Intraocular Pressure Changes During General Anesthesia in Children, Comparing No Mask, Undermask and Laryngeal Mask Airway

SUWIMON TANGWIWAT, M.D.*,
SUWANEE SURASARANEEWONG, M.D.*,
THAMANOON SURACHATKUMTHORNKUL, M.D.**,
PARICHIKA TONGKUMPAN, M.D.*,
PISAMORN KUMPHONG, M.D.*,
LAOUNGSRI AUDCHANEEYASAKUL, M.D.**,
MOLEE NAKSARN, M.D.*,
TANAPORN NAPACHOTI, B.Sc.*

Abstract

In a before and after study of 35 children's eyes, we compared the intraocular pressure (IOP) during general anesthesia consisting of 6-8 per cent sevoflurane in 100 per centoxygen at induction. IOP measurement, blood pressure, oxygen saturation, and heart rate were recorded in patients with an applied face mask while the patient became unconscious and proceeded to surgery. These measurements were compared with those using no face-mask and after insertion of a laryngeal mask airway (LMA). The IOP with an applied face-mask was significantly statistically different from that after insertion of a LMA (12.8 ± 3.1 and 12.0 ± 3.3, $p<0.05$) but not significantly different cilnically. We concluded that clinically, the IOP does not change in children given general anesthesia with a correct size of face mask when compared with insertion of an LMA or no face mask.

Key word : Intraocular Pressure, Children, Face Mask, Laryngeal Mask Airway

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* Department of Anesthesiology,
** Department of Ophthalmology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

Intraocular pressure (IOP) measurement is an important technique used by ophthalmologists to diagnose, follow-up and guide treatment of patients who have a borderline increase in IOP. Accurate, reliable IOP measurements in children are difficult so they are frequently performed under halothane-nitrous oxide anesthesia through a face mask, which may limit the ophthalmic surgeons' access to the eyes and mechanically compress the globe of the eyes, making an error in the value recorded.

A laryngeal mask airway (LMA) is a device that may replace the oxygen face-mask in some operations. Its use in maintaining airway control without a laryngoscope leaves the surgical field largely unobstructed and the anesthesiologist's hands free to perform other duties. Watcha MF, et al[1] reported that the use of an LMA did not change the IOP in children when compared with endotracheal tube insertion. This study was similar to others[2-7]. However, the number of LMA's at Siriraj hospital is limited because of its cost, so most of the IOP measurements are performed under general anesthesia using a face-mask.

This before and after study was designed to compare the IOP and hemodynamic responses associated with three methods which were; 1) oxygen face-mask, 2) no face-mask, and 3) after insertion of LMA in anesthetized children. The information obtained will help guide the appropriate anesthetic technique and accurate IOP measurement.

METHOD

After obtaining approval from the Human Studies Committee of Siriraj Hospital and Medical School and written informed consent from the parents (or legal guardians) of the children, we studied outpatients that were scheduled for IOP measurement or elective strabismus surgery.

Inclusion criteria

1. Healthy children with ASA status I or II
2. Body weight 6.5-30 kg. (LMA size 2.0-2.5)

Exclusion criteria

1. Body weight less than 6.5 kg or more than 30 kg.
2. Children with pulmonary disease
3. Contraindications to the use of sevoflurane
4. Children with diseases with markedly increased IOP e.g., gluacoma
5. Those where LMA use was not appropriate e.g., full stomach

The patients were asked not to take milk or solids for 6 hours before induction of anesthesia and we applied the criteria that included or excluded the patients. No patients received preanesthetic medication. Anesthesia was induced in all patients with 6-8 per cent sevoflurane in 100 per cent oxygen through an oxygen face mask by spontaneous ventilation. After loss of consciousness, the patients were monitored by a non-invasive blood pressure monitor, pulse oximeter, ECG, precordial stethoscope and a vein was cannulated with a Venflon® No. 22-24G (only in strabismus surgery), and the sevoflurane concentration was increased or decreased according to the depth of anesthesia and vital signs. The IOP measurements were made with a Schiotz tonometer by one of the same two ophthalmic surgeons. In all patients, the IOP measurements were made at the same depth of anesthesia which was indicated from their eye signs: mid-position and normal-sized pupils, no nystagmus, and no eye-tear.

All of the three methods were used in the same patient. We measured the IOP, systolic, diastolic and mean blood pressure, pulse rate, and oxygen saturation following induction with 1) no face mask 2) face-mask 3) after insertion of LMA. At the surgical stage with stable vital signs, the ophthalmic surgeon measured the IOP from the left eye three times as soon as possible after we maintained the patient airway by insertion of a proper-sized oral airway and manipulation of the jaw without a face mask. These three values were calculated as the first mean IOP (IOP1 No face-mask). There was a 5 minute interval (surgery). The second IOP measurements were made after the face-mask was applied again (IOP2 face-mask). This was followed by insertion of LMA and a 5-minute interval (surgery). Following this, the third measurements were made (IOP3 LMA).

