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Original Article

Comparison of Four Different Supraglottic Airway Devices in Terms of Efficacy, Intra-ocular Pressure and Haemodynamic Parameters in Children Undergoing Ophthalmic Surgery

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Abstract

Objective: The aim of this study was to compare insertion parameters of four different types of supraglottic airway devices (SGAD) (Classic LMA, I-gel LMA, Proseal LMA, Cobra PLA) in children undergoing ophthalmic surgery and to determine the effect on intra-ocular pressure (IOP) and haemodynamic responses during insertion.

Methods: Sixty American society of Anesthesiologists (ASA) I–II children aged 1–10 years undergoing extra-ocular ophthalmic surgery were randomly divided into four groups (Group LMA, Group I-gel LMA, Group PLMA and Group CPLA) in this prospective, randomised study. Anaesthesia was induced with decreasing sevoflurane concentrations (8%–2%) in a mixture of 50% N_2O-O_2. All SGADs were inserted under deep anaesthesia. The characteristics of insertion (number of attempts, ease and time), oropharyngeal leak pressure (OLP) and complications were recorded. IOP in both eyes, heart rate (HR), mean arterial pressure (MAP) and $EtCO_2$ were measured before and 2 and 5 min after insertion of the SGADs.

Results: There was no difference between the groups in terms of the characteristics of insertion. The mean IOP did not increase significantly in all groups. MAP and HR changes were similar among the groups during follow-up. In all groups, HR increased 2 min after insertion (statistically insignificant) and returned to the baseline value 5 min after insertion. A statistically significant correlation was seen between HR increase and IOP values before and after insertion of the SGADs (p=0.006, correlation coefficient=0.352). Desaturation was seen in one patient in Groups LMA, PLMA and CPLA, and laryngospasm was seen in two patients in Group CPLA and in one patient in Group LMA.

Conclusion: It was seen that during insertion of Classic LMA, I-gel LMA, Proseal LMA and Cobra PLA, IOP did not increase and haemodynamic stability was maintained in children undergoing extra-ocular ophthalmic surgery.

Keywords: Laryngeal mask, intra-ocular pressure, haemodynamics

Introduction

In paediatric ophthalmic surgery, various instruments are used for providing airway safety during the administration of general anaesthesia. It is known that conventional laryngoscopy and endotracheal intubation cause sympathoadrenal stimulation and thus lead to temporary increases in blood pressure, heart rate (HR) and intraocular pressure (IOP) (for approximately 5 min) (1, 2). While haemodynamic and IOP changes can be tolerated in patients who have a good general health state and who will not undergo ophthalmic surgery, not allowing any increase in IOP for patients who will undergo ophthalmic surgery is very important for surgical results. It has been reported that increased IOP can be excessive in children with high IOP or accompanying pathologies and that it can result in undesired outcomes (3).

Supraglottic airway devices (SGADs) have been being increasingly used in recent years to provide safe and efficient airway in suitable cases. As shown in many studies conducted with adult and paediatric patients, compared with endotracheal intubation, SGAD is more advantageous because it does not need muscle relaxation, it is easily applied without laryngoscopy, it is less traumatic and it provides more stable haemodynamic and IOP profiles in paediatric ophthalmic surgery (4-6). Following classical laryngeal mask (CLMA), which was first used in 1988, various types of SGADs with different anatomical features have been developed. Among these devices, I-Gel LMA, Proseal-LMA (PLMA) and Cobra-perilaryngeal airway (Cobra-PLA) devices are beginning to be used more frequently in paediatric and adult patients. Proseal-LMA was developed by modifying CLMA in the 2000s. Some advantages of PLMA include the applicability of high positive pressure ventilation,

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existence of bite block and ability of emptying the stomach by inserting a gastric catheter through the drainage tube next to ventilation. I-gel LMA has been designed as it does not cause any pressure on the anatomical structures of the larynx and pharynx. It has a structure of a thermoplastic elastomer, and it does not have a cuff. In contrast, Cobra-PLA is a tube with a grooved tip, and its oropharyngeal cuff has a high volume and low pressure. It allows using higher pressures than classical LMA.

