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Evaluation of Hemodynamic Response between Laryngeal Mask Airway and Endotracheal Tube Extubation with General Anaesthesia

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Abstract

Introduction: Airway management is an essential, but challenging skill in the field of anaesthesiology. Since many years, endotracheal tube has been in vogue for surgeries involving general anaesthesia. However, endotracheal extubation causes serious hemodynamic changes, which could result in several cardiovascular complications. Among several advanced techniques, Laryngeal Mask Airway (LMA) is a less invasive procedure, with similar therapeutic outcomes. This study was carried out to compare the hemodynamic responses between LMA and endotracheal tube extubation.

Methodology: This study was done as a single blind randomized controlled trial among 60 normotensive individuals who underwent elective surgeries under general anaesthesia, with 30 participants in each group. Values of heart rate and blood pressure were recorded, while rate pressure product was calculated. The hemodynamic parameters were recorded at baseline, pre-extubation 1, 2, 3, 5 and 10 min after extubation/removal. Independent samples t test was carried out to check for statistical significance at 95% level.

Results: The mean age of the participants in LMA group was 39.3 ± 8 years while that of endotracheal tube group was 40.1 ± 9.4 years. There was a steady increase in the hemodynamic responses with both the groups. Overall the mean increase in the values of heart rate, blood pressure and rate pressure product were lower for the LMA group compared to the endotracheal tube group beginning from one min ($p<0.05$).

Conclusion: This study elucidates the advantages of LMA over endotracheal tube extubation, in terms of minimizing the cardiovascular complications among normotensive individuals.

Keywords: Cardiovascular complications; Endotracheal tube extubation; Laryngeal mask airway; Heart rate

Introduction

Airway management is one of the most important skills in the field of anaesthesiology, and an inability to secure the airway can lead to catastrophic results. Endotracheal intubation for the purpose of providing anaesthesia was first described by William Mac Ewan in 1878 [1]. Before 1990, only the face mask and endotracheal tube were available. Since then, several supraglottic airway devices have been developed, of which the Laryngeal Mask Airway (LMA) has been very popular. LMA was conceived and designed by Dr. Archie Brain in UK in 1981 [2]. From then on, it has become an integral part of routine airway management and has proved to be extremely useful in managing the difficult airway.

Endotracheal extubation is done in lighter plane of anaesthesia which produces a significant increase in heart rate and blood pressure which persists into the recovery period [3-5]. Even this transient increase in heart rate and blood pressure is a matter of concern in patients with cardiovascular diseases as it may lead to left ventricular failure, cerebrovascular accidents and intracranial hypertension [6]. There are minimal complications with LMA during insertion as compared to endotracheal tube [7]. This study was carried out to look out for complications in the cardiovascular response with LMA and endotracheal tube extubation. This study will go a long way in implementation of the technique with lower cardiovascular risk and thereby minimize the peri-operative morbidity and mortality among patients who undergo general anaesthesia.

Objective

To compare the hemodynamic responses between Laryngeal Mask Airway and endotracheal extubation for surgeries done under general anaesthesia with controlled ventilation.

Methodology

Study design

This study was carried out as a single blind Randomized Controlled Clinical Trial.

Study setting

The study was carried out by the Department of Anaesthesia of our medical college.

Study population

All the patients who underwent surgery under general anaesthesia formed the study population.

Inclusion criteria

- ASA-1 patients
- 20-50 years
- Patients posted for elective surgeries; intra-abdominal and upper limb surgeries

Exclusion criteria

- Obese patients
- Pregnant women
- Diabetic patients
- Patients with history of Chronic Obstructive Pulmonary Disease
- Patients with existing cardiovascular diseases
- Anticipated difficult airway

Study period

The duration of the study was for a period of three months from November 2010 to February 2011.

Sample size

A study done by Mohamed M Abdul Fettah observed the mean heart rate at 1 min after removal was 79.8 ± 3.6 in the LMA group and 96.8 ± 6.2 in the endotracheal group [8]. Based on this, at 95% level of significance, and with a power of 80% and 20% error, the sample size was calculated as 54, with 27 in each group. The final sample size was rounded off to 60, with 30 participants in each group, after accounting 10% for non-response.

Randomization and blinding

A single blind randomization was done in this study. Before surgery patients were randomly allocated to the computer generated sequence into two equal groups. The sequence was generated as codes to which the study participants were allotted to. The investigator was provided with a sealed envelope consisting of the code specific for the intervention. In this study both the participants and the investigator were blind to the allocation of the participants into group A and group B. Group A consisted of LMA=30 patients while the group B consisted of ET tube extubation=30 patients.

Ethical approval and informed consent

Ethical approval was obtained from the institutional ethics committee. Each participant was explained in detail about the study and informed consent was obtained prior to the surgery.

