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ORIGINAL RESEARCH AIRWAY MANAGEMENT

Intraocular pressure response to airway management: Comparison between LMA Supreme® and C-MAC® videolaryngoscope in day care surgery

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1. Abstract

Background: Airway maintenance procedures during anesthesia are usually associated with a rise in intraocular pressure (IOP). This is an important issue especially in vulnerable patients. In the present study we compared the rise in IOP with two different group of airway devices i.e. Laryngeal mask airway Supreme (LMA-S) and endotracheal intubation (ETT) using C-MAC® videolaryngoscope (VLS).

Methodology: The present study was conducted on 100 adult patients of ages >18 yrs, of either sex, belonging to American Society of Anesthesiologist (ASA) I and II, scheduled to undergo non-ophthalmic elective surgery under general anesthesia. Patients were divided into two equal groups of 50 each, Group A and Group B. In group A (n = 50), lubricated appropriate sized LMA-S was inserted and in Group B (n=50), lubricated appropriate sized ETT was inserted by an anesthesiologist using VLS. IOP was measured in right eye just before insertion of device and subsequently at 1 min, 3 min, 5 min and 10 min after insertion of device. Hemodynamic parameters were recorded along with IOP measurement.

Results: Both the groups were comparable regarding demographic data ($p > 0.05$), ASA grade ($p = 0.069$), and Mallampati grade (MPG) ($p = 0.646$). Airway establishment time ($p = 0.011$) was significantly less with C-MAC VLS. IOP were comparable at all measurement times, e.g., 1 min ($p = 0.216$), 3 min ($p = 0.093$), 5 min ($p = 0.859$) and 10 min ($p = 0.060$) after insertion of each device. Hemodynamic parameters measured were also comparable between two groups ($p > 0.05$).

Conclusion: Both LMA Supreme and intubation using C-MAC® videolaryngoscope are safe regarding rise in intraocular pressure. Both methods can be safely used for airway management in suitable patients.

Key words: Airway; Anesthesia; Intraocular pressure; LMA; Endotracheal intubation

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2. Introduction

Securing airway is one of the most important skill for safe anesthesia practice. Intraocular pressure (IOP) response to airway management by an endotracheal tube or a supraglottic device (SGD) insertion is often an ignored but very important phenomenon. An unnoticed effect can have serious implications, especially in susceptible patients. Acute rise in IOP is considered an important risk factor for development of glaucoma, which is the one of the most common cause of irreversible blindness worldwide. There are more than 60 million documented glaucoma cases worldwide which may rise to over 80 million by 2020.[1] More importantly it was observed that 90% of glaucoma cases were undiagnosed and identified only at the time of survey.[2] Any sudden increase in IOP is of extreme importance as witnessed in open globe injury and cataract surgeries where it can cause catastrophic expulsion of ocular contents. Till date routine perioperative IOP evaluation has not been included in modern day anesthesia practice.

Macintosh laryngoscope (MCL) is commonly used since for endotracheal tube (ETT) placement. A relatively high forward and upward force is applied on the MCL handle to visualize glottis.[3] But it has been associated with an increase in IOP along with tachycardia and hypertension.[4,5,6]

The newer videolaryngoscopes (VLS) introduced in anesthesia practice are associated with significantly less hemodynamic responses perhaps due to less forceful manipulations for visualization of vocal cords.[7,8] There have been a variety of VLS models available in the market. C-MAC® (Karl Storz, Tutlingen, Germany) is a new portable VLS which has been found to be useful in difficult airways.[9]

Laryngeal mask airway (LMA) is an excellent SGD that sits outside the trachea and provides a hands free means of achieving an airtight airway. LMA has been shown to have numerous advantages over invasive airway techniques.[10,11] There are some notable complications associated with its use like risk of aspiration of gastric contents, trauma, nerve injuries and compression of vascular structures.[12] LMA Supreme (LMAS) is a single use second generation SGD which has an added safety margin from aspiration by incorporation of a gastric access port.[13]

Although VLS and LMAS have been studied separately to effectively prevent the IOP fluctuations as compared to conventional intubation techniques but to the best of our knowledge the efficacy of both these devices over one another is has not been studied. We aimed to evaluate and compare C-MAC® VLS assisted intubation and the insertion of LMAS for their effect on IOP changes during airway management during different surgical procedures.