In a paediatric patient group, the effects of these devices on cardiovascular and IOP changes during the insertion and in determining superiority of one device over another are unclear because of inadequate number of comparative studies on this issue.

In this study, in paediatric patients undergoing ophthalmic surgery, the effects of 4 different types of SGADs (Classical LMA, I-Gel LMA, proseal LMA and Cobra PLA) on insertion parameters and also on IOP and haemodynamic changes during insertion were compared.

Methods

This study was conducted by the Department of Anaesthesiology and Reanimation in Ankara Education and Research Hospital in the operating room of ophthalmology after having received approval from the ethics committee of Ankara Education and Research Hospital (with the decision dated 23 November, 2011, and numbered 3682 taken in the meeting numbered 441). A total of 60 children in the age range of 1–10 years, who were in the American Society of Anesthesiologists (ASA) I-II group and who would undergo elective extraocular ophthalmic surgery were included in this prospective, randomised and single-blind study after written and verbal informed consents were obtained from their parents.

Patients having a history of previous intraocular surgery and a difficult intubation, glaucoma in addition to cardiovascular and pulmonary diseases, gastro-oesophageal reflux and upper respiratory tract pathologies and also children having respiratory tract infection before surgery, aspiration risk, and those who were taken for an emergency operation were excluded from the study. The patients were randomly divided into 4 groups using a list formed on the computer for the insertion of 4 different SGADs. These groups were Group CLMA: Classical LMA (Laryngeal Mask Company, Henley-on-Thames, UK), Group ILMA: I-Gel LMA (Intersurgical LTD, USA), Group PLMA: ProSeal LMA (Laryngeal Mask Company, Henley-on-Thames, UK) and Group CPLA: Cobra PLA (Engineered Medical Systems, Indianapolis, IN, USA).

Children were given no solid food for 6 h, no breast milk for 4 h and no clear liquid for 2 h. After orally administering a premedication (0.3 mg kg^{-1} midazolam) 30 min before the operation, the patients were taken into the operating room, and they were monitored with ECG, pulse oximetry and non-invasive blood pressure (Drager Primus). Before anaesthesia induction, all patients were preoxygenated with 3 L min^{-1} of 100% O_2. Anaesthesia induction was provided with the administration of sevoflurane in decreasing concentration (8%-2%) in a mixture of 50% N_2O and 50% O_2. After the establishment of intravenous access, 1–1.5 mcg kg^{-1} fentanyl was added. Anaesthesia was deepened with controlled manual ventilation until eyelash reflex disappeared. For the selection of SGAD number to be used, the recommendations of the producing company, which they formed based on the body weights of patients, were taken into consideration. In all groups, a gel was applied on the exterior surfaces of LMAs before insertion, and the procedure was performed in the sniffing position. After insertion, the cuff was inflated for each SGAD at the volume recommended by the producing company, and the airway device was attached to the ventilator circuit. Hearing bilateral lung sounds, the existence of bilateral chest wall expansion, occurrence of end-tidal carbon dioxide ($ETCO_2$) trace in capnography, peak inspiratory pressure at a level lower than 20 cm H_2O during the application of at least 6 mL kg^{-1} tidal volume and SpO_2 of >93% with 100% O_2 were accepted as adequate and effective ventilation. Then, volume controlled ventilation was applied (respiratory rate as 8 mL kg^{-1} tidal volume, inspiration/expiration ratio 1:2 and $EtCO_2$: 30–35 mmHg), and the maintenance of anaesthesia was provided with 2–3% of sevoflurane in the mixture of 50% O_2-N_2O.

After securing the airway, oropharyngeal gas leak pressures were measured. For this, the expiration valve was closed, and fresh gas flow was then decreased to 3 L min^{-1}. The airway pressure at which the sound of leak was heard from the mouth was recorded as leak pressure. During this test, the airway pressure was not allowed to increase over 30 cmH_2O.

