*RESEARCH*

# Comparison of Laryngeal Mask Airway and Endotracheal Tube on Intraocular Pressure in Vitrectomy

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## ABSTRACT

**Background:** Increased intraocular pressure (IOP) is a common complication after vitrectomy. Tracheal intubation and insertion of a laryngeal mask airway (LMA) are noxious stimuli that can increase IOP.

**Objective:** To analyze the difference between the use of LMA and an endotracheal tube (ETT) on the increase in IOP in vitrectomy.

**Method:** Experimental study with a randomized controlled trial design in 28 patients undergoing vitrectomy who met the inclusion and exclusion criteria. Subjects were divided into 2 groups with the use of LMA and ETT. Intraocular pressure (IOP) was measured using a Schiotz tonometer before induction of anesthesia, 5 minutes after intubation, 5 minutes before extubation, 5 minutes after extubation and 24 hours after vitrectomy in healthy eyes. The analysis was carried out with the unpaired T-test and the alternative Mann Whitney test, the results were significant if the p value <0.05.

**Results:** The mean IOP in the LMA group was 11.71 ± 1.90 mHg before induction of anesthesia; 11.04 ± 1.71 mmHg 5 min after induction; 10.86 ± 1.44 mmHg 5 min before discharge; 12.11 ± 1,49 mmHg after removal and 12.21 ± 2.63 mmHg 24 hours after discharge. The mean IOP in the ETT group was 11.05 ± 2.57 mHg before induction of anesthesia; 14.26 ± 2.59 mmHg 5 min after induction; 11.71 ± 1.90 mmHg 5 min before extubation; 14.70 ± 0,98 mmHg after extubation and 12.74 ± 1.82 mmHg 24 hours after extubation. A significant difference in IOP was found after ETT intubation and extubation ($p < 0.05$).

**Conclusion:** Endotracheal tube (ETT) significantly increases IOP compared to LMA during intubation and extubation in vitrectomy surgery.

**Keywords:** airway management; endotracheal tube; intraocular pressure; laryngeal mask airway; vitrectomy

## INTRODUCTION

Vitrectomy is a surgical procedure in which the vitreous humor that fills the eye cavity is removed to provide better access to the retina. This allows for a variety of repairs, including scar removal, laser repair of retinal detachment, and macular treatment. After the surgery is complete, saline, a gas bubble, or silicone oil may be injected into the vitreous cavity to help hold the retina in place. Serious complications are rare and the anatomical success rate of vitrectomy is over 90%. Advances in instrumentation, technique, and understanding of vitreous and retinal disease have made vitrectomy and retinal surgery more successful.[1]

The normal eye has clear vitreous throughout life until adulthood filling the eye from anterior (ora serrata) to posterior (optic nerve). This area comprises 2/3 of the eye's volume and is called the vitreous cavity, which together with the retina, retinal pigment epithelium, choroid, and sclera, forms the posterior segment. Traction of the vitreous and retina can cause a variety of problems. Vitrectomy is performed to prevent complications or improve the outcome of the primary surgery. For example, during anterior segment surgery (cataract, glaucoma, cornea, intraocular lens), sometimes vitreous leaks out through the pupil and an anterior vitrectomy is performed.[1]

Increased intraocular pressure (IOP) is a common complication after vitrectomy. Silicone oil tamponade is associated with a risk of increased IOP and has long-term effects on IOP. Drugs and surgery are used to control IOP, and some patients require long-term IOP-lowering therapy. Several studies have investigated that the incidence of ocular hypertension in eyes that have undergone vitrectomy (including all tamponade methods) varies from 18% to 28%, and the incidence of increased IOP after vitrectomy with silicone oil ranges from 20% to 56%. Risk factors for ocular hypertension after vitrectomy include a history of glaucoma, a history of diabetes mellitus, scleral buckling procedures, lensectomy, use of silicone oil or gas expansion, and others.[2]

Normal IOP is 10-22 mmHg (mean 15 mmHg). Changes of 1–2 mmHg may occur during ventricular contraction, and changes of 1–6 mmHg may occur depending on the patient's body position. Intra ocular pressure (IOP) is also affected by blood pressure, breathing, coughing, valsalva maneuver, blinking, mask pressure, and endotracheal intubation. Most anesthetic drugs affect IOP in a dose-dependent manner. Barbiturates, muscle relaxants, opioids, sedatives, etomidate, and propofol can decrease normal IOP.[3]