3. Methodology

The present study was conducted in a randomized single blind manner after approval by Hospital Ethics Committee our department from August 2016 to March 2017. A written informed consent was obtained from all patients. A total of 100 adult patients of age >18 yrs, of either sex, belonging to American Society of Anesthesiologist (ASA) Grade I and II, scheduled to undergo non ophthalmic elective surgery under general anesthesia were included. The computerized randomization procedure was performed by an independent person who was not involved in the study by sealed envelopes.

For sample size calculation, effect size was calculated to be 0.601 based on IOP measurements of previous studies comparing Proseal LMA and conventional intubation. Type 1 error was taken as 0.05 and power of 0.8 which came out to be 45 patients in each group, so total sample size of 100 was taken with 50 patients in each group.[14] Patients were divided into two equal groups of 50 each, Group A (LMAS group) and Group B (ETT group). Patients with already raised IOP, Body Mass Index (BMI) > 35kg/m, pregnant ladies and patients with Mallampati grade (MPG) III and IV were excluded from the study.

Pre-anesthetic checkup was conducted one day prior to surgery. All the patients were given tablet alprazolam 0.5 mg and tablet ranitidine 150 mg orally at night before surgery and were kept nil orally for at least 6 hrs prior to surgery.

After shifting the patient to operation theatre, intravenous line was secured and ringer lactate infusion was started. Standard ASA non-invasive monitoring was started. After a stabilizing time of 5 min, a baseline reading of IOP, HR and MAP were recorded. Patients were premedicated with 0.01 mg/kg of midazolam and 0.1 mg/kg of morphine. After preoxygenation with 100% O_2 for 5 min, all patients were induced with 2 mg/kg of propofol, and 0.8 mg/kg of vecuronium. Decrease in systolic blood pressure (more than 30% below baseline) was recorded as hypotension and treated with crystalloids and phenylephrine. Bradycardia (HR < 50 beats/min) was treated by intravenous atropine. Manual ventilation with appropriate sized clear anatomical face mask was done for 5 min with 100% O_2 and isoflurane. After that airway was secured using appropriate device as per group allocation.

In Group A (n = 50), lubricated LMAS (size 3, 4 or 5) was inserted by senior anesthesiologist by senior anesthesiologist depending upon the weight of the patient and the manufacturer's recommendation. After insertion, the cuff was inflated with air to the recommended inflation volume. In Group B (n=50), lubricated ETT was inserted by senior anesthesiologist using C-MAC® VLS, blade D. The time to device insertion was recorded by an independent observer not involved in the study, from insertion of device till confirmation by end tidal carbon diaoxide ($EtCO_2$) tracings on monitor. It was labeled as airway establishment time.

The IOP was measured by one of the ophthalmologists who was unaware of the nature of the study in right eye (previously prepared with topical proparacaine hydrochloride 0.5%) just before insertion of device and subsequently at intervals of 1 min, 3 min, 5 min and 10 min after insertion of device using schiotz tonometer. Hemodynamic parameters were recorded along with. Throughout the study period, each patient was in the supine position, and the head was not elevated.

Anesthesia was maintained with a mixture of

isoflurane in oxygen and nitrous oxide. Top up doses of vecuronium were given as required. Patients were ventilated using standard anesthesia ventilators keeping $EtCO_2$ within normal range.

At the end of surgery patient was reversed with glycopyrrolate and neostigmine and airway device was removed when regular and adequate breathing resumed.

Statistical analysis:

The data were entered into an Excel spreadsheet, and converted into SPSS, version 16 for further analysis. All continuous variables were checked for normal distribution. The continuous variables which satisfied normal distribution assessment are given using mean and standard deviation. Outcome measures which satisfied normal distribution were assessed using independent sample t-test, and $p < 0.05$ was taken as significant and < 0.001 as highly significant.

4. Results

A total of 100 patients were enrolled in the study. No patients were excluded from the study. All the airway devices were inserted easily and rapidly, providing adequate ventilation and oxygenation. There was no significant difference in demographic data ($p > 0.05$) and ASA grade ($p > 0.069$), and Mallampati grade (MPG) ($p = 0.646$) (Table 1). Airway establishment time ($p = 0.011$) was significantly less with C-MAC® VLS (Table 1). IOP changes at different time interval is shown in Table 2. Heart Rate and Mean arterial pressure (MAP) changes at different time interval is shown in Table 3 and 4 respectively. There was no significant difference in base line IOP ($p = 0.047$), HR ($p = 1.480$), and MAP ($p = 0.893$) between the two groups. Although post induction there is fall in HR, MAP and IOP in both the groups but IOP ($p = 0.600$), HR ($p = 1.040$), and MAP ($p = 1.38$) were also comparable between the two groups at these time intervals (Table 2, 3 and 4).