The time between the removal of the facial mask and the observation of the $EtCO_2$ wave was recorded as the duration of insertion. The easiness degree of insertion was evaluated over the following 3 scores: 1) very easy (insertion of laryngeal mask on the first attempt, no resistance), 2) easy (insertion of laryngeal mask on the first attempt, mild resistance) and 3) difficult (insertion of laryngeal mask on the second or third attempt, observation of apparent resistance). The interventions that failed despite the third attempt with more than 2 additional manoeuvres were accepted to be unsuccessful insertions, and these patients were excluded from the study after being intubated. Complications that might develop during insertion (cough, hiccup, laryngospasm, stridor, bronchospasm, desaturation or traumatic haemorrhage) were recorded.

IOP measurements for both eyes were performed by an ophthalmologist who was not informed about the airway device used, with TONO-PEN AVIA applanation tonometry after induction performed just before the insertion of SGAD and 2–5 min after the insertion of SGAD. When the anaesthetist reported that the patient was ready, the ophthalmologist was taken out of the operating room after measuring the pressures of both eyes before the insertion of the airway device. One of four different airway devices was inserted by the anaesthetist, and it was then fixed on the anterior chest wall of the patient before covering the patient with a surgical drape. At this stage, the ophthalmologist was taken into the operating room again for re-measuring the pressures of both eyes 2–5 min after the insertion of the airway device. The pressure of the right eye was first measured, followed by that of the left eye. By evaluating the pressures of both eyes, the mean IOP was found. During measurement, the pressure at which the device displayed 95% sensitivity was recorded. Pressures between 8 and 22 mmHg were accepted to be normal, and pressures that increased by 30% and over compared with the baseline pressure were accepted to be significant. After the last measurement, an antibiotic eye drop was applied to both eyes. Moreover, HR, mean arterial pressure (MAP) and $EtCO_2$ of the patients were recorded at the times of measurements. Increases by 30% and over in blood pressure and HR compared with baseline pressures were recorded to be statistically significant.

Statistical analysis

The data were analysed using SPSS (Statistic Package for Social Sciences, Chicago, IL, USA) for Windows 11.5. The distribution of continuous variables was evaluated with Shapiro–Wilk test. The homogeneity of variances was investigated with Levene's test. Continuous variables and descriptive statistics were presented as mean±standard deviation, and categorical variables were presented as the number of observations and percentage (%). The significance of differences in means between the groups was evaluated using one-way ANOVA. When the result was found to be significant, post hoc Tukey's HSD test was used for revealing the source of difference. Moreover, Pearson's chi-square test was employed to assess the categorical variables. Spearman's correlation test was used for investigating the existence of correlation between insertion parameters and changes in IOP and haemodynamic parameters and also between the changes in IOP and those in haemodynamic parameters.

IOP and haemodynamic parameters were assessed with repeated-measures analysis of variance. Whether mean changes occurring in IOP and haemodynamic parameters according to the times of measurements demonstrated any difference among the groups was evaluated with Greenhouse–Geisser test statistics by controlling the significance level of interaction effect. $P<0.05$ was accepted to be statistically significant.

Results

This study included a total of 60 children (15 in each group). Of these patients, 60% (36 children) were males and 40% (24 children) were females. No statistically significant difference was detected with regards to demographic data (Table 1).

Information on the insertion of SGADs are specified in Table 2. When comparing the number of LMA insertions, it was found that more than one attempt was performed in 3 children in Group CLMA and in 1 child each in Groups ILMA, PLMA and CPLA ($p>0.05$) (Table 2). With regard to the easiness of the degree of insertion, insertion was generally performed very easily in all groups except Group PLMA. For Group PLMA, the insertion was very easy in 26.7% of children and easy in 66.7%. Difficulty in insertion was seen in only 2 children, one from Group PLMA and the other from Group CPLA. The insertion of the device failed only in 1 patient in Group CLMA. However, no statistically significant difference was found among the groups (Table 2).

When the durations of the insertion of SGADs were compared, no statistically significant difference was detected among the groups. However, it was observed that the duration of insertion was shorter in Group ILMA (Table 2).