Laryngeal mask airway (LMA) and endotracheal intubation are among the most important artificial airway devices used during general anesthesia labor. Traditionally, placement of a laryngoscope and endotracheal tube (ETT) has been the mainstay in providing adequate airway management. Traditional eye surgery requires general anesthesia with tracheal intubation which may have an adverse effect on IOP. Laryngeal mask airway (LMA) was found to be superior to tracheal intubation in terms of maintaining stable IOP.[3]

Laryngoscopy and tracheal intubation cause increased sympathetic and sympathoadrenal activity in response to oropharyngeal, laryngeal, and tracheal stimulation. Tracheal intubation and LMA insertion are noxious stimuli, which manifest as an increase in IOP that lasts for approximately 5 minutes. Numerous studies in adults as well as in children have shown that LMA placement causes less hemodynamic response and therefore a lower increase in IOP compared to ETT placement.[3]

Control of IOP during ophthalmic surgery is clinically important because increased IOP can cause transient visual loss or acute glaucoma. Tracheal intubation can be associated with acute increases in IOP, due to the pressure of the laryngoscope and the passage of the ETT through the glottic slit. Laryngeal mask airway (LMA) placement does not require a laryngoscope, but placement of the device and inflation of the cuff stimulates and exerts pressure on the anterior pharyngeal wall.[3]

The increases in IOP, blood pressure, and heart rate that occur due to reflex sympathetic discharge in response to laryngotracheal stimulation may have few consequences in healthy individuals, but may be more severe or even dangerous in patients with hypertension, myocardial insufficiency, and cardiovascular disease. In addition, sudden increases in blood pressure can lead to left ventricular failure, cerebral hemorrhage, and myocardial ischemia.[3]

Tracheal intubation with an ETT is associated with increased IOP. An alternative device the LMA has been reported to have negligible effect on IOP measurements compared with the ETT. Patrick et al determined the change in IOP after LMA placement in children receiving general anesthesia using sevoflurane and found that small but significantly higher IOPs were found after LMA placement than before. A meta-analysis by Obsa et al found that the LMA provided a lower IOP response compared with a conventional ETT.[3]

Madan et al conducted a study comparing IOP between normal and glaucoma pediatric patients undergoing intraocular surgery at the time of intubation and extubation. The increase in IOP after intubation was greater in the glaucoma group than in the normal group. The increase in IOP was greater after extubation than intubation in both groups, but was similar in both groups. The increased IOP in children with glaucoma may lead to an increased risk of visual impairment after intubation and extubation. However, this study has not compared the use of ETT and LMA during intubation and extubation in the adult population.[5]

A study comparing IOP between ETT and LMA during intubation and extubation was conducted by Kilickan in subjects aged 20-50 years undergoing orthopedic surgery and found that ETT extubation significantly increased IOP but there was no increase in IOP during intubation in both groups. However, this study was conducted in orthopedic surgery which may have accumulated previous increases in IOP because orthopedic patients tend to experience acute pain which increases sympathetic stimulation, thereby increasing IOP during the previous preoperative period.[4] Therefore, there needs to be research in other adult populations that do not have acute pain conditions to assess IOP.

Our study aims to compare the use LMA and ETT on IOP in vitrectomy patients during intubation and extubation.

## METHOD

This study is an experimental study with a randomized controlled trial design conducted for 30 days. The sample of this study were patients who underwent vitrectomy procedures at Dr. Kariadi General Hospital Semarang and met the inclusion and exclusion criteria.

a) Inclusion criteria:
Patients who will undergo vitrectomy:

- ASA score I-II
- Age 18-60 years
- BMI 18-25 kg/m2
- Systolic blood pressure <140 and diastolic <90 mmHg
- Respiratory rate <20 times/minute
- Random blood sugar <200 mg/dl;
- Pulse rate <100x/minute
- Agree to the study and sign the informed consent

b) Exclusion criteria

- Have a history of glaucoma, severe hypermetropia, severe myopia
- Have a history of autoimmune.
- Have a history of chronic obstructive pulmonary disease or other chronic cough.
- History of previous eye surgery
- Have a history of corticosteroid consumption before the procedure.

c) Drop out criteria

- Death of patients;
- Patients with more than 15 seconds of difficult intubation, re-intubation, and intubation.

