RESEARCH ARTICLE

A Comparison between Hemodynamic Changes and Intraocular Pressure after Intubation with Endotracheal Tube, Laryngeal Mask Airway Classic™, and I-gel in Patients Candidate for Elective Eye Surgery

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Abstract

Background and Objective: Hemodynamic changes following laryngoscopic tracheal intubation can trigger catecholamine release which consequently increases blood pressure and intraocular pressure (IOP) resulting in the disc rupture and ultimately blindness. Endotracheal intubation (endotracheal tube [ETT]) is a common technique for stress response management. The present study aims to comparatively investigate the hemodynamic changes and IOP after three intubation approaches of ETT, laryngeal mask airway (LMA) Classic™, and I-gel in patients undergoing elective cataract surgery. **Materials and Methods:** This clinical trial was conducted on 75 patients with ASA classes I and II (age range: 50–65 years old) who were the candidate for elective cataract surgery admitted in Ahvaz Imam Hospital, Iran, during 2013–2014. The hemodynamic changes and IOP values were measured in the patients before and after intubation with ETT, LMA Classic™, and I-gel. The pulse rate, systolic and diastolic blood pressures, and IOP were measured at four intervals at 1 minute before and at 1, 2, and 5 min after the insertion of the airway devices. The IOP was measured with Tonopen. **Results:** Immediately, before inserting ETT, LMA, and I-gel, the heart rate, systolic and diastolic blood pressures significantly increased in all groups. The results showed that the hemodynamic changes and IOP following I-gel were more stable than the LMA Classic™ and ETT devices. In addition, the LMA Classic™ intubation showed more stable hemodynamic response than the ETT. **Conclusions:** The findings showed that I-gel intubation results in more stable hemodynamic responses in elective cataract surgery.

Key words: Cataract surgery, endotracheal intubation, hemodynamic response, I-gel intraocular pressure, laryngeal mask airway

INTRODUCTION

Hemodynamic changes following tracheal intubation through laryngoscopy are significant concerns of anesthetists in the respective surgical procedures. The stress response with the release of catecholamines leads to increased blood pressure and heart rate, which consequently lead to life-threatening risks in the patients susceptible to the cardiovascular and cerebral diseases. Intraocular pressure (IOP) changes are other health issues associated with laryngoscopy and intubation, which can lead to a ruptured disk and exophthalmos and ultimately blindness.[1-3] Several methods have been used to avoid the stress response and increased IOP. One of these methods is using supraglottic

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Received: 22-11-2017
Revised: 05-12-2017
Accepted: 10-12-2017

airway device that is designed for the lower stimulation and prevention of injuries caused by tracheal intubation to the soft tissues, teeth, vocal cords, etc.[4-6] Due to non-placement of laryngeal mask airway (LMA) within the trachea and less irritation caused, complications of the procedure of endotracheal intubation (endotracheal tube [ETT]) are less.[7] I-gel is a supraglottic device made of thermoplastic elastomer and has an acceptable hardness (soft) and loose mode like without inflating cuff. It is anatomically designed so that is well-equipped on the perilaryngeal and hypopharyngeal structures and that we can point out to some of its benefits such as ease of insertion, less tissue damage, lack of movement caused by the inflating cuff, and the simplicity of the structure and reduction of costs.[8-10]

LMA, which also is designed by the brain, is among the devices that if it can be autoclaved, can be used several times. LMA first used in Royal London Hospital in 1981, and since then, there have been no reports of deaths by it.[11]

The laryngeal mask insertion technique is completely different to how to use laryngeal mask ETT. In this way, there is no need to laryngoscopy to see the vocal cords; also, the laryngeal mask is not instead into the trachea, and instead, it is placed in the hypopharynx. These factors cause less stress to the patient, and therefore, better control of patients' hemodynamic responses and IOP. The most important part related to proper control of IOP is likely related to non-performing laryngoscopy.[12]

This study aimed to investigate hemodynamic changes and IOP in the patients undergoing elective cataract surgery after intubation of an ETT, LMA, and I-gel.

MATERIALS AND METHODS

The experimental procedures of the present study including interventions, data collections, and clinical assessments were performed in the Ahvaz Imam Khomeini Hospital, which is affiliated to Ahvaz Jundishapur University of Medical Sciences (AJUMS), Ahvaz, Iran. All of the study protocols and experimental procedures were approved by the local ethics committee of AJUMS, Ahvaz, Iran (registration code: Ajums.REC.1392.292), which were in complete agreement with the ethical regulations of human studies set by the Helsinki declaration (2013). After the enrolment of all subjects and before the start of the study, researchers completely and clearly explained all objectives and protocols of the study and possible benefits and side effects of the treatments to all participants, and then, all of the patients filled and signed a written consent form on their participation in the study.