With regard to the oropharyngeal leak pressures (OLPs) of SGADs, statistically significant difference was found between Group ILMA and Group CPLA ($p<0.03$). On the other hand, no statistically significant was observed among the other groups. While leak pressure was lower in Group ILMA than in the other groups, it was higher in Group CPLA. However, adequate ventilation was provided in all groups in a way that the peak inspiratory pressure was below 20 cm H_2O (Table 2).

Table 1. Demographic and clinical features of patients according to the groups

Variables	Group CLMA	Group ILAM	Group PLMA	Group CPLA	p
Age (years)	5.6±2.6	6.4±2.5	7.3±2.2	6.2±2.7	0.322
Gender					**0.644**
Female	6 (40.0%)	4 (26.7%)	7 (46.7%)	7 (46.7%)	
Male	9 (60.0%)	11 (73.3%)	8 (53.3%)	8 (53.3%)	
ASA 1/2	15/0	12/3	14/1	15/0	0.071
Body weight (kg)	20.0±5.8	23.5±8.9	24.8±6.0	23.3±8.1	0.330
Duration of surgery (min)	47.0±13.6	48.0±13.2	52.7±18.1	43.7±11.6	0.395
Duration of anaesthesia (min)	56.4±14.1	57.5±13.9	62.5±17.5	52.7±12.6	0.347

Group CLMA: classical laryngeal mask; Group ILMA: I-Gel laryngeal mask; Group PLMA: proseal laryngeal mask; Group CPLA: Cobra perilaryngeal mask

The mean change observed in the right and left eye pressures and the mean IOPs while monitoring was statistically similar among the groups (Table 3).

Haemodynamic parameters are presented in Table 4. The mean change in HR, MAP and $EtCO_2$ while monitoring was statistically similar among the groups.

In the investigation of the effects of insertion parameters on IOP among the groups, no statistically significant correlation was detected with regard to the number of insertion attempts, easiness degree of insertion, duration of insertion and leak pressure and IOP.

In addition, the effects of insertion parameters on haemodynamic parameters were evaluated in the groups, and it was found that HR was influenced by the number of insertion attempts and easiness degree of insertion, especially 2 min after the insertion of SGAD, but that this was not statistically significant (Table 5). Moreover, it was detected that MAP was affected by the number of insertion attempts and easiness degree of insertion. The effect of the easiness degree of insertion was found to be statistically significant (p=0.014) (Table 5).

Furthermore, it was found that $ETCO_2$ was affected by the parameters of insertion, number of insertion attempts and easiness degree of insertion in the measurements taken at the 2nd and 5th minutes after the insertion of SGAD. $ETCO_2$ was significantly increased by the duration of insertion in the 2nd minute measurement (p=0.017) and by the number of insertion attempts in the 5th minute measurement (p=0.014) (Table 5).

Table 2. Distribution of cases in terms of insertion parameters according to the groups

Variables	Group CLMA	Group ILAM	Group PLMA	Group CPLA	p
Number of insertion					**0.582**
Once	12 (80.0%)	14 (93.3%)	14 (93.3%)	14 (93.3%)	
More than once	3 (20.0%)	1 (6.7%)	1 (6.7%)	1 (6.7%)	
Easiness of insertion					**0.056**
'1'	8 (53.3%)	12 (80.0%)	4 (26.7%)	10 (66.7%)	
'2'	7 (46.7%)	3 (20.0%)	10 (66.7%)	4 (26.7%)	
'3'	-	-	1 (6.7%)	1 (6.7%)	
Failure in insertion	1 (6.7%)	-	-	-	-
Duration of insertion (s)	24.4±20.5	17.4±7.0	25.7±14.2	19.1±14.7	0.361
Leak pressure (mmHg)	22.4±3.7	20.0±3.2a	22.1±3.8	25.1±4.4[a]	0

Group CLMA: classical laryngeal mask; Group ILMA: I-Gel laryngeal mask; Group PLMA: proseal laryngeal mask; Group CPLA: Cobra perilaryngeal mask. 1=very easy (insertion of laryngeal mask on the first attempt, no resistance, insertion only with the jaw opening movement), 2=easy (insertion of laryngeal mask on the first attempt, mild resistance) and 3=difficult (insertion of laryngeal mask on the second or third attempt, observation of apparent resistance). [a]The difference between Group ILMA and Group CPLA is statistically significant (p=0.003).

