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The effects of the Cobra perilaryngeal airway on intraocular pressure

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Aim: To compare the effects of the Cobra perilaryngeal airway on intraocular pressure with the effects of the classic laryngeal mask and endotracheal intubation.

Materials and methods: Forty-five ASA I or II patients were randomly allocated into 3 equal groups. Endotracheal intubation (EI group), the classic laryngeal mask airway (cLMA group), and the Cobra perilaryngeal airway (Cobra PLA group) were applied to the groups. Heart rate and systolic, diastolic, and mean arterial pressures were recorded. Intraocular pressure was measured with an applanation tonometer before and during the 15 min after application.

Results: Heart rate and systolic, diastolic, and mean arterial pressures were lower in the cLMA group than in the other groups at 1 and 5 min after application ($P < 0.05$). In all of the groups, the mean intraocular pressure increased significantly compared to the baseline during the study. In the Cobra PLA and cLMA groups, these increases at 1 min (14.9 mmHg and 14.2 mmHg, respectively) were significantly lower than those in the EI group (mean: 18.8 mmHg) ($P = 0.001$).

Conclusion: The Cobra PLA and cLMA should be chosen over EI in patients for whom increased intraocular pressure is not desirable.

Key words: Endotracheal intubation, laryngeal mask, perilaryngeal airway, intraocular pressure

Kobra perilaringeal maskenin göz içi basıncına etkileri

Amaç: Kobra perilaringeal maskenin göz içi basıncı üzerine etkilerini klasik laryngeal maske ve endotrakeal entübasyonla karşılaştırmak.

Yöntem ve gereç: Göz içi basınçları normal olan ASA I ya da II 45 hasta randomize olarak üç eşit gruba ayrıldı. Aynı anestezik ajanların uygulandığı gruplara; endotrakeal entübasyon (EI grup), klasik laringeal maske (cLMA grup) ve kobra perilaringeal maske (Cobra PLA grup) uygulandı. Kalp atım hızı ile sistolik, diyastolik ve ortalama arteriyel basınçlar monitörize edildi. Uygulamadan önce ve sonraki 15 dk sürede göz içi basıncı aplanasyon tonometresiyle her iki gözden ölçülerek kaydedildi.

Bulgular: Kalp atım hızı ile sistolik, diyastolik ve ortalama arteriyel basınç değerleri klasik laringeal maske grubunda uygulamadan 1 dk ve 5 dk sonra diğer gruplardan daha düşük bulundu ($P < 0,05$). Ortalama göz içi basıncı; bazal değere göre her üç grupta da çalışma süresince anlamlı artış gösterdi. Ancak kobra perilaringeal maskede ve laringeal maskede bu artışlar 1. dk da (sırasıyla 14,9 mmHg ve 14,2 mmHg) endotrakeal entübasyon grubunda olduğundan (ort 18,8 mmHg) anlamlı derecede daha düşük bulundu ($P = 0,001$).

Sonuç: Kobra perilaringeal maske uygulaması laringeal maske uygulamasına benzer şekilde, göz içi basıncını endotrakeal entübasyondan daha az artırmaktadır. Göz içi basınç artışı istenmeyen hastalarda endotrakeal entübasyona tercih edilebilir.

Anahtar sözcükler: Endotrakeal entübasyon, laringeal maske, peri laringeal maske, göz içi basıncı

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Introduction

The management of anesthesia for ophthalmic surgery requires control of intraocular pressure (IOP) before, during, and after the procedure. Since control of IOP is often important for the success of the procedure, anesthesiologists must understand the physiologic effects of IOP and the implications of anesthetic drugs and airway maneuvers on IOP (1).

The most important influences on IOP are aqueous humor dynamics, changes in choroidal blood volume, central venous pressure, and extra ocular muscle tone. Moreover, IOP is affected by anesthetic applications and drugs. It is well known that laryngoscopy and endotracheal intubation (EI) cause significant hemodynamic responses and increases in IOP (2-5). Recently, new supraglottic devices, similar to classic laryngeal mask airway (cLMA), have been developed. The Cobra perilaryngeal airway (Cobra PLA) mask airway is one of the laryngeal mask types developed to provide a safe and easy airway, which is superior with respect to airway sealing pressure (6-9). Although the cLMA is known to minimally increase the IOP (2-5), the effects of the Cobra PLA on IOP have not yet been researched.

