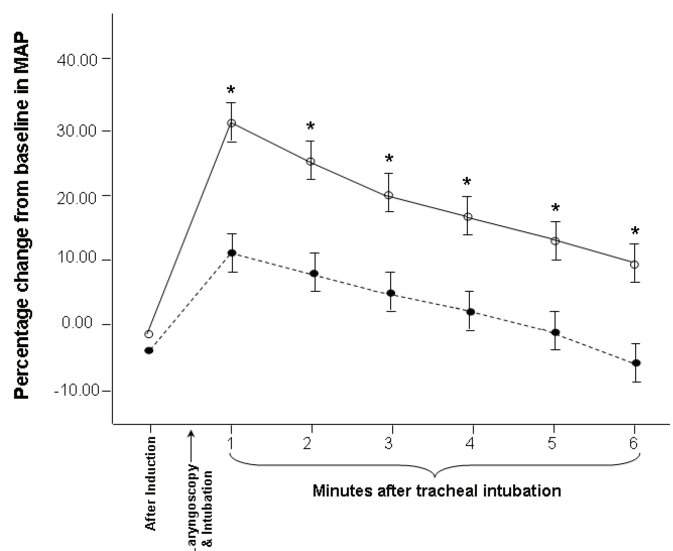

Fig. 3
*Mean percentage change in mean arterial blood pressure between groups associated with tracheal intubation at specified time points in the supine (●) and lateral (o) groups with 95% confidence intervals. *P<0.05 between groups*

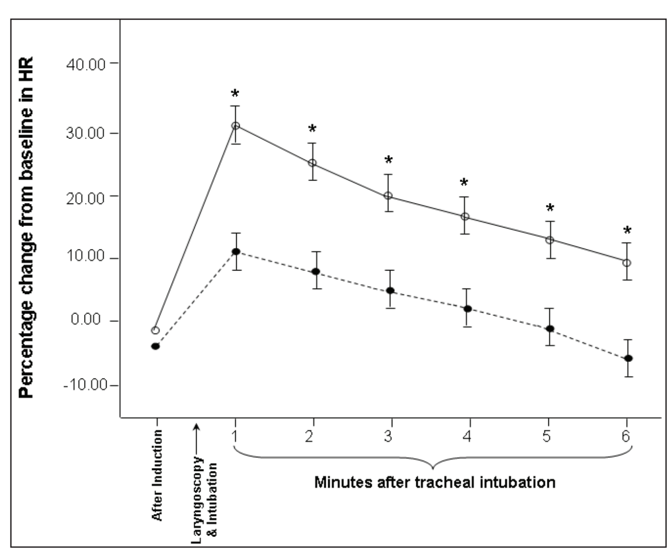

Fig. 4
*Mean percentage change in heart rate associated with tracheal intubation at specified time points in the supine (●) and lateral (o) groups with 95% confidence intervals. *P <0.05 between groups*

Complications

None of the patients in either group had a heart rate of less than 60 beats/minutes during the study period. No desaturation below 95%, as measured by pulse oximetry or ST segment changes were observed in either group. Esophageal intubation was not observed in either group. No mucosal or dental injury was reported.

Discussion

Supine position is the conventional position used for tracheal intubation, however intubation in left lateral position is recommended by some authorities in failed intubation drills[6] and as a safer position for post tonsillectomy hemorrhage[7]. It may also be helpful in posteriorly located pathology like cervical meningomylocele, injuries, abscesses, and in large goiters.

The left lateral position prevents the laryngeal structures from collapsing[8]; it also decreases upper airway obstruction in anesthetized adults and in children with sleep apnea[9]. McCaul recently looked at the airway management in the lateral position and subsequent use of tracheal tube or LMA[1]. The left lateral position resulted in deterioration of laryngoscopic view in 35% of patients. In eight out of 39 patients there was failure of tracheal tube insertion compared to one out of 30 in the LMA group. The paper did not mention whether the anesthetists were trained or felt comfortable in intubating in the lateral position. The exact duration of training to learn this technique is also not clear. In a study by Nathanson the reduction in intubation time from first to third attempt was 12% versus, 27% for supine and lateral positions[10], but there are no universal recommendations. The intubation time in our study was 32 $\pm$ 12.7 seconds in lateral position compared to 12.9 $\pm$ 4.2 seconds in the supine position. We did not have any failed intubation. This difference in success of intubation in lateral position was probably due to the experience of the principle investigator who underwent a formal training period till he felt comfortable in airway management in the lateral position.

Majority of our patients in supine position (90%) required a single operator for bag mask ventilation following muscle relaxation versus 17% in the lateral position. The laryngoscopic view also deteriorated in lateral position and 58% of the patients in this group required external pressure to bring vocal cords in view and tracheal intubation took significantly longer Time. Our results are similar to McCaul et al[1], in this respect. Nathanson[10] et al reported a higher rate of esophageal intubation in lateral position, whereas we did not encounter any esophageal intubation in our series.

Other studies have compared alternate airway devices besides tracheal tubes in both supine and lateral positions e.g. intubating laryngeal mask airway (ILMA)[11], LMA[1] fiber optic laryngscope[8], and light wand[3]. Both LMA and light wand provided reliable airway control in the lateral position. None of these studies looked at the hemodynamic responses.

Laryngoscopy and intubation lead to hemodynamic instability due to sympathetic stimulation. The major stimulus is said to be the force exerted by the laryngoscope[12]. Our rationale to look at this response was that the force maybe different in the two positions as gravity aids the movement of the tongue and lesser laryngoscopic force maybe needed in the lateral position hence leading to a lesser hemodynamic response.

There was a significant difference in the baseline systolic, diastolic and mean blood pressure in our groups inspite of random allocation. This has also been pointed out in a study by Whiteman et al[13] who found cardiac output to be higher in the left lateral position compared to supine or right lateral position. Similar results were seen by Nakao et al[14] in animals where cardiac output increased from supine to left lateral position. In order to overcome the difference in the baseline blood pressure we only compared the percentage rise in the values rather then the absolute rise. No change in the heart rate was observed. Our findings were similar with higher blood pressure recorded in left lateral position but the heart rate remained the same.

The hemodynamic response to laryngoscopy and intubation was exaggerated in the lateral position compared to supine position. In supine position all readings post intubation were within 20% of baseline. In lateral position the parameters remained above 20% of baseline until three minutes post intubation. A prolonged intubation time and a higher number of multiple attempts in lateral position could have exaggerated the response further. Duration of laryngoscopy is one of the factors that increase this response[15]. This could be a limitation in our study.

Another limitation of our study is that an experienced user inserted the tracheal tube in the lateral position and our results may not be applicable to inexperienced users. Thirdly although patients were randomly assigned, double blinding was not practical in our study.

We recommend that tracheal intubation in lateral position be formally taught in the training program but the exaggerated hemodynamic response should be kept in mind. This response still occurred inspite of giving fentanyl 1.5 micrograms kg^{-1} and though attenuated, but could be detrimental in patients with pre-existing ischemic heart diseases, hypertension or cerebrovascular pathology; and manipulating the airway in the lateral position in such patients may not be desirable. The hemodynamic response also needs to be studied with other airway devices recommended for insertion in the lateral position. More work needs to be done on the teaching curve required to learn this skill.

Conclusion

Our study indicates that both mask ventilation and intubation are more difficult in the lateral position compared to supine, probably due to alteration in larangeal anatomy. The blood pressure response is also exaggerated in the lateral position but there is no change in the heart rate response. We recommend that lateral intubation should be formally taught as a skill in the residency programs and further work needs to be done in this area.

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