Table 3. IOP levels during monitoring times according to the groups

Variables	Group CLMA	Group ILMA	Group PLMA	Group CPLA
Right				
Before LMA	11.1±2.7	12.4±4.3	12.0±3.0	12.1±2.0
2nd min after LMA	11.7±2.9	13.5±5.2	13.5±3.1	12.7±2.3
5th min after LMA	11.3±2.2	12.7±5.7	12.2±2.6	12.6±2.0
Left				
Before LMA	10.5±2.6	11.7±3.1	12.7±3.2	12.2±3.2
2nd min after LMA	11.5±2.7	12.5±1.4	12.9±3.9	13.4±2.8
5th min after LMA	11.5±1.9	11.8±2.0	12.7±3.5	12.4±3.5
Mean				
Before LMA	10.8±2.4	12.1±2.6	12.3±2.9	12.1±2.5
2nd min after LMA	11.6±2.7	13.0±2.8	13.2±3.4	13.0±2.3
5th min after LMA	11.4±2.0	12.2±3.3	12.4±2.9	12.5±2.5

Group CLMA: classical laryngeal mask; Group ILMA: I-gel laryngeal mask; Group PLMA: proseal laryngeal mask; Group CPLA: Cobra perilaryngeal mask

In the evaluation of the effects of haemodynamic parameters (HR, MAP and $ETCO_2$) on IOP, a statistically significant correlation was revealed between increased HR before and after the insertion of SGAD and IOP (p=0.006). However, as these increases in IOPs were within normal intervals, they were not found to be clinically significant (Table 6).

The occurrence of side effects was found to be similar across all groups. During insertion, desaturation was observed in one patient each for Groups CLMA, PLMA and CPLA. Laryngospasm developed in 1 patient in Group CLMA and in 2 patients in Group CPLA.

Discussion

In this study where the effects of CLMA, ILMA, PLMA and CPLA on IOP and haemodynamics during insertion in paediatric patients who underwent ophthalmic surgery were compared, it was found that these 4 SGADs did not increase IOP and impair haemodynamic stability.

The success rate of LMA insertion in paediatric patients was reported to vary between 67% and 99% (7, 8). These different rates can be explained by different definitions of insertion success and by the use of different insertion techniques. Shimbori et al. (9) found the easiness degree of insertion to be similar for CLMA and PLMA in their study conducted on 60 children. The success rate of the first SGAD insertion attempt was reported to be 80–90% for CLMA and 90–100% for PLMA (9, 10). In another study conducted by Bağuş et al. (11) where the efficiencies of CLMA and PLMA were compared in paediatric patients, the success rate of insertion was reported to be 100% for both groups. The success rate for the first trial of CPLA insertion in paediatric patients was found to be 90% by Passariello et al. (12) and 95% by Szmuk et al. (13). In our study, the success rate for the first attempt was detected to be 80% for Group CLMA and 93% for Groups ILMA, PLMA and CPLA. Although it was statistically insignificant, insertion was also unsuccessful in a patient in Group CLMA. This might have resulted from the fact that CLMA devices used in our clinic lost their elasticity because they were sterilised in the clinic many times. Our high success rates in other groups can be explained with the reason that SGADs were applied by an experienced anaesthetist using ideal techniques. For instance, PLMA was inserted using a 90° rotation technique, which was demonstrated to facilitate insertion and reduce the risk for pharyngeal trauma by Yun et al. (14).