Table 1: Demographic and airway data

Parameter	LMA Group (n = 50)	CMAC (n = 50)	P value
Gender (male: female)	7:43	8:42	0.779
Age in years (mean ± SD)	48.98 ± 13.060	44.44 ± 13.626	0.092
Weight in kg (mean ± SD)	67.40 ± 7.396	66.28 ± 6.158	0.413
ASA grade(I : II)	24:26	33:17	0.069
Mallampati grade (I : II)	2:48	3:47	0..646
Airway establishment time in sec (mean ± SD)	23.42 ± .96	22.82 ± 1.32	0.011*

*p > 0.05 Not significant; *p<0.05 Significant.SD=Standard deviation; ASA=American Society of Anesthesiologist*

Table 2: Intraocular pressure changes at different time interval (mean ± SD)

Measurement time	Intraocular Pressure (mmHg)		p-value
	LMA Group (n = 50)	CMAC (n = 50)	
Base line	15.50 ± .909	15.32 ± .935	0.332
Post induction	12.16 ± .976	12.26 ± .922	0.600
1 min	14.92 ± 1.104	15.20 ± 1.143	0.216
3 min	14.92 ± 1.122	14.56 ± .993	0.093
5 min	14.78 ± 1.075	14.82 ± 1.173	0.859
10 min	14.76 ± 1.255	14.70 ± 1.093	0.060

*p > 0.05 Not significant; *p<0.05Significant.SD=Standard deviation.*

Table 3: Heart rate readings at different time intervals (mean ± SD)

Measurement time	Hear rate (beats / min)		p-value
	LMA Group (n = 50)	CMAC (n = 50)	
Base line	81.30 ± 7.715	79.82 ± 7.569	1.480
Post induction	75.16 ± 6.290	74.12 ± 5.208	1.040
1 min	80.26 ± 7.959	84.72 ± 10.270	4.460
3 min	82.10 ± 8.087	83.42 ± 7.778	1.320
5 min	80.32 ± 7.828	81.08 ± 7.453	0.760
10 min	79.68 ± 5.404	78.86 ± 4.185	0.820

*.p > 0.05 Not significant; *p<0.05Significant.SD=Standard deviation.*

Table 4: Mean arterial pressure at different time intervals (mean ± SD)

Measurement time	Mean arterial pressure (mmHg)		p - value
	LMA Group (n = 50)	CMAC (n = 50)	
Base line	93.12 ± 6.64	92.23 ± 5.06	0.893
Post induction	86.06 ± 7.53	84.68 ± 5.54	1.380
1 min	89.16 ± 9.62	92.45 ± 5.22	3.29
3 min	92.02 ± 7.11	92.13 ± 5.11	0.11
5 min	93.34 ± 9.94	93.87 ± 3.93	0.53
10 min	92.78 ± 6.65	90.65 ± 5.59	2.13

*.p > 0.05 Not significant; *p<0.05Significant.SD=Standard deviation.*

5. Discussion

The normal range for IOP is 10–20 mmHg and is maintained at this level throughout life with some diurnal and seasonal variation. Rise in IOP is a known risk during airway manipulations. During ophthalmic surgery one of the primary goals of anesthesiologist is to maintain the IOP within normal range and to prevent sudden increases. Although the transient rise in IOP is not sufficient enough to cause damage in normal eye but it may be detrimental in patients with chronically raised IOP.

IOP increase associated with airway manipulation is strongly linked with other stress responses like hypertension, tachycardia and increased central venous pressure. It is due to increase in sympathoadrenal activity secondary to pharyngo-laryngeal stimulation.[14] In addition adrenergic stimulation increases the resistance to the outflow of aqueous humor in trabecular meshwork between anterior chamber and Schlemn's canal, thereby increasing the IOP. This explains the close relationship between hemodynamic and IOP response.[4] The hemodynamic changes following insertion of the LMA may be attributed to the pressure exerted by the inflated cuff and the dome of the LMA on the pharyngeal walls and structures.[15]

To prevent sudden rise in IOP at the time of airway manipulation, drugs like propofol, fentanyl, dexmedetomidine and clonidine have been used.[16-19] A slight miscalculation if the dosage of these drugs can be detrimental in geriatric patients with already compromised cardiovascular system and most of the patients undergoing ophthalmic surgery are of old age.