The basis for determining the sample size is calculated based on the unpaired numerical analytical sample formula and the results obtained are that each group has a sample size of 14 subjects with a total of 28 subjects. The subjects were then randomly grouped using the simple random sampling technique. Each subject underwent an IOP assessment using tonometry and was grouped into 2 groups, namely P1 and P2.

- P1: Patients who will undergo vitrectomy with an airway device using LMA
- P2: Patients who will undergo vitrectomy with an airway device using ETT.

The independent variable in this study was the use of airway devices during vitrectomy:

- LMA
- ETT

The dependent variable in this study was IOP.

All subjects underwent anamnesis and examination to obtain research subjects who met the inclusion and exclusion criteria. Before the operation process, all subjects underwent hemodynamic assessments including pulse rate, systolic and diastolic blood pressure before surgery.

In the LMA group, the airway was secured with an LMA (size adjusted to the patient's weight), while the ETT group represented patients whose airway was secured with a tracheal tube whose size was selected based on the largest appropriate size to avoid leakage and increased resistance after the cuff was inflated. The anesthesia operator performed laryngoscopy and ETT or LMA placement in all patients studied. The intubation process was carried out by at least a 6th semester resident or by an anesthesia specialist. The anesthesia operator filled the ETT cuff until there was no air leakage at an inspiratory pressure of 25 cmH2O. The success of ETT and LMA installation was carried out by auscultation examination in both lung bases, both lung apices and the epigastrium to ensure air entered the lungs and was symmetrical between the two sides.

Premedication was performed by administering midazolam 0.1 mg/kgBW. Anesthesia was induced with propofol (2-2.5 mg/kg) and fentanyl (2 mcg/kg) titrated to eliminate the eyelash reflex and this was followed by an intubation dose of rocuronium (0.6 mg/kg). Placement of the ETT or LMA was continued for 3 minutes thereafter. Anesthesia was maintained with sevoflurane (1 MAC). Monitoring consisted of continuous three-lead electrocardiography, non-invasive blood pressure, and pulse oximetry.

At the end of the operation, pre-extubation values for heart rate, blood pressure and IOP were measured. Residual neuromuscular blockade was reversed with neostigmine 50 µg/kg and atropine sulfas 0.01-0.02 mg/kgBW. At the onset of spontaneous breathing, the tracheal tube was removed after pharyngeal suction.

Schiotz tonometer was used to measure IOP after instillation of one drop of 0.5% tetracaine in the non-operated eye pre-induction. Measurements were taken 5 minutes before surgery and 5 minutes after airway was secured. Intraocular pressure (IOP) measurements were taken again 5 minutes before extubation and 5 minutes after extubation. Hemodynamic parameters including heart rate, systolic blood pressure, diastolic blood pressure, and IOP were compared between groups after airway instrumentation. The incidence of nausea, vomiting and coughing after extubation was also recorded. Intraocular pressure (IOP) was measured again after 24 hours to compare the effects of nausea, vomiting, coughing and hemodynamic changes after surgery.

The primary data obtained were subjected to descriptive analysis to obtain the mean and standard deviation of IOP. The data were then tested for normality using the Shapiro-Wilk test to see the distribution of the data. If the data was normally distributed, an unpaired T-Test was performed. If the data is not normally distributed, the Mann Whitney test is performed with a significance level value if $p < 0.05$ at a 95% confidence interval. The factors analyzed together are carried out with a multivariate test.

Ethical Clearance will be proposed to the Health Research Ethics Commission *Komisi Etik Penelitan Kesehatan (KEPK)* of the Faculty of Medicine, Diponegoro University, Semarang, Dr. Kariadi General Hospital before the research is conducted. The research was conducted based on Ethical Clearance number 961/EC/KEPK-RSDK/2021.

**RESULT**

Our study included 28 subjects who underwent vitrectomy at Dr. Kariadi General Hospital, Semarang and had met the inclusion and exclusion criteria of the study. During the research process, no subjects were found to have dropped out.

The characteristics of the subjects in this study are shown in Table 1. Our subjects had a mean age of 50.36 ± 8.04 years in the LMA group and 42.29 ± 7.38 years in the ETT group. Our subjects had a homogeneous body mass index both in the LMA group of 22.30 ± 1.88 Kg/m2 and in the ETT group of 22.58 ± 2.00 Kg/m2.