It is important for paediatric patients in particular to not prolong the duration of the insertion of airway devices. Therefore, the method used for airway patency must be a technique that can be easily and rapidly applied. Andrews et al. (15) compared CLMA and CPLA in adult patients, and they reported that the duration of CPLA application (39±21 s) was longer than that of CLMA application (27±10 s). Bağuş et al. (11) stated that they found no difference between the durations of CLMA and PLMA insertion (19.80±3.39 sec and 20.28±4.92 s, respectively) in paediatric patients. In comparative studies conducted on single-use LMA (15.20–30.04 s) and I-Gel LMA (8.50–21.40 s), the duration of insertion was found to be shorter in ILMA (16-18). Some authors attribute the shorter duration of insertion for ILMA to the easy use of I-Gel and because it is used without a cuff, which means that no time is spent inflating the cuff. Bamgbade et al. (19) reported that the duration of insertion was less than 5 s in 290 of 300 patients on whom I-gel was applied. However, they did not define which time the duration of insertion included. Generally, in all studies conducted on SGAD, the duration of insertion is defined as the time passing from the moment when a practitioner take the device until the first ventilation, that is until the appearance of a square wave capnograph. This definition was also used in our study. According to this,

Table 4. Levels of haemodynamic parameters during monitoring times according to the groups

Variables	Group CLMA	Group ILMA	Group PLMA	Group CPLA
Heart rate (beat min^{-1})				
Before LMA	104.5±18.3	93.4±15.9	96.1±14.4	99.3±16.4
2nd min after LMA	110.7±19.6	99.8±21.4	101.5±15.3	106.3±15.5
5th min after LMA	103.2±33.3	95.4±18.3	99.0±17.4	102.1±15.2
Mean arterial pressure (mmHg)				
Before LMA	68.7±13.6	70.3±11.8	73.8±16.3	63.5±9.2
2nd min after LMA	69.3±11.3	66.1±8.2	70.9±11.2	66.9±8.2
5th min after LMA	67.7±11.3	65.3±6.1	68.5±14.6	65.1±10.5
$EtCO_2$ (mmHg)				
Before LMA	33.7±2.2	34.5±2.7	34.5±1.8	34.7±2.3
2nd min after LMA	39.2±3.0	38.5±3.1	38.7±2.4	38.7±2.3
5th min after LMA	36.1±2.9	34.9±3.9	35.1±3.8	36.5±3.4

Group CLMA: classical laryngeal mask; Group ILMA: I-gel laryngeal mask; Group PLMA: proseal laryngeal mask; Group CPLA: Cobra perilaryngeal mask

Table 5. Correlation coefficients between the number of insertion attempts, easiness degree of insertion, duration of insertion and leak pressure and the amount of changes in haemodynamic parameters and their significance levels

Variables		Number of insertion attempts	Easiness degree of insertion	Duration of insertion	Leak pressure
Δ_{12} HR	Correlation coefficient	–0.029	–0.032	0.051	0.113
	p-value[a]	0.827	0.809	0.701	0.388
Δ_{13} HR	Correlation coefficient	0.154	0.104	0.258	0.036
	p-value[a]	0.240	0.430	0.046	0.788
Δ_{23} HR	Correlation coefficient	0.148	0.182	0.279	–0.108
	p-value[a]	0.261	0.163	0.031	0.412
Δ_{12} MAP	Correlation coefficient	–0.006	0.145	0.139	0.115
	p-value[a]	0.961	0.270	0.291	0381
Δ_{13} MAP	Correlation coefficient	0.042	0.317	0.256	0.021
	p-value[a]	0.752	0.014	0.049	0.871
Δ_{23} MAP	Correlation coefficient	0.237	0.270	0.221	–0.075
	p-value[a]	0.068	0.037	0.090	0.570
Δ_{12} $EtCO_2$	Correlation coefficient	–0.003	0.039	0.132	0.098
	p-value[a]	0.981	0.767	0.315	0.455
Δ_{13} $EtCO_2$	Correlation coefficient	0.289	0.243	0.306	0.178
	p-value[a]	0.025	0.061	0.017	0.174
Δ_{23} $EtCO_2$	Correlation coefficient	0.315	0.197	0.238	0.080
	p-value[a]	0.014	0.132	0.067	0.543

HR: heart rate; MAP: mean arterial pressure; Δ_{12}: Compared to pre-LMA, change in haemodynamic parameters that occurs 2 min after LMA; Δ_{13}: Compared to pre-LMA, change in haemodynamic parameters that occurs 5 min after LMA; Δ_{23}: Compared to the 2nd minute after LMA, change in haemodynamic parameters that occurs 5 min after LMA; aAccording to Bonferroni correction, the results of p<0.017 were accepted to be statistically significant.

no statistically significant difference was found among the groups with regard to the durations of insertion, and the duration of insertion was shorter in Group ILMA in particular (17.4 s). We also suggest that the absence of a cuff in ILMA has a role in this result.