In this study, changes in IOP in Cobra PLA applications were investigated and compared with those of EI and cLMA under standard conditions maintained by the same anesthetic drugs.

Materials and methods

After obtaining the approval of the institutional ethics committee and written informed consent from each patient, 45 adult patients of American Society of Anesthesiologists (ASA) physical status I or II, between 18 and 68 years of age and scheduled to undergo elective operation under general anesthesia, were enrolled in this randomized prospective clinical study. Patients with a history of glaucoma or previous intraocular surgery, thyromental distance of <6 cm, mouth opening of <3 cm, modified Mallampati class of >2, preanesthetic intraocular pressure of >20 mmHg, number of airway establishment attempts of >3, or a high risk of aspiration were excluded from the study. Patients were randomly assigned to 3 equal groups. The patients in the EI group (n = 15) were orally intubated with a suitable endotracheal tube by using a laryngoscope blade (Macintosh) of suitable size for standard laryngoscopic EI. The patients in the cLMA group (n = 15) received a suitable classic laryngeal mask and the patients in the Cobra PLA group (n = 15) received a perilaryngeal mask (Cobra PLA, Engineered Medical Systems, Indianapolis, IN, USA).

The patients were fasted for 6 h prior to anesthesia and were not premedicated. They were positioned supine on the operating table, with the head resting. Heart rate (HR), systolic arterial pressure (SAP), diastolic arterial pressure (DAP), mean arterial pressure (MAP), peripheral oxygen saturation (SpO_2), end tidal carbon dioxide ($ETCO_2$), and anesthesia depth as measured by the bispectral index (BIS) were monitored (Julian Plus, Dräger, Lübeck, Germany). Preoxygenation was carried out with oxygen for 3 min followed by intravenous propofol (2-3 mg/kg) and fentanyl (1 μg/kg). Rocuronium (0.6 mg/kg) was administered for neuromuscular blockade after confirmation of successful manual bag-mask ventilation. Maintenance of anesthesia was provided with 4%-7% desflurane inhalation in oxygen at 4 L/min with air mixture and intermittent fentanyl boluses when necessary. During the study, the BIS was kept at 50 ± 10% (Bispectral Index Monitor Model 2000, Aspect Medical Systems, Inc., Newton, MA, USA). The size of the airway device was chosen and lubricated according to manufacturers' recommendations. One of the airway devices or an endotracheal tube was inserted 3 min after the administration of the neuromuscular blocking drug. The cuff of the airway device was inflated with air to attain a cuff pressure of 60 cmH_2O, as measured with a handheld aneroid manometer before confirmation of correct placement. The appearance of the first square end-tidal carbon dioxide trace denoted successful establishment of effective ventilation. Otherwise, the device was completely removed for another insertion attempt. Volume-controlled positive pressure ventilation was used to achieve an O_2 saturation of ≥95% and end-tidal CO_2 of 35-45 mmHg during tidal volumes of 8-10 mL/kg and a respiratory rate of 10/min to 16/min.

In order to detect and standardize the difficulty of the intubation, Mallampati scoring, thyromental distance, and mouth opening degrees were recorded.

Insertion score (1: easy, 2: mild resistance, 3: difficult attempt, and 4: insertion failed), patient response (1: no response, 2: mild response, and 3: intense body movement) and blood visible on device (none/present) were graded in the supraglottic device groups (7,10). The number of insertion attempts upon which the laryngeal airway or endotracheal tube was successfully inserted was recorded. Three insertion attempts were allowed. Each attempt was defined as reinsertion of the airway device into the mouth. Insertion failure of the device was defined as an effort comprising >3 unsuccessful attempts or if the entire process of insertion exceeded 120 s.