Subjects with LMA use consisted of 57.1% men and 42.9% women, this proportion was similar to the ETT group. Subjects with LMA use had 78.6% with ASA I physical status and 21.4% with ASA II physical status, while the ETT group had 35.7% subjects with ASA I physical status and 64.3% with ASA II physical status. The preoperative blood glucose levels of patients using LMA had an average of 122.21 ± 14.56 mg dl, while in the group using ETT it was 118.57 ± 11.62 mg/dl.

The characteristics of the vital signs of patients in this study before surgery were obtained in the optimal range. The LMA group had a mean systolic blood pressure of 121.71 ± 7.61 mmHg and a diastolic pressure of 74.86 ± 6.37 mmHg, while the ETT group had a mean systolic blood pressure of 119.50 ± 10.18 mmHg and a diastolic blood pressure of 73.14 ± 4.61 mmHg. The mean preoperative pulse rate in the LMA group was 81.64 ± 8.15 times per minute and in the ETT group it was 82.71 ± 9.59 times per minute. The average respiratory frequency in the group using LMA was 18.71 ± 3.27 and the average respiratory frequency in the group using ETT was 18.36 ± 1.08 times per minute.

**Table 1.** Characteristics of research subjects

| Characteristics | LMA (n=14) | ETT (n=14) |
|---|---|---|
| Age (years) | 50.36 ± 8.04 | 42.29 ± 7.38 |
| Body mass index (Kg/m$^2$) | 22.30 ± 1.88 | 22.58 ± 2.00 |
| ASA Score | | |
| • ASA I | 11 (78.6%) | 5 (35.7%) |
| • ASA II | 3 (21.4%) | 9 (64.3%) |
| Sex | | |
| • Male | 8 (57.1%) | 8 (57.1%) |
| • Female | 6 (42.9%) | 6 (42.9%) |
| Preoperative glucose levels (mg/dl) | 122.21 ± 14.56 | 118.57 ± 11.62 |
| Initial vital signs | | |
| • Systolic blood pressure (mmHg) | 121.71 ± 7.61 | 119.50 ± 10.18 |
| • Diastolic blood pressure (mmHg) | 74.86 ± 6.37 | 73.14 ± 4.61 |
| • Pulse rate (bpm) | 81.64 ± 8.15 | 82.71 ± 9.59 |
| • Respiratory rate (x/minute) | 18.71 ± 3.27 | 18.36 ± 1.08 |

Description: LMA = laryngeal mask airway, ETT = endotracheal tube, ASA = American Society of Anesthesiologist

Intraocular pressure (IOP) analysis begins with a data normality test on IOP values measured before anesthesia induction (IOP1), 5 minutes after intubation (IOP2), 5 minutes before extubation (IOP3), 5 minutes after extubation (IOP4) and 24 hours after surgery (IOP5). Data normality test using the Saphiro-Wilk test showed that the data were not normally distributed before anesthesia induction (IOP1), 5 minutes after intubation (IOP2), 5 minutes before extubation (IOP3), 5 minutes after extubation (IOP4) and 24 hours after surgery (IOP5). Data transformation performed obtained normally distributed data on IOP measurements 5 minutes after intubation (IOP2) with a p value $> 0.05$, not normally distributed on measurements before anesthesia induction (IOP1), 5 minutes before extubation (IOP3), 5 minutes after extubation (IOP4) and 24 hours postoperatively (IOP5) with a p value $< 0.05$. Comparative tests with unpaired T-tests were performed on IOP measurements 5 minutes after intubation (IOP2). Comparative tests with the Mann-Whitney alternative test were performed on IOP measurements before anesthesia induction (IOP1), 5 minutes before extubation (IOP3), 5 minutes after extubation (IOP4) and 24 hours postoperatively (IOP5). The results of the comparative test analysis can be seen in Table 2.