As an indicator of the efficiency of SGADs, OLPs gain importance (20). In different studies, OLPs were found to be 20–30 cm H_2O for ILMA, 20–27 cm H_2O for CLMA, 23–33 cm H_{2O} for PLMA and 23–30 cm H_{2O} for CPLA, when the head was in the neutral position. In studies comparing I-gel and LMA, OLP was detected to be higher in the I-Gel group (16-18). Gasteiger et al. (21) compared I-Gel LMA and Proseal LMA in their study and found that OLPs were higher for 7 cm H_20 (30 vs. 23) in the Proseal LMA group.

In our study, OLPs of all groups were consistent with those found in literature [Group KLMA 22.4 (17-29), Group ILMA 20 (14-26), Group PLMA 22 (15-28) and Group CPLA 25.1 (19-33)]. OLPs were lower in Group ILMA and higher in Group CPLA (p=0.003).

Considering the easiness degree and duration of insertion and due to the absence of any failure, it can be thought that I-Gel LMA is more advantageous than other SGADs in terms of insertion characteristics. Therefore, it can be preferred especially for paediatric patients with a comorbid disease (hereditary cardiovascular system pathology, glaucoma, etc.).

In the comparison of SGADs with endotracheal airway devices during intubation and extubation, it was stated that the effect of SGADs on haemodynamic parameters was lower (22). Evans et al. (23) examined the haemodynamic parameters of 268 patients in their PLMA series that included 300 cases, and they detected a slight decrease in HR in the 5th minute after application and a significant decrease in MAP in the 1st and 5th minutes after insertion. In a study performed by Turan et al. (24) on 90 patients, an increase was detected in HR, MAP and peripheral oxygen saturation in the 1st minute after the insertion of a laryngeal tube, LMA and CPLA. In other measurements, a significant decrease was found compared with preoperative measurements. In our study, 2 min after the insertion of SGAD, a clinically insignificant and minimal increase in HR was observed in all patients. This minimal increase returned to the previous level before insertion in the 5th minute measurement. It was detected that MAP showed a tendency to slightly decrease, which was statistically and clinically insignificant.

In paediatric patients with glaucoma, penetrating eye injury and cyanotic or non-cyanotic cardiovascular system pathology, in particular, the importance of controlling haemody-

Table 6. Correlation coefficients between change in IOP and change in haemodynamic parameters and their significance levels

Variables		Right IOP	Left IOP	Mean IOP
Δ_{12} HR	Correlation coefficient	0.379	0.303	0.352
	p-value[a]	0.003	0.019	0.006
Δ_{12} MAP	Correlation coefficient	0.038	0.097	0.091
	p-value[a]	0.774	0.461	0.489
Δ_{12} $EtCO_2$	Correlation coefficient	0.021	−0.069	−0.058
	p-value[a]	0.871	0.599	0.660
Δ_{13} HR	Correlation coefficient	0.010	0.207	0.088
	p-value[a]	0.937	0.112	0.506
Δ_{13} MAP	Correlation coefficient	0.082	0.117	0.120
	p-value[a]	0.533	0.372	0.362
Δ_{13} $EtCO_2$	Correlation coefficient	0.067	0.036	−0.036
	p-value[a]	0.613	0.784	0.785
Δ_{23} HR	Correlation coefficient	0.049	0.144	0.104
	p-value[a]	0.711	0.272	0.428
Δ_{23} MAP	Correlation coefficient	0.228	0.290	0.287
	p-value[a]	0.080	0.025	0.026
Δ_{23} $EtCO_2$	Correlation coefficient	0.009	0.154	−0.122
	p-value[a]	0.946	0.240	0.352