When the operation was finished, we stoped administering sevoflurane, and gave 100 per cent oxygen. The LMA was removed when the anesthetic level was still deep. We maintained an adequate airway, transferred the patient to the recovery room, and maintained close observation until the patient regained consciousness.

Sample size calculation

A paired *t*-test was used to calculate the sample size needed for comparing the three methods of measuring IOP in the same patient.

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \times SD^2}{\Delta^2}$$

when SD = standard deviation of the difference of the IOP between the two methods = 4.2 (from a pilot study)

Δ = the difference of the mean IOP between the two methods that was clinically significantly different.

Δ = 2 mmHg.

Limited

α = 0.05 (2-sided) $Z\alpha_{/2}$ = 1.96

β = 0.02 $Z\beta$ = 0.842 (power = 80%)

$$n = \frac{(1.96 + 0.842)^2 \times 4.2^2}{2^2}$$

$$= 5.88^2 = 35$$

so sample size = 35 eyes = 35 people (one eye, one person)

Statistical methods

One way analysis of variance (ANOVA) for repeated measurement was used for comparing the IOP with no face-mask, with face-mask, and after insertion of LMA in the same children. When there was a significant difference ($p<0.05$), we further analyzed the difference between 1) no face-mask and face-mask, 2) no face-mask and after LMA, 3) face-mask and after LMA in that order. There was a significant difference when $p<0.0167$. (0.05/3)

RESULTS

35 left-eyes of children were enrolled in this study. The patient data is shown in Table 1.

We tried to stabilize the factors that affect the IOP (shown in Table 2) such as the blood pressure, pulse rate, oxygen saturation, and the depth of anesthesia. The results showed no difference in systolic, diastolic, mean blood pressure or PaO_2 between the three methods. Although there was a statistically significant difference in the mean pulse rate between each method, there was not a significant clinical difference because the mean pulse rate was within the range of mean ± 20 per cent (115 ± 20%) which minimally affects the IOP provided the blood pressure does not change.

Although the IOP measured during general anesthesia with face mask was statistically significantly more than that meausred during anesthesis with LMA ($p<0.0167$) there was not a clinically significant difference because we limited a clinically significant difference to be 2 mmHg as shown in Table 3.

DISCUSSION

The aim of the study was to compare the change in IOP while receiving general anesthesia with face mask and after insertion of an LMA. The results showed a statistically significant difference between the two groups ($p<0.0167$). General anesthesia through an oxygen face mask increased the IOP more than after LMA insertion did, but there was no clinically significant difference if we limited the difference to 2 mmHg. This limitation was obtained from the opinion of expert ophthalmologists, that the movement for one mark on the scale of a Schiotz tonometer is 2-3 mmHg. None of the previous review

Table 1. Patient data.

Number of patient	35
Sex (number)	
Female	22 (62%)
Male	13 (38%)
Mean age (yr) ± SD	2.8 ± 2.6 (1.9-3.7)
Mean body weight (kg) ± SD	1.7 ± 4.7 (10.1-13.4)

Table 2. Factors that may be affected the IOP.

Control factors	Mean ± SD			P-value*
	No mask	Mask	LMA	
Blood pressure				
Systolic	90.1 ± 13.6	89.1 ± 11.6	91.4 ± 11.0	0.3846
Diastolic	46.9 ± 8.9	47.9 ± 8.1	48.9 ± 6.7	0.1268
Mean	66.4 ± 13.2	64.8 ± 8.4	67.4 ± 9.6	0.2573
Pulse rate	112.1 ± 18.3	113.6 ± 20.5	119.8 ± 21.5	<0.0001**
O_2 Saturation	99.5 ± 0.9	99.5 ± 1.0	99.5 ± 1.0	0.7534
IOP	12.6 ± 3.0	12.8 ± 3.1	12.0 ± 3.3	0.0072***

* Compare p-value with $\alpha = 0.05$

** When further analyzed, there was a significant difference in pulse rate between No mask *vs* LMA, p<0.0001 and Mask *vs* LMA, p=0.0007 when comparing p-value with $\alpha = 0.05/3 = 0.0167$

*** When further analyzed comparing p-value with $\alpha = 0.0167$, shown in Table 3

Table 3. Comparison of the differences in the IOP measured between: No mask *vs* Mask, No mask *vs* LMA and Mask *vs* LMA.