Measurement of IOP before induction of anesthesia obtained homogeneous values in both groups and no significant differences were found (LMA = 11.71 ± 1.90 mmHg; ETT = 11.05 ± 2.57 mmHg; p>0.05). Measurement of IOP at 5 minutes after intubation obtained IOP in the group with ETT use significantly higher (14.26 ± 2.59 mmHg) compared to the use of LMA (11.04 ± 1.71 mmHg) with a p value = 0.001 (p <0.05). Measurement of IOP at 5 minutes before extubation showed that the IOP in the group using ETT was higher (11.71 ± 1.90 mmHg) compared to the use of LMA (10.86 ± 1.44 mmHg) but did not have a statistically significant difference with a value of p = 0.222 (p > 0.05). Measurement of IOP at 5 minutes after extubation showed that the IOP in the group using ETT was higher (14.70 ± 0.98 mmHg) compared to the use of LMA (12.11 ± 1.49 mmHg) and had a statistically significant difference with a value of p = 0.000 (p < 0.05). Intraocular pressure (IOP) measurements 24 hours after surgery obtained homogeneous values in both groups and no significant differences were found (LMA = 12.21 ± 2.63 mmHg; ETT = 12.74 ± 1.82 mmHg; p > 0.05).

**Table 2.** Difference in IOP between the use of LMA and ETT in vitrectomy

| IOP | LMA (n=14) | ETT (n=14) | P-value |
|---|---|---|---|
| TIO1 | 11.71 ± 1.90 | 11.05 ± 2.57 | 0.228¥ |
| TIO2 | 11.04 ± 1.71 | 14.26 ± 2.59 | 0.001£* |
| TIO3 | 10.86 ± 1.44 | 11.71 ± 1.90 | 0.222¥ |
| TIO4 | 12.11 ± 1.49 | 14.70 ± 0.98 | 0.000¥* |
| TIO5 | 12.21 ± 2.63 | 12.74 ± 1.82 | 0.316¥ |

Description: Intraocular pressure (IOP) measured at the time before induction of anesthesia (IOP1), 5 minutes after intubation (IOP2), 5 minutes before extubation (IOP3), 5 minutes after extubation (IOP4) and 24 hours postoperatively (IOP5). £ = Unpaired T test, ¥ = Mann-Whitney test, *significant p <0.05.

A number of complaints of nausea, vomiting and cough reported 24 hours after vitrectomy were recorded (Table 3 dan Table 4). As many as 35.7% of study subjects with LMA users complained of nausea, significantly different from ETT users who did not report any complaints of nausea. Complaints of vomiting were experienced in LMA users reported by one study subject, but were not found in the group with ETT use. Complaints of cough were more dominantly complained of by the group of subjects with ETT use as many as 42.9% of subjects compared to the group with LMA use where no subjects with cough complaints were found, this has a statistically significant difference (p <0.05).

**Table 3.** Differences in complaints of nausea, vomiting and coughing 24 hours after the use of laryngeal mask airway (LMA)and endotracheal tube (ETT) in vitrectomy

| Complaints | | LMA (n=14) | ETT (n=14) | P value |
|---|---|---|---|---|
| Nausea | Yes | 5 (35.7%) | 0 | 0.020£* |
| | No | 9 (64.3%) | 14 (100%) | |
| Vomiting | Yes | 1 (7.1%) | 0 | 1.000£ |
| | No | 13 (92.9%) | 14 (100%) | |
| Coughing | Yes | 0 | 6 (42.9%) | 0.016£* |
| | No | 14 (100%) | 8 (57.1%) | |

Description: £ = Fischer's test, *significant ($p < 0.05$)

**Table 4.** The relationship between nausea and cough complaints and intraocular pressure (IOP) 24 hours after vitrectomy

| Complaints | | TIO after 24 Hours (mmHg) | P-value |
|---|---|---|---|
| Nausea | Yes | 14.38 ± 3.14 | 0.178£ |
| | No | 12.07 ± 1.82 | |
| Vomiting | Yes | 13.48 ± 1.94 | 0.164¥ |
| | No | 12.21 ± 2.27 | |

Description: £ = Unpaired T test, ¥ = Mann-Whitney test, *significant $p <0.05$.

We conducted hemodynamic assessments including systolic blood pressure, diastolic blood pressure and pulse rate at the end of the 24-hour observation period after vitrectomy. The normality test with Saphiro-Wilk showed that the data were normally distributed in systolic blood pressure and pulse rate values ($p>0.05$). Data transformation on diastolic blood pressure values showed that the data were still not normally distributed. Numerical comparative tests with unpaired T-tests were performed on systolic blood pressure and pulse rate values, while non-parametric alternative tests with Mann Whitney tests were performed on diastolic blood pressure values shown in Table 5.