HR: heart rate; MAP: mean arterial pressure; Δ_{12}: Compared to pre-LMA, change in haemodynamic parameters that occurs 2 min after LMA; Δ_{13}: Compared to pre-LMA, change in haemodynamic parameters that occurs 5 minutes after LMA; Δ_{23}: Compared to 2[nd] minute after LMA, change in haemodynamic parameters that occurs 5 min after LMA; [a]According to Bonferroni correction, the results of $p<0.017$ were accepted to be statistically significant.

namic responses during the airway manipulations is clear. It should be kept in mind that haemodynamic responses can have negative effects on the surgical outcome in these patients. In this respect, we think that the 4 SGADs in our study can be safely used in this type of patient group owing to the haemodynamic stability they provided.

In a study conducted by Watts et al. (25), it was detected that a little but significant increase was observed in IOPs with LMA compared with previous values. On the other hand, Akhtar et al. (26) compared IOPs measured after LMA insertion to tracheal intubation, and they found insignificant changes in IOPs. İsmail et al. (27) evaluated the effects of CLMA, I-Gel and ETT use on IOP and reported that the use of I-Gel did not increase IOP, but the use of ETT significantly increased IOP. They specified that IOPs also increased after the insertion of CLMA. In the study by Madan et al. (3) where the effects of tracheal intubation and LMA on IOP in adult and paediatric patients with and without glaucoma were investigated, they revealed that tracheal intubation caused a higher increase in pressure than LMA. In addition to this, they emphasised that these pressure increases were more excessive in glaucomatous eyes than in normal eyes. Similarly, Watcha et al. (4) stated that IOPs were not different from normal pressures after the insertion of LMA. Bhardwaj et al. (5) reported in their study on children with glaucoma that intubation increased IOP significantly, that IOPs were minimally influenced in children inserted with LMA, and that they returned back to the pressures before insertion in the 5[th] minute measurements.

In our study, clinically insignificant increases were observed in IOPs 2 min after the insertion of SGAD, which is consistent with reported increases in literature. These increases that were at minimal levels returned back to the baseline pressures in the 5[th] minute measurements. The cause of these minimal increases can be explained with the inflation of the SGAD cuff and elevated pressure that occurred in the anterior wall of the pharynx.

It is known that the anaesthesia technique used during the application of SPAD can also affect both haemodynamic parameters and IOP. In the study by İyilikçi et al. (29) where the effects of propofol and midazolam on IOP and haemodynamics during laryngeal mask application were investigated, it was reported that IOP slightly decreased with propofol and that cardiovascular stability was better maintained with midazolam. Therefore, the administration of anaesthesia was standardised for preventing the effect of the technique on the results of the study.

In studies on the effects of changes in $ETCO_2$ levels on IOP, it was reported that increased levels of $ETCO_2$ caused vasodilatation in choroidal blood vessels and thus elevated IOP. In our study, it was observed that IOP was not affected because $ETCO_2$ levels were between normal intervals (30–40 mm Hg).

Our study revealed a correlation between IOP and HR, which was important although being clinically insignificant. Increase in HR must be kept under control in risky patients. Therefore, necessary precautions must be taken before the insertion of SGAD. For this aim, the use of opioid or lidocaine, which is frequently used for increasing the depth of anaesthesia and suppressing the upper airway reflex, can be possible.

In our study, a correlation was revealed between MAP and the easiness degree of insertion and between HR and increased IOP. However, these increases observed in MAP, HR and IOP were clinically insignificant. Besides, this relationship between insertion parameters and MAP must be considered especially in risky patients. The insertion of SGAD must be thought after providing an adequate depth of anaesthesia and by implementing minimum intervention.

Conclusion

We therefore concluded that IOP did not increase and that haemodynamic stability was preserved during the insertion of CLMA, ILMA, PLMA and CPLA in paediatric patients who underwent extraocular ophthalmic surgery under general anaesthesia.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Ankara Training and Research Hospital.

Informed Consent: Written informed consent was obtained from patient's parents who participated in this study.

Peer-review: Externally peer-reviewed.

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