Investigators involved in the studies underwent specific training for Cobra PLA use. All of the airway insertions were supervised by the senior anesthetist, experienced in supraglottic airway management, and were performed by trainee anesthetists with 2-4 years of experience in cLMA and Cobra PLA insertions before the commencement of the trial.

Intraocular pressures for both eyes were separately measured and recorded with an applanation tonometer (Tono-Pen XL, Medtronic, Jacksonville, FL, USA) at induction (baseline) and during the 15 min after application, before the beginning of the surgical procedure. Following tonometer calibration, 3 measurements were performed for each recorded value. The value obtained in the first measurement, immediately after induction, was considered as the baseline value. Measurements were then made 2 min after induction and 1, 5, 10, and 15 min after the insertion of the airway devices. All of the measurements were performed while the patient was in a supine position with the head in the neutral position.

Statistical analysis

Power analysis was performed using the NCSS-PASS software program to estimate the required sample size in each group prior to conducting the research. The sample size was calculated as 15 for probability of error (α) = 0.05 and power = 0.84.

Results were expressed as number or mean ± standard deviation where appropriate. One-way analysis of variance (ANOVA) was used for comparisons among the groups and Bonferroni tests were used as multiple comparison tests. For SAP, DAP, MAP, and mean IOP, paired t-tests were used to compare induction time to other time measurements within the groups. Repeated measures of 2-way ANOVA were applied to determine the time-dependent differences in the hemodynamic parameters among the groups. Pearson's moment product correlation analysis was used to determine the relationships among SAP, DAP, MAP, and mean IOP. $P < 0.05$ was considered statistically significant.

Results

The demographic properties of the patients are given in Table 1. There were no significant differences in the demographic properties of the patients and characteristics of the airway and device applications (Table 2) among the 3 groups ($P > 0.05$). During the study, the BIS level was kept at 40% – 60% for general anesthesia in all of the groups (Table 3).

Although HR control values were similar, HR was found to be low in the cLMA group from anesthesia induction to 15 min after application ($P < 0.05$). The decrease in HR was significantly lower at 1 min of application in the cLMA group than in the other 2 groups ($P < 0.05$). The time-dependent differences among the groups in HR were significant, as well ($P < 0.05$) (Table 4).

The SAP, DAP, and MAP values in all 3 of the groups decreased throughout the study compared to the controls, but the decreases in the cLMA group at 1 and 5 min after application were significantly lower than in the other 2 groups ($P < 0.05$). Time-dependent differences among the groups were observed only in the DAP and MAP measurements ($P < 0.05$), not in the SAP values (Table 5).

The right, left, and mean IOP displayed a significant increase in all 3 of the groups at 1 min after application compared to the baseline. That increase continued until 15 min after application in the EI group (right side and mean) and the Cobra PLA group (left side and mean) (Table 6). However, it was continuous until 10 min after application in the cLMA group (mean). No significant increase occurred in the right intraocular pressure in the cLMA and Cobra PLA applications. Increases in the pressure in the right eye and mean values at 1 min after application in the EI group (right: 10.4 to 19.3

Table 1. Demographic properties [(n) or (mean ± SD)].

	EI group (n = 15)	cLMA group (n = 15)	Cobra PLA group (n = 15)
Sex (F/M)	10/5	7/8	8/7
Age (years)	30.73 ± 11.92	34.53 ± 16.28	40.20 ± 14.24
Height (cm)	165.46 ± 8.99	168.26 ± 7.54	166.13 ± 8.80
Weight (kg)	62.33 ± 14.64	70.46 ± 14.48	71.57 ± 8.95
Body mass index (kg/m^2)	22.76 ± 5.29	24.68 ± 3.33	26.28 ± 4.28

Table 2. Characteristics of the airway and device applications (n).