The results of the statistical analysis test showed that there was no significant difference in systolic blood pressure, diastolic blood pressure and pulse rate 24 hours after vitrectomy between the use of LMA and ETT ($p>0.05$).

**Table 5.** Differences in hemodynamics 24 hours after th use of laryngeal mask airway (LMA) and endotracheal tube (ETT) in vitrectomy

| Hemodynamics | LMA (n=14) | ETT (n=14) | P-value |
|---|---|---|---|
| Systolic blood pressure (mmHg) | 121.86 ± 15.04 | 123.86 ± 6.94 | 0.657£ |
| Diastolic blood pressure (mmHg) | 73.43 ± 4.40 | 73.36 ± 3.63 | 0.739¥ |
| Pulse rate (bpm) | 82.14 ± 8.36 | 83.43 ± 5.79 | 0.640£ |

Description: £ = Unpaired T test, ¥ = Mann-Whitney test, *significant $p<0.05$.

## DISCUSSION

Measurement of IOP before induction of anesthesia obtained homogeneous values in both groups and no significant differences were found (LMA = 11.71 ± 1.90 mmHg; ETT = 11.05 ± 2.57 mmHg; p>0.05). Measurement of IOP at 5 minutes after intubation obtained IOP in the group with ETT use significantly higher (14.26 ± 2.59 mmHg) compared to the use of LMA (11.04 ± 1.71 mmHg) with a value of p = 0.001 (p <0.05). In line with our findings, Salah Ismail et al showed that the use of ETT significantly increased IOP values from before induction of anesthesia by 11.6 ± 1.6 mmHg to 16.5 ± 1.7 mmHg after intubation. Meanwhile, the use of LMA increased IOP values before induction of anesthesia by 13.0 ± 1.5 mmHg to 14.7 ± 1.8 mmHg. Pairwise analysis of both showed that both LMA and ETT still significantly increased IOP,[6] although the increase in IOP in ETT was higher than the use of LMA. This study showed that i-gel, another supraglottic device like LMA but without using a balloon cuff significantly had significantly lower IOP values compared to the use of ETT and conventional LMA. I-gel is a relatively new supraglottic device with an anatomically designed mask made of soft, gel-like, and transparent thermoplastic elastomer. This device does not have a cuff to inflate, providing ease of use and stability after insertion, and reducing the possibility of tissue compression stimulation effects.[6]

In line with our findings, Neerja Bhardawaj et al. conducted a comparative assessment of IOP between LMA and ETT in glaucoma patients showing that IOP increased significantly from 27.3 ± 5.2 to 31.2 ± 5.4 mmHg (p < 0.01) after tracheal intubation but returned to baseline within 5 minutes. Intraocular pressure (IOP) did not change from baseline after LMA insertion. Intraocular pressure (IOP) was significantly higher in the ETT group compared to the LMA group at 2 minutes (p = 0.004) and 5 minutes (p = 0.01) after device insertion.[7]

Laryngoscopy and tracheal intubation cause increased sympathetic and sympathoadrenal activity in response to oropharyngeal, laryngeal, and tracheal stimulation. Tracheal intubation and LMA insertion are noxious stimuli, which manifest as increased IOP lasting for approximately 5 minutes. LMA placement in both children and adults causes less hemodynamic response resulting in a lower increase in IOP compared to ETT.[3]

Laryngoscopy and intubation during general anesthesia cause increased sympathetic activity leading to increased IOP. Adrenergic stimulation can produce an acute increase in IOP by increasing resistance to aqueous humor outflow across the trabecular meshwork by the anterior chamber and Schlemm's canal, which may be problematic in patients with glaucoma. The adrenergic response is greater during tracheal intubation because of distortion of the supraglottic structures caused by laryngoscopy. Insertion of the LMA does not require laryngoscopy, but insertion of the device and inflation of the cuff stimulates and exerts pressure on the anterior pharyngeal wall producing a minimal adrenergic response. The increase in IOP occurs with a concomitant decrease in blood pressure and an increase in HR and endtidal carbon dioxide concentration (ETCO2). The difference in outcomes may be related to the higher ETCO2. There is a direct linear relationship between IOP and PaCO2, and choroidal blood volume (CBV), and therefore IOP, increases in response to respiratory acidosis, hypercarbia, and hypoxia.[7] Our study has not monitored the influence of changes in PaCO2 and ETCO2 as one of the factors that may influence IOP variations in surgery with general anesthesia.