This clinical trial study was conducted on 75 patients (age range: 50–65 years old) with ASA class (I and II) in both genders, referred to Imam Khomeini Hospital in Ahvaz, Iran, for elective eye surgery during 2013–2014. The inclusion criteria included patients with NPO, candidate of elective eye surgery, ASA class I or II. Exclusion criteria included patients with previous history of gastroesophageal reflux, diabetes, strabismus, previous failure in use airway devices, body mass index higher than 25, and surgery duration of >90 min, any contraindication for use subgullet airway devices. Height and weight of patients were measured after entering them to the operating room. Then, the patient underwent routine monitoring, including electrocardiography, pulse oximetry, and systolic and diastolic blood pressure, and after the establishment of the venous route, 5 cc/kg 9.0% normal saline solution was administered. Patients were preoxygenated with spontaneous breathing for 3 min, and up to the loss of the eyelid reflex, they were under general anesthesia with the use of the following drugs: Midazolam 0.02 mg/kg, fentanyl 1.5 μg/kg, and propofol 1 mg/kg. Then, atracurium 0.5 mg/kg was used, and after 3 minutes, airway devices were used. The used LMA was from Teleflex Silicon base of weight and sex patients, and ETT used was PVC from a manufacturing company (SUPA LMA) that was inserted by an anesthesia assistant with a method similar to tracheal tube intubation and I-gel. As holder of anesthesia, propofol infusion at a dose 50 μg/kg/min, oxygen and N^2O 50% and a flow of 4 L were used. Cuff pressure in the LMA Classic™ and ETT reached to 60 and 25 cm H_2O measured by manometer. The patient's vital signs were recorded by the Reichert and at four intervals at 1 minute before and at 1, 2, and 5 min after the inserting airway device. The measurements were performed by an anesthesia resident and the IOPs were measured using Tonopen Avia (Reichert co.)

Statistical analysis

One-way ANOVA was used for comparison between the groups, the *post hoc* Bonferroni test was used for evaluating the significant difference. $P = 0.05$ was considered as significance level, and all statistical analyzes were performed with statistical package of SPSS (Windows, version 16).

RESULTS

The treatment groups were compared with respect to age and weight and the groups showed no significant differences [Table 1]. In addition, the groups showed no significant difference in the levels of hemodynamic parameters and IOP [$P < 0.05$, Table 2]. Immediately, before inserting ETT, LMA, or I-gel, the heart rate, systolic and diastolic blood pressures, IOP significantly increased in all groups [$P < 0.01$, Table 2]. The heart rate and systolic blood pressure remained significantly higher than the baseline values till 1 minute after inserting the airway devices [$P < 0.01$; Table 2]. Increase in the heart rate in the ETT was significantly higher than the I-gel group. In addition, the amount of increase in the systolic and diastolic blood pressures and IOP was highest in the ETT, followed by the

Table 1: Demographic data of the three groups

Group	Number of samples	Age (years) mean±SD	Weight (kg) mean±SD	Gender	
				Female	Male
ETT	33	59.5±2.41	73.04±6.71	9	24
LMA	33	58.6±17.08	71.29±8.56	12	21
I-gel	33	58.5±93.71	73.79±8.08	10	23

Alpha significance is considered at a level of $P<0.05$; no significant difference was observed between the groups. ETT: Endotracheal tube, LMA: Laryngeal mask airway

Table 2: Hemodynamic changes and IOP in groups at different stages

Variable	Group	Resting	1 minute before inserting	1 minute after inserting	2 minutes after insertion	5 minutes after insertion
Heart rate (beats per minute)	ETT	76.68±5.64	88.8±23.17[a]	105.11±61.02[a, b]	100.10±3.58[a, b, c]	90.11±36.83[a, b, c]
	LMA	76.59±7.02	87.9±71.15[a]	95.10±37.17[a]	84.12±36.23	82.11±10.73
	I-gel	7.23±7.71	85.9±92.01[a]	90.11±22.11[a]	80.11±23.54	78.12±18.84
Systolic blood pressure (mmHg)	ETT	135.7±7.02	105.7±31.67[a]	155.6±71.54a, [b, c]	138.7±65.36[b, c]	126.7±22.21[b]
	LMA	132.±97.01	103.6±73.41[a]	111.6±65.81[a]	107.6±44.91	118.6±90.62[b]
	I-gel	132.6±41.35	100.6±87.37[a]	105.7±4.59[a]	103.6±71.23	105.7±61.63
Diastolic blood pressure (mmHg)	ETT	84.31±6.61	66.7±39.05a	98.7±84.35[a, b, c]	90.6±35.22[b, c]	85.8±38.15
	LMA	80.43±6.12	64.6±2529[a]	76.6±73.92	72.7±43.24	82.7±34.33
	I-gel	82.5±72.47	67.5±40.75[a]	74.7±39.15	70.7±39.05	80.8±45.41
Intraocular pressure	ETT	16.3±64.01	9.2±24.13[a]	16.1±62.36[b, c]	14.1±53.49[a, b, c]	13.3±20.01[a, b, c]
	LMA	17.2±12.21	9.3±32.41[a]	12.2±25.73[a, b]	10.3±98.15[a]	11.1±67.94[a]
	I-gel	17.3±11.34	9.2±28.42[a]	10.2±31.39[a]	10.2±17.03[a]	10.2±73.08[a]