		EI group (n = 15)	cLMA group (n = 15)	Cobra PLA group (n = 15)
Mallampati	(class 1/2)	13/2	14/1	14/1
Thyromental distance	(≥6cm/<6 cm)	15/0	14/1	14/1
Mouth opening	(≥4 cm/<4 cm)	15/0	14/1	14/1
Insertion score	(easy/with mild resistance)	-	15/0	15/0
Patient's response	(none/mild/intense)	-	12/2/1	12/2/1
Number of attempts	(1/2/3)	-	12/3/0	15/0/0
Blood visible on device	(none/present)	-	15/0	14/1

Table 3. BIS values [(%), (mean ± SD)]*.

Time	EI group (n = 15)	cLMA group (n = 15)	PLA group (n = 15)
Control	97.5 ± 0.5	97.7 ± 0.4	97.6 ± 0.5
Induction	38.8 ± 11.3	43.6 ± 13.8	41.6 ± 11.8
After 1 min	47.8 ± 11.1	47.0 ± 13.9	46.6 ± 15.1
After 5 min	47.2 ± 12.3	46.8 ± 8.4	46.2 ± 12.8
After 10 min	43.8 ± 9.4	47.1 ± 9.9	49.9 ± 13.3
After 15 min	44.5 ± 6.4	42.7 ± 9.2	51.0 ± 15.3

*BIS range is 40%-60% for general anesthesia.

Table 4. HR values (beats/min) (mean ± SD).

	EI group (n = 15)	cLMA group (n = 15)	Cobra PLA group (n = 15)
Control	81.73 ± 29.57	83.06 ± 12.37	83.00 ± 27.44
Induction	74.26 ± 14.04	74.20 ± 11.87*	84.86 ± 16.86
After 1 min	88.73 ± 11.99	74.80 ± 14.29 *†	87.46 ± 16.62
After 5 min	80.13 ± 14.50	71.86 ± 12.63*	81.73 ± 16.43
After 10 min	77.13 ± 12.97	72.53 ± 13.57*	75.57 ± 16.80
After 15 min	73.30 ± 14.02	71.66 ± 12.97*	74.57 ± 14.14

*$P < 0.05$ versus control.
†$P < 0.05$ versus the EI group and Cobra PLA group.

Table 5. SAP, DAP, and MAP values (mmHg) (mean ± SD).

	EI group (n = 15)			cLMA group (n = 15)			Cobra PLA group (n = 15)		
	SAP	DAP	MAP	SAP	DAP	MAP	SAP	DAP	MAP
Control	130.6 ± 16.8	76.8 ± 12.0	92.7 ± 13.0	138.3 ± 18.1	81.4 ± 12.6	98.8 ± 14.8	140.4 ± 27.1	79.1 ± 16.1	97.5 ± 13.9
Induction	99.5 ± 13.2*	55.4 ± 10.1*	66.6 ± 10.1*	102.2 ± 13.5*	58.8 ± 11.2*	70.9 ± 11.2*†	110.8 ± 14.0*	64.6 ± 9.7*	78.5 ± 10.1*
After 1 min	128.4 ± 20.5	84.3 ± 12.3*	99.4 ± 15.6	106.5 ± 12.3*†	61.5 ± 10.7*†	75.2 ± 12.3*†	123.8 ± 23.5*	76.3 ± 19.0	92.4 ± 18.6
After 5 min	115.6 ± 15.5*	72.4 ± 13.3	83.9 ± 13.9*	101.6 ± 12.7*†	57.0 ± 7.3*†	70.7 ± 9.0*†	116.5 ± 15.7*	69.0 ± 12.3*	83.8 ± 11.5*
After 10 min	107.7 ± 15.4*	65.9 ± 13.1*	78.4 ± 14.0*	100.2 ± 13.1*	60.5 ± 8.6*	72.2 ± 9.2*	109.9 ± 12.8*	65.5 ± 9.2*	79.3 ± 9.3*
After 15 min	106.4 ± 17.2*	63.3 ± 11.5*	75.3 ± 13.1*	104.6 ± 17.3*	61.6 ± 9.5*	76.0 ± 16.3*	114.1 ± 10.8*	68.3 ± 8.1*	83.2 ± 8.2*

*P < 0.05 versus control. †P < 0.05 versus the EI group and Cobra PLA group.