	No mask-Mask	No mask-LMA	Mask-LMA
IOP Difference ± SE	-0.16 ± 0.25	0.61 ± 0.28	0.77 ± 0.21
98.33% CI*	-0.76 to 0.44	-0.06 to 1.27	0.27 to 1.27
P-value**	0.5256	0.0169	0.0029

* In order to compare p-value

** with $\alpha = 0.05/3 = 0.0167$, chose 98.33% CI (1-0.0167)

literature has compared the difference on the IOP between using a face mask and LMA. However, Watcha MF, et al have compared the differences in IOP between LMA insertion and endotracheal intubation in children and reported that LMA did not statistically significantly increase the IOP in contrast to endotracheal intubation, similar to the studies of Whitford AM, et al and Holden R, et al[2,3]. In the study by Brimacombe J[6] the association of the use of LMA and changes in IOP were not reported but it was concluded that the advantage of the LMA was that it was convenient to use, allowed the hands to be free, and did not obstruct the access of the ophthalmic surgeon.

In our study, we decreased the bias in the IOP measurements as it was measured with the same Schiotz tonometer by the two same expert ophthalmic surgeons and general anesthesia was given by the two same expert anesthesiologists. However, there was unavoidable bias since the IOP values were known by the opthalmic surgeons. The research has limitations: 1) we could not randomize the methods to the patients because some patients needed to receive the operation after the IOP measurement such as strabismus correction, 2) we could not record the end tidal CO_2 which affects the IOP.

General anesthesia through an oxygen face mask statistically significantly increased the IOP when compared with LMA but there was no clinically significant difference. So the face mask method is a convenient technique for IOP measurement but an appropriate size and technique must be chosen and one must be careful of patients with a borderline increase of IOP. A LMA also is an effective device and may be suitable for the group with increased IOP. This will require further study.

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ผลของเทคนิคการระงับความรู้สึกทั่วไปต่อความดันภายในลูกตาเปรียบเทียบขณะเด็กหลับ (โดยไม่ได้ครอบหน้ากากออกซิเจน), ขณะครอบหน้ากากออกซิเจน และหลังใส่ Laryngeal Mask Airway (LMA)

สุวิมล ต่างวิวัฒน์, พ.บ., พิสมร คุ้มพงษ์, พ.บ.*, สุวรรณี สุรเศรณีวงศ์, พ.บ.*, ละอองศรี อัชชนียะสกุล, พ.บ.**, ธรรมนูญ สุรชาติกำธรกุล, พ.บ.**, โมฬี นาคสาร, พ.บ.*, ปริชิกา ทองคำพันธ์, พ.บ.*, ธนาภรณ์ นะภาโชติ, วท.บ.**

วัตถุประสงค์ : เพื่อศึกษาผลกระทบของการครอบหน้ากากออกซิเจนต่อความดันภายในตา เปรียบเทียบกับการใส่ laryngeal mask airway (LMA) ขณะให้การระงับความรู้สึกทั่วไป

คณะผู้ทำการวิจัยทำการศึกษา ผู้ป่วยเด็กซึ่งมีความดันภายในลูกตาปกติ อายุ 1.9–3.7 ปี น้ำหนัก เฉลี่ย 11.7 ± 4.8 กิโลกรัม เปรียบเทียบความดันภายในตาขณะผู้ป่วยได้รับการระงับความรู้สึกทั่วไป โดยให้ 6–8% sevoflurane ใน 100% ออกซิเจนนำสลบจนผู้ป่วยหลับและเข้าสู่ surgical stage หลังจากนั้น จักษุแพทย์วัดความดันภายในตาโดยใช้ Schiotz tonometer เปรียบเทียบความดันภายในตาขณะครอบหน้ากากออกซิเจน, ขณะเด็กหลับโดยไม่ได้ครอบหน้ากากออกซิเจน (เปิดทางหายใจโดยการเชยคางและยกขากรรไกร) และหลังใส่ LMA ผลการศึกษาพบว่าความดันภายในตาขณะครอบหน้ากากออกซิเจนและหลังใส่ LMA มีความแตกต่างอย่างมีนัยสำคัญทางสถิติ (12.8 ± 3.1 *vs* 12.0 ± 3.3, p=0.0029) แต่ไม่มีความสำคัญทางคลินิก สรุปได้ว่าผู้ป่วยเด็กที่มีความดันภายในตาปกติ การครอบหน้ากากออกซิเจนเพื่อให้ยาดมสลบอย่างถูกวิธี โดยเลือกขนาดหน้ากากออกซิเจนที่เหมาะสมกับผู้ป่วยจะไม่ทำให้ค่าความดันภายในตาเปลี่ยนแปลงไป เมื่อเปรียบเทียบกับการใส่ LMA และขณะเด็กหลับโดยไม่ได้ครอบหน้ากากออกซิเจน

คำสำคัญ : ความดันในตา, ผู้ป่วยเด็ก, การครอบหน้ากากออกซิเจน, การใช้ LMA

สุวิมล ต่างวิวัฒน์, พิสมร คุ้มพงษ์, สุวรรณี สุรเศรณีวงศ์, และคณะ
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* ภาควิชาวิสัญญีวิทยา,

** ภาควิชาจักษุวิทยา, คณะแพทยศาสตร์ศิริราชพยาบาล, มหาวิทยาลัยมหิดล, กรุงเทพ ฯ 10700