The letter "a" indicates a significant difference with the rest. The letter "b" indicates significant differences with I-gel group and the letter "c" represents a significant difference between the LMA groups. Alpha significance is considered at $P<0.05$. ETT: Endotracheal tube, LMA: Laryngeal mask airway

LMA and I-gel groups and significant difference in IOP were observed between the two groups of ETT and I-gel ($P < 0.01$; Table 2]. 2 minutes after inserting, hemodynamic changes and IOP in the ETT group were higher than the LMA and I-gel group [$P < 0.01$; Table 2]. 5 minutes after inserting, heart rate and IOP in the ETT group were higher than the LMA and I-gel groups and systolic blood pressure in the I-gel group was lower than the ETT and LMA group [$P <0.01$; Table 2].

DISCUSSION

This prospective randomized clinical trial was conducted on 75 patients (age range: 65–50 years old) candidate of elective eye surgery. No significant difference was observed between the three groups in terms of hemodynamic parameters and IOP immediately before insertion of airway devices, but all the parameters significantly increased 1 minute after inserting airway devices in all groups. In summary, our study showed that the I-gel resulted in more stable hemodynamic responses and IOP compared with the tracheal tube and LMA approaches.

Kilic *et al.* (1999) compared the two showed that after anesthesia, a significant reduction occurred in IOP in the two groups, but then inserting the LMA or ETT, IOP increased that the amount of the increase in the groups had ETT was significantly higher.[7] On the other hand, no significant difference in IOP between the tracheal tube and LMA approaches.[13]

Ayendi *et al*. (2011) compared the impacts of I-gel and LMA Classic™ approaches between the two groups of 21 patients and concluded that the time of insertion in the I-gel group was shorter and the frequency of dysphagia after 1 hour post-operation was higher the LMA, whereas airway pressure was higher in the I-gel group.[14]

Oczenski *et al*. (2000) compared hemodynamic changes during the insertion of ETT, Combitube, and LMA in 75 patients and concluded that after insertion of ETT and

Combitube, substantial increases were observed in diastolic blood pressure, systolic blood pressure, heart rate, and mean arterial pressure during 1 to 10 minutes after insertion. However, after LMA insertion, heart rate did not significantly change, but after 1 minute, the diastolic blood pressure, systolic blood pressure, and mean arterial pressure showed a mild increase.[4]

Our results were consistent with the findings of a study by Watch *et al.* (1992) that compared the LMA and ETT impacts on hemodynamic changes and IOP in children.[15] They reported that ETT group resulted in greater instabilities in hemodynamic and IOP parameters compared to the LMA group.[15] Bukhari *et al*. (2003) in a similar study also confirmed these findings.[1]

Our findings did not support the findings of the study conducted by Helmy *et al.* (2010) where they reported no difference in blood pressure and IOP values between LMA Classic™ and I-gel. They also reported no significant difference in post-operative complications, except the LMA group showed more frequent nausea and vomiting complications and more amount of air entering the inside of stomach than the I-gel method.[16] The differences between our findings and the aforementioned previous similar studies can be attributed to some factors. One of the main factors distinguishes our study with other studies is that the different assessment tool for measuring IOP where previous studies used the tonometer, but we used the Tono-pen to reach a greater accuracy.

Finally, we recommend I-gel as a more appropriate anesthetic agent for eye surgeries, particularly in the patients with heart disease or those with high eye pressure.

ACKNOWLEDGMENTS

The authors would like to thank the vice chancellor of Deputy of Research and Technology Affairs of Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran, as well as Dr Seyed Mehdi Aslani, department of ophtalmology and the Pain Research Center, for their technical and financial assistance in conducting this study.

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Source of Support: The study was financially supported by Ahvaz Jundishapur University of Medical Sciences and Pain Research Center No.: Pain-9205). **Conflict of Interest:** None declared.