Table 6. Right, left, and mean IOP values** (mmHg, mean ± SD).

	EI group (n = 15)			cLMA group (n = 15)			Cobra PLA group (n = 15)		
	Right	Left	Mean	Right	Left	Mean	Right	Left	Mean
Baseline	10.46 ± 2.44	10.80 ± 2.27	10.63 ± 1.97	11.73 ± 2.54	12.20 ± 2.83	11.96 ± 2.09	12.33 ± 2.91	11.86 ± 2.44	12.10 ± 2.56
After 1 min	19.33 ± 4.70*†	18.33 ± 5.55*	18.83 ± 4.90*†	13.60 ± 4.38	14.93 ± 4.74*	14.26 ± 4.47*	14.86 ± 2.9*	15.00 ± 3.25*	14.93 ± 2.93*
After 5 min	14.26 ± 2.60*	15.66 ± 3.77*	14.96 ± 2.88*	13.06 ± 3.51	14.06 ± 4.18	13.56 ± 3.77*	13.60 ± 2.74	13.33 ± 3.51	13.46 ± 3.01*
After 10 min	14.33 ± 3.69*	14.13 ± 2.89*	14.23 ± 3.12*	12.60 ± 2.61	13.73 ± 2.57	13.16 ± 2.49*	13.64 ± 2.79	13.78 ± 2.77*	13.71 ± 2.73*
After 15 min	14.07 ± 4.73*	13.46 ± 3.28	13.76 ± 3.80*	12.80 ± 2.33	13.66 ± 2.76	13.23 ± 2.49	13.71 ± 2.46	14.07 ± 3.02*	13.89 ± 2.68*

*P < 0.05 versus control. †P < 0.05 versus the cLMA group and Cobra PLA group. **Normal range = 12 to 20 mmHg.

mmHg, mean: 10.6 to 18.8 mmHg) were found to be significantly higher than those in the other 2 groups (Figure) (P < 0.05). The time-dependent differences among the groups in IOP were found to be significant for the right side and mean value, but not for the left side.

Discussion

In general, anesthetics reduce IOP, and only succinylcholine and ketamine may increase IOP. Laryngoscopy and endotracheal intubation are the anesthesia-related practices most likely to significantly increase IOP. This increase is probably related to sympathetic cardiovascular responses to laryngoscopy and tracheal intubation (1). However, insertion of cLMA after various anesthetic applications has been shown to have a minimal effect on IOP (10-13). The literature reveals no studies evaluating changes in IOP during insertion of Cobra PLA.

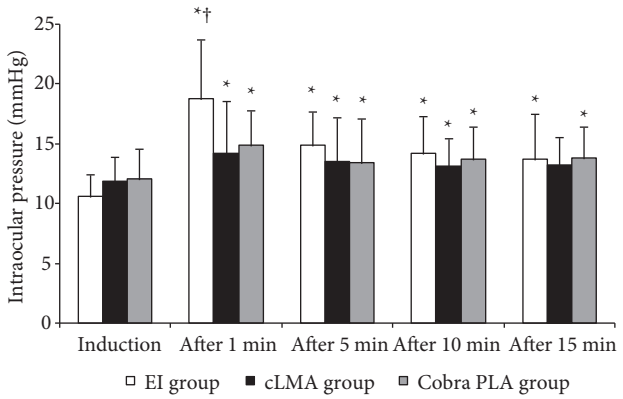

Figure. The means of the right and left IOP values (mmHg, mean ± SD).
*P < 0.05 versus control.
†P < 0.05 versus the cLMA group and Cobra PLA group.

In the present study, a significant increase in IOP compared to the baseline was observed at 1 min after application in all 3 of the groups. However, this increase in the EI group was greater than those in the other 2 groups, in which supraglottic airway devices were used. In all of the groups, IOP was similar at the other times. Moreover, the increase in the EI group did not return to preintubation levels throughout the 15 min of study.