Anaesthetic procedure

The patients were kept nil per oral for eight hours prior to the surgery. Patients were explained about the procedure and then received premedication of Alprazolam. Induction was carried out with an 18 gauge cannula inserted into the dorsal vein. A multichannel monitor was used for continuous monitoring of EKG, heart rate, blood pressure and oxygen saturation. After pre-oxygenation, all patients were precurarized with 0.02 mg/kg vecuronium induced with 5 mg/kg thiopentone sodium, 2 mcg/kg fentanyl and succinylcholine 2 mg/kg was used to facilitate the endotracheal intubation or LMA insertion in a randomized manner. KY jelly was used as a lubricant before insertion. Anaesthesia was maintained 66% N_2O in O_2 and 0.5% halothane. Vecuronium bromide 0.08 mg/kg was used for muscle relaxation with a top up of 25% of the loading dose when the participant came out of relaxation, with the use of peripheral nerve stimulator. Ventilation was provided manually using Bains co-axial circuit to maintain normocarbia. At the end of the surgery, neuromuscular status was assessed using peripheral nerve stimulator, pharyngeal nerve suction was done under direct vision 100% oxygen was provided for 3 min and residual neuromuscular block was restored with neostigmine 0.05 mg/kg wisth glycopyrrolate 0.02 mg/kg. On demonstration of satisfactory spontaneous respiration, the participants were shifted to recovery room.

Data collection tools

Pre induction values of heart rate and blood pressure were recorded and they were taken as baseline balues. All the patients were given general anaesthesia as per standard anaesthetic protocol. At the end of the surgery, heart rate, systolic and diastolic blood pressure was noted at 1, 2, 3, 5 and 10 min following extubation/LMA removal. Rate pressure product was calculated as a product of systolic blood pressure and heart rate.

Statistical analysis

Data was entered and analyzed using SPSS ver.15 software. The hemodynamic changes were expressed as means, and Independent t test was used to test the statistical significance in the mean values between the two groups.

Results

This study was carried out among 60 participants, with 30 in LMA group and 30 participants in Endotracheal tube extubation group. The mean age of the participants in LMA group was 39.3 ± 8 years while that of endotracheal tube group was 40.1 ± 9.4 years. The comparison of background characteristics between the two groups is given in Table 1. Most of the participants (66.7%) in LMA group and (53.3%) in endotracheal tube group were between 51 and 60 kg in weight. The comparison of hemodynamic responses between the two groups is described below. The comparison of heart rate between LMA group and endotracheal tube group is given in Table 2. A statistical significance in the mean heart rates was observed from one min after removal ($p<0.05$). Overall the mean heart rates were lower for the LMA group compared to the endotracheal tube group.

The comparison of systolic blood pressure between the two groups is given in Table 3. Significant difference in the mean systolic blood pressure was observed from one min onwards ($p<0.005$). It was also observed that lower values of systolic blood pressure in LMA group lasted up to 10 min.

The comparison of diastolic blood pressure between the two groups is given in Table 4. Significant difference in the mean diastolic blood pressure was observed from one min onwards ($p<0.005$). The LMA group showed lower diastolic blood pressure up to 10 min and the observed reduction was statistically significant. The comparison of rate pressure product between the two groups is given in Table 5. Significant difference in the mean rate pressure product was observed

from one min onwards ($p<0.005$). The rate pressure product was significantly lower in the LMA group compared to endotracheal tube group. This difference initiated at 1 min and lasted up to 10 min.

S. No	Characteristics	LMA group		Endotracheal tube group	
		Frequency	Percentage	Frequency	Percentage
1	**Age (in years)**				
	20-29	5	16.7	5	16.7
	30-39	8	26.7	5	16.7
	40-49	16	53.3	14	46.7
	50-59	1	3.3	6	20
2	**Sex**				
	Males	12	40	15	50
	Females	18	60	15	50
3	Weight (in kilograms)				
	41-50	0	0	2	6.7
	51-60	20	66.7	16	53.3
	61-70	9	30	12	40
	71-80	1	3.3	0	0
4	Type of surgery				
	Intra-abdominal	26	85	25	85
	Extra-abdominal	4	15	5	15

Table 1: Comparison of the two groups based on background characteristics.

S. No	Time points	LMA group		Endotracheal tube group		t. value	p. value
		Mean	S.D	Mean	S.D		
1	Baseline	79.3	6.5	82.9	10	1.60	0.124
2	Pre extubation/LMA removal	86.1	9.6	86.9	23.3	0.20	0.874
3	1 min	87.2	7.3	103.7	21.5	3.97	0.0001
4	2 min	86.2	7.3	97.7	21.9	2.70	0.009
5	3 min	82.2	6.6	93.1	21.4	2.66	0.010
6	5 min	79.5	6.3	87.1	21.9	1.82	0.073
7	10 min	76.5	6.1	83.9	18.6	2.07	0.043

Table 2: Comparison of heart rate between the two groups.