Previous studies have shown that the use of LMAs are associated with stable hemodynamics and IOP.[14,20, 21] There is minimal laryngo-tracheal stimulation associated with LMA placement. VLS like C-MAC® is associated with significantly less rise in MAP and HR. but there are limited studies showing the IOP changes with C-MAC®..[22]

We hypothesized that use of C-MAC® could be associated with lesser rise in IOP as it has been shown to be hemodynamically less stressful so would be a useful alternative to intubation.

After insertion of airway device in respective groups we found that IOP rise in both groups at 1 min was statistically insignificant ($p = 0.216$). Similarly, values were statistically insignificant between the groups at 3 min, 5 min and 10 min after insertion of device (Table 2). This could be due to less pressor response associated with the use of VLSs and LMAS. We also noticed similar insignificant pressor response at 1 min in both the groups, being almost equivalent ($p = 3.28$). Same trends were also noticed at 3, 5, 7 and 10 min (Table 4).

Airway establishment time was significantly less with C-MAC® assisted intubation although clinically these values seems to less relevant (Table 1).

Das et al.[4] conducted a study to compare the IOP following laryngoscopy and intubation with conventional Macintosh blade and Airtraq optical VLS in 2014. They found that Airtraq laryngoscope resulted in significantly fewer rises in IOP and lesser increase in hemodynamic response to laryngoscopy and intubation. The IOP measured immediately after intubation in Macintosh group was 26.05 ± 3.02 mmHg and 19.8 ± 3.12 mmHg in Airtraq group and was statistically significant ($p = 0.023$). We found IOP to be 14.92 ± 1.104 in LMAS group and to 15.20 ± 1.143 in C-MAC group at 1 min ($p = 0.216$).

Çaparlar et al.[22] compared IOP, hemodynamic parameters and throat pain with the use of C-MAC VLS and the Macintosh laryngoscope under general anesthesia. A total of 78 patients were included in the study. The mean IOP at 3rd min after intubation was determined to be statistically significantly higher in Macintosh Group (23.56 ± 8.23 vs. 16.26 ± 5.3 mmHg) as compared to C-MAC group ($p = 0.0001$). In our study IOP at 3 min was 14.92 ± 1.12 in LMA group and $14.56 \pm .99$ in C-MAC group ($p = 0.093$). Although in study done by Çaparlar et al. the MAP and HR were also lower in C-MAC group but they were not statistically significant ($p > 0.05$). They concluded that C-MAC VLS can be recommended as the first choice in patients with high IOP requiring general anesthesia with endotracheal intubation.

Bukhari et al.[20] compared pressor responses and intraocular pressure changes following insertion of laryngeal mask airway and endotracheal tube. They found that there was significant increase in systolic and diastolic blood pressure as well as in intraocular pressure in endotracheal tube group as compared to laryngeal mask airway group ($p<0.01$).

Sahu et al.[21] used and compared I-gel™ SGD and LMA Supreme in children for routine airway management and IOP changes. They found that IOP increase was more after use of LMA Supreme. We observed an increase from 14.92 ± 1.104 (post induction value) to 14.92 ± 1.122 at 3 min in adults patients. I gel was associated with a fall in IOP.

Hence, both LMA supreme and VLS can be used to secure airway in patients susceptible to rise in IOP. VLS assisted intubation could be an attractive alternative in patients where intubation is a must. Most of the studies in literature have focused on the hemodynamic aspect of the stress response instead of IOP during airway management; our study is unique in itself comparing two different novel airway management devices, LMAS and C-MAC® VLS regarding their stress response e.g., raised IOP. It can open a gateway for further studies comparing their efficacy in patients with already raised IOP undergoing ophthalmic surgeries.

But this study has some inherit limitations.

6. Limitations

We included patients with normal IOP only; whether the results of the present study will replicate in patients with already raised IOP is still questionable and other variables for glaucoma like optic disc and visual acuity have not been studied. So further studies can be planned in patients with raised IOP and more variables to strengthen the evidence. Moreover, operator experience and time taken for performing the airway management can also affect the results. In present study the airway was managed by senior anesthesiologist so these results could be different in the hands of novice anesthesiologist.

7. Conclusion

We conclude that both videolaryngoscope (C-MAC®) and LMA Supreme® can be safely and effectively used to avoid wide fluctuations in IOP. C-MAC® may be especially useful in situation where intubation is deemed necessary.

8. Conflict of interest

Nil declared by the authors.

9. Authors' contribution

HK, GS: Concept, conduction of the study, literature search, statistical analysis and manuscript editing
JS, AK: conduction of the study work, literature search and manuscript editing
MD: conduction of the study, manuscript editing
AS: Concept, literature search and manuscript editing

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