Bharti et al. (11), observed a 9.6 mmHg increase in IOP that lasted for 5 min after laryngoscopy. Similarly, in the present study, a maximum increase of 8.9 mmHg (from 10.4 mmHg to 19.3 mmHg on the right side) in IOP was detected at 1 min after laryngoscopy and intubation; however, it lasted longer than 5 min throughout the 15 min of study.

Increases in the systolic arterial blood pressure lead to temporary elevations in choroidal blood volume, and then the temporary outflow improves itself in favor of normal values of IOP (1). In this study, the maximum increase in the IOP values in the initial minute of the procedures in the groups tended to normalize in the following minutes. It has been reported that a systolic arterial blood pressure below 90 mmHg may reduce choroidal blood volume and thus reduce IOP (1). Nevertheless, in the present study, the systolic arterial blood pressure was never below 90 mmHg, and as a consequence, IOP was never reduced.

Murphy (14) observed that arterial blood pressure had a minimal effect on IOP within the normal physiological range of blood pressure due to autoregulation. In this study, the increases determined in IOP after each of the 3 procedures did not seem to be directly associated with changes in the arterial blood pressure that were within the normal physiological range.

Opioids, tranquilizers, and inhalation anesthetics generally reduce IOP. They show this effect by reducing the extraocular muscle tonus, increasing the outward flow of aqueous humor, and decreasing the venous and arterial blood pressures. Only succinylcholine and ketamine are known to increase IOP (1). However, none of these agents were used in the present study. Nondepolarizing muscle relaxants reduce IOP (1). Thus, it is likely that rocuronium, a nondepolarizing neuromuscular blocker used in the present study, was not associated with IOP increase. As well as the anesthetic agents and methods used, the depth of anesthesia is also an effective factor in keeping IOP under control. Therefore, in this study, the desired depth of anesthesia was achieved by using a BIS monitor.

Several pretreatment regimens have been advocated to control the sympathetic response to tracheal intubation (15,16). Some of these have been successful in attenuating the IOP response to tracheal intubation, such as lidocaine, opioids, clonidine, nitroglycerine, and beta blockers. Fentanyl, a semisynthetic opioid, may have inhibited both the sympathetic responses to intubation and the expected increase in IOP in our study.

During the induction of general anesthesia, after opioid pretreatment, IOP was best managed through the full-dose administration of an induction anesthetic such as propofol and a nondepolarizing muscle relaxant, and by placement of a laryngeal mask (1,14). Similarly, propofol, fentanyl, and rocuronium, a nondepolarizing muscle relaxant, were used during the induction of anesthesia. As a result, it was observed that both the hemodynamic responses and IOP increase were at the lowest level in cLMA applications. In Cobra PLA applications, the changes in IOP were similar to those with cLMA applications.

In patients with normal IOP, Lamb et al. (3) observed that the most marked increase in IOP occurred after extubation. Studies that have evaluated the IOP increase during extubation showed marked increases in IOP during this period, which were more marked due to superficial anesthesia. Moreover, in comparison with normal patients, glaucomatous patients were shown to have an exaggerated response to insertion of airway devices in IOP. Even a small increase in IOP for a short time, particularly in patients with severe closed-angle glaucoma, can compromise optic disk perfusion and may result in disc ischemia and loss of vision (17). It has been recommended that the preoperative measurement of IOP in patients receiving a general anesthetic be carried out before the insertion of the laryngeal mask airway (12). Further studies are required to find out whether these increases of IOP may exaggerate the intubation and extubation responses, especially in glaucomatous patients.

In conclusion, the increase in IOP was significant with EI using laryngoscopy compared with the Cobra PLA and cLMA supraglottic airway devices. In both Cobra PLA and cLMA applications, the increase in IOP immediately after application was less than that during intubation with laryngoscopy. Even though these increases were kept within the normal clinical range, the use of Cobra PLA and cLMA may be advantageous compared to laryngoscopic tracheal intubation, especially in selected patients for ophthalmic surgery.

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