S. No	Time points	LMA group		Endotracheal tube group		t. value	p. value
		Mean	S.D	Mean	S.D		
1	Baseline	124.4	6.8	124.3	11.3	0.30	0.978
2	Pre extubation/LMA removal	125.5	8.2	125.6	15.2	0.02	0.983

3	1 min	130	6.4	141.5	13.6	4.19	0.0001
4	2 min	127.9	5.4	136.6	13.2	3.35	0.001
5	3 min	124	5.5	134	12.5	4.01	0.0001
6	5 min	121.8	6	129.9	11.1	3.53	0.001
7	10 min	120.3	5.5	128.1	10.1	3.73	0.0001

Table 3: Comparison of systolic blood pressure between the two groups.

S. No	Time points	LMA group		Endotracheal tube group		t. value	p. value
		Mean	S.D	Mean	S.D		
1	Baseline	79.7	3.9	80	5.9	0.26	0.798
2	Pre extubation/LMA removal	82.6	7.9	83.3	13.5	0.26	0.798
3	1 min	83.9	5	94	11.8	4.34	0.0001
4	2 min	83.1	5	89.2	9.1	3.22	0.002
5	3 min	80.7	4.4	85.1	7.6	2.80	0.007
6	5 min	78.6	4.1	83.1	6.4	3.26	0.002
7	10 min	77.5	4.5	80.2	6.2	1.91	0.061

Table 4: Comparison of diastolic blood pressure between the two groups.

S. No	Time points	LMA group		Endotracheal tube group		t. value	p. value
		Mean	S.D	Mean	S.D		
1	Baseline	9884.9	1133.3	10579.6	2139	1.57	0.121
2	Pre extubation/LMA removal	10877.5	1808.1	11077.3	3860.6	0.26	0.798
3	1 min	11369.1	1382.2	14690.1	3512.1	4.82	0.0001
4	2 min	11048.9	1265.2	13367.9	3451.9	3.45	0.001
5	3 min	10214	1130.7	12523.7	3309.9	3.62	0.01
6	5 min	9705.2	1110.3	11348	3148.5	2.70	0.007
7	10 min	9224.4	1039.1	10770.1	2602	3.02	0.004

Table 5: Comparison of Rate pressure product between the two groups.

Discussion

The laryngeal mask has been shown to be an effective means of securing a clean airway during elective surgeries. Its insertion does not require penetration of larynx, thereby making the placement less stimulating than tracheal tube insertion or extubation. As a result, there is less likelihood of pressor response with LMA. LMA has been in use in 30-60% of surgeries with general anaesthesia in the UK and USA. However, its use has been less than one percent in India. There are several advantages of using LMA, namely easy insertion, minimal cardiovascular stimulations at insertion, and minimal or no requirement of muscle relaxants. The potential disadvantage with endotracheal tube lies with the fact that an increase in arterial pressure associated with intubation can cause complications, such as cardiac failure, pulmonary oedema and cerebrovascular hemorrhage [8].

This study was done with an objective of comparing the hemodynamic responses between removal of LMA and extubation of endotracheal tube. Both the groups were similar with respect to background characteristics like age, sex and weight. The baseline hemodynamic parameters between the two groups were also similar and no significant difference was observed. With observations made between one and ten min of removal/extubation, there was a rise in all the hemodynamic responses namely heart rate, systolic blood pressure, diastolic blood pressure and rate pressure product. However, the mean increase in the values was significantly lower in the LMA group

compared to endotracheal tube group. The differences were statistically significant.

The extent and pattern of change in hemodynamic parameters following the removal of LMA/ETT extubation are very similar to those reported in various studies. A study done by Yohitaka Fujii et al. found that HR, MAP and RPP increased significantly in association with extubation in normotensive individuals and this increase was greater than that of the LMA group [9]. Bidwai et al. demonstrated an increase in hemodynamic variables following extubation. The precise mechanism responsible for these hemodynamic changes is unclear but could be associated with catecholamines [10]. Catecholamines is not done. This increase was lower in the LMA group. Dyson et al. demonstrated an increase by 20% in the hemodynamic responses with extubation among normotensive individuals [11]. Although the increase was brief, there could be a dangerous possibility of increase in myocardial oxygen demand in patients with coronary artery disease.

The above findings clearly demonstrate that LMA has advantage over endotracheal tube in controlling the hemodynamic changes by minimizing the catecholamine release. Although the rate pressure product increased significantly in both the groups in our study, levels below 20,000 are known to be commonly associated with angina and myocardial infarction.

Conclusion

In our study, it was observed that during extubation of endotracheal tube and removal of LMA, the heart rate, blood pressure and rate pressure product increased in both the groups. However, the rate of increase was significantly lower in the LMA group. Therefore, this study throws light on the advantages in the use of LMA over endotracheal tube, which in the long run would minimize the perioperative morbidity and mortality.

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