Our findings are in line with the study of Ali Shiri et al. who assessed the difference in IOP between LMA and ETT in general eye surgery. The mean IOP of the right eye after 3 minutes of anesthesia in the ETT group was 16.31 ± 1.45 and the left eye 16.71 ± 1.74 mmHg. The mean IOP of the left eye LMA group was 12.73 ± 1.47 and the right eye 12.54 ± 1.39 mmHg. A statistically significant increase in IOP was seen in patients with ETT 3 minutes after ETT placement ($p = 0.012$).[8] Bharti et al showed that during laryngoscopy there was a significant increase in IOP (from 7.2 ± 1.4 to 16.8 ± 5.3 mmHg, p value <0.01), which did not return to pre-intubation values within five minutes, the mean arterial pressure after tracheal intubation returned to baseline values after five minutes. In the LMA group there was no significant change in IOP (from 7.6 ± 1.8 to 10.4 ± 2.8 mmHg, $p > 0.05$) or mean arterial pressure after tracheal intubation. The time to successful intubation was longer with the LMA, 56.8 ± 7.8 seconds, compared to the laryngoscopy group, 33 ± 3.6 seconds ($p < 0.01$). Mucosal trauma was more frequent with the LMA (8 of 30) compared with the laryngoscopy group (three of 30) ($p < 0.01$).16 Bharti et al explained that Although intubation time was longer with the LMA compared with the conventional laryngoscope, the LMA allowed ventilation to continue during the intubation attempt reducing the likelihood of hypoxemia and hypercarbia during intubation. Although mucosal trauma was more frequent in the LMA group, postoperative pharyngolaryngeal morbidity was not significantly increased.[9]

Dae Hyun Jo et al recorded IOP in the operating room in 5 phases; on arrival (Phase 1), just before LMA or ETT (Phase 2), immediately after (Phase 3), 1 minute (Phase 4) and 3 minutes (Phase 5) after LMA or ETT placement. Changes in IOP during phases 2, 3, 4 and 5 were not significant in LMA but significant in ETT.[10]

Intraocular pressure (IOP) measurements at 5 minutes before extubation showed that the IOP in the group using ETT was higher (11.71 ± 1.90 mmHg) compared to the use of LMA (10.86 ± 1.44 mmHg) but did not have a statistically significant difference with a p value of 0.222 ($p > 0.05$). Intraocular pressure (IOP) measurements at 5 minutes after extubation showed that the IOP in the group using ETT was significantly higher (14.17 ± 0.98 mmHg) compared to the use of LMA (12.11 ± 1.49 mmHg) statistically with a p value of 0.000 ($p < 0.05$). In line with our findings, Omar et al showed that after extubation of both devices, there was an increase in IOP measurements in both groups although the increase was not significantly different between the two groups ($p > 0.05$).[11] The results of a study in a non-ophthalmic surgery population where Pandya Malti et al showed results that were in line with our findings that the IOP value in the ETT group 3 minutes after extubation was 16.0 ± 1.72 mmHg and the (IOP) value in the LMA group 3 minutes after device removal was 10.4 ± 0.03 mmHg and the LMA was significantly lower in terms of post-extubation (IOP).[12] Gulati et al showed that there was no significant change in mean IOP after LMA placement, but LMA removal caused a significant increase to 19.3 ± 7.6 mmHg (from baseline 13.9 ± 4.3 mmHg). In the ETT group, intubation significantly increased mean IOP to 19.9 ± 7.3 mmHg (from baseline 13.1 ± 4.0 mmHg) and extubation caused an increase to 24.6 ± 10.4 mmHg which was clinically and statistically significant. However, Gulati et al did not present an unpaired analysis comparing post-extubation IOP between LMA and ETT.[13] In general, there is a similarity in the graphic pattern of a higher increase in IOP values after ETT extubation compared to LMA removal.

Gokcen et al conducted a trial of LMA installation with low-dose rocuronium intervention, the results showed that there was no significant difference in IOP values after removal of the LMA device. Rocuronium is a nondepolarizing muscle relaxant that provides rapid onset with medium duration of action and no obvious side effects. Rocuronium has been shown to cause no increase and cause a decrease in IOP during stable anesthesia.[14] Differences in other interventions in the components of anesthesia may influence the final outcome of IOP values after extubation.

Intraocular pressure (IOP) measurements 24 hours after surgery obtained homogeneous values in both groups and no significant differences were found (LMA = 12.21 ± 2.63 mmHg; ETT = 12.74 ± 1.82 mmHg; $p>0.05$). Phaugat et al showed that all patients who were followed up to 24 hours after surgery, no complications related to IOP measurements were seen in any subjects.[15]

A number of complaints of nausea, vomiting and cough reported 24 hours after vitrectomy were recorded. As many as 35.7% of study subjects with LMA users complained of nausea, significantly different from ETT users who did not report any complaints of nausea. Complaints of vomiting were experienced in LMA users reported by one study subject, but were not found in the group with ETT use. In line with our findings, Gulati et al showed that the incidence of postoperative vomiting was higher in the LMA group (5 patients) compared to the ETT group (2 patients).[13]

Porhomayon et al in a Meta-analysis investigated the impact of ETT compared with LMA on postoperative nausea and vomiting (PONV) in patients undergoing surgery under general anesthesia. A total of 14 studies were selected for meta-analysis with a total of 1866 patients. A total of 9 studies focused on PONV outcomes in adult patients. This showed that the incidence of PONV with LMA and ETT in adults was approximately 204/690 (30%) and 145/725 (20%) respectively with [Odds Ratio (OR) = 1.69, 95% CI, 0.76-3.75, P = 0.20]. The heterogeneity was high (I2 = 87%). Five studies focused on PONV outcomes in pediatric patients with PONV in the LMA and ETT groups were 85/229 (37%) and 72/222 (32%) respectively with (OR = 1.30, 95% CI, 0.61-2.76, P = 0.50). Heterogeneity was moderate at (I2 = 53%). When all patients were combined, heterogeneity was high at 81% with OR = 1.56, 95% CI, 0.87-2.79, P = 0.14. Prohomayon et al concluded that the risk of PONV showed an increased trend with LMA use. However, larger randomized trials are needed to assess the impact of airway devices on PONV.[11]

Cough complaints were more dominantly complained by the group of subjects with ETT use as many as 42.9% of subjects compared to the group with LMA use where no subjects were found with cough complaints, this had a statistically significant difference ($p < 0.05$). In line with our findings, Omar et al showed that ETT had a higher incidence of post-extubation cough by 24% compared to the incidence of cough after LMA removal by 8%, although this figure was not statistically significant.[11] Another study conducted by Sangeeta et al in 2016 showed that the use of ETT had a post-extubation cough incidence 2 times higher than the use of LMA.[16] Furthermore, research by Lalwani et al showed that the use of ETT had significantly higher post-extubation complaints of 30% compared to the use of LMA, which was reported as only 6.6% of subjects reporting cough complaints.[17] Based on our findings, it can be seen that although there were complaints of nausea, vomiting, and cough, these complaints did not have a significant impact on causing changes in IOP after 24 hours of surgery. Although, this finding still needs to be further confirmed by considering the frequency of cough, nausea and vomiting which were not carried out in our study.

The results of statistical analysis tests showed that there was no significant difference in systolic blood pressure, diastolic blood pressure and heart rate 24 hours after vitrectomy between the use of LMA and ETT ($p > 0.05$). In line with our findings, Sabah et al. saw that LMA removal and endotracheal extubation did not cause significant differences in hemodynamic responses (blood pressure and heart rate) even 5 minutes after the removal of both devices.[11] These findings indicate that both LMA and ETT use do not cause hemodynamic disturbances after 24 hours of use.

The limitation of our study is that our study has not monitored the influence of changes in $PaCO_2$ and $ETCO_2$ as one of the factors that may affect IOP variations in surgery with general anesthesia. Our study also has not conducted a kappa test to reduce subjective bias in IOP examination between examiners.

## CONCLUSION

The study concludes that the use of endotracheal tube (ETT) significantly increases intraocular pressure (IOP) compared to the use of laryngeal mask airway (LMA) during both intubation and extubation in vitrectomy procedures. Furthermore, the study finds that nausea and vomiting after vitrectomy do not significantly affect IOP 24 hours post-surgery, nor does coughing have a significant impact on IOP at the same time point. Additionally, no difference in hemodynamics, specifically blood pressure and heart rate, was observed between the use of LMA and ETT 24 hours after vitrectomy.

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