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EXPERIMENTAL STUDY

Comparison of effects of classic LMA, cobraPLA and V-gel rabbit on QTc interval

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ABSTRACT

AIM: We aimed to compare the effects of three different supraglottic airway devices, the classic LMA, PLA, and V-gel, on hemodynamics and QTc in rabbits under general anesthesia.

METHOD: The rabbits were divided into four groups: Group C (n = 5) control group with no airway device used, Group L (n = 5, classic LMA), Group P (n = 5, CobraPLA) and Group V (n = 5, V-gel-rabbit). Basal values of heart rate (HR), mean arterial pressure (MAP) and ECG for QTc interval were measured and the measurements were evaluated at 1, 5, 15, and 30 minutes after inserting the airway device

RESULTS: The values of HR, MAP and QTc in Group V at minutes 1 and 5 were significantly different to those in Group L and Group P ($p < 0.05$).

DISCUSSION: The classic-LMA and cobraPLA cover a wide part of the perilaryngeal area with cuffs inflated to about 60 cmH_2O of pressure resulting in mucosal compression. As V-gel rabbit does not have a cuff, it covers a smaller part of the laryngopharyngeal area, and thus does not cause mucosal compression, and the hemodynamic response is weaker.

CONCLUSION: When comparing hemodynamic responses to other supraglottic airway devices, the response to V-gel rabbit is minimal and we consider that similar studies using the I-gel on humans are required *(Fig. 5, Ref. 31)*. Text in PDF *www.elis.sk.*

KEY WORDS: LMA, cobraPLA, V-gel, supraglottic airway, QTc.

Introduction

Supraglottic airway devices are frequently used in general anesthesia applications, especially for outpatient and short surgeries. The use of supraglottic airway devices reduces the need for muscle relaxants, shortens the duration to discharge, and allows the patients to return early to their social and occupational activities (1, 2).

Various types of supraglottic airway devices are used in relation to age group, intubation difficulty, and elective and emergency situations in a reliable fashion (1, 3, 4). Airway devices may have inflatable cuffs similar to those in cobraPLA and LMA and may be produced from thermoplastic elastomer appropriate to the anatomy of the perilaryngeal area, similar to I-gel, while non-inflatable supraglottic airway devices are also available (5, 6).

No matter how much endotracheal intubation has gained acceptance as the gold standard for reliable airways in general anesthesia (1, 7), laryngoscopy and endotracheal intubation cause an unwanted reflex of sympathetic stimulation and increase the plasma catecholamine levels (1, 8, 9). The increase in plasma catecholamine levels may cause unwanted hemodynamic responses such as hypertension, tachycardia, myocardial ischemia, reduction in myocardial contractility, and ventricular arrhythmia (1, 9). Ventricular arrhythmia may lengthen the QT interval (9–11), while arrhythmia occurring with lengthened QT interval may even cause sudden cardiac death (9–11).

As supraglottic airway devices do not require laryngoscopy and provide reliable airway without tracheal intubation, they induce a weaker hemodynamic response which is beneficial for patients with cardiovascular disease (12).

This study was aimed at comparing three different supraglottic airway devices, classic LMA, cobraPLA, and V-gel rabbit (13) produced by I-gel to be appropriate for rabbit anatomy, in terms of their effects on MAP, HR, and QTc interval.

Material and method

This study used 20 adult New Zealand white rabbits weighing 2.5–3.5 kg. Experiments received required permissions from Canakkale Onsekiz Mart University Animal Experiments Ethics Committee and were completed at Canakkale Onsekiz Mart University Experimental Research Center. Before the study had begun, the rabbits underwent clinical examinations for behavior, and respiratory and cardiovascular systems, while no negatives

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had been found in the animals included in the study.

All experiments took place between 09:00 and 16:00. During the experiments, animals were fed standard feed, and had constant access to water. The temperature of the housing was 21 ± 2 °C and the light was regulated to 12/12-hour light/dark intervals.

Twenty rabbits were randomly divided into four groups:

Group C (n = 5): Control group without airway device. Respiration was supported by a face mask.

Group L (n = 5): Group used classic LMA airway device (Size 1, La Premiere Plus, Amstrong Medical Ltd. Coleraine, Northern Ireland)

Group P (n = 5): Group used cobraPLA airway device (Size ½, Pulmodyne Inc., Indiana, USA)

Group V (n = 5): Group used V-gel rabbit airway device (R-3, Docsinnovent® Ltd. London, UK)

The front and rear extremities of the rabbits to be held in crocodile clips to obtain electrocardiographic recording (ECG) were shaved. Before the procedure the rabbits were starved for 12 hours. To prevent loss of heat during anesthesia a blanket set to 39 °C was spread on the ground. The rabbits' initial ECG (Digital ECG system Poly-Spectrum-8/E, Neurosoft Ltd. 5, Voronin str., Ivanovo, Russia) was recorded. Rectal temperature was taken. A 24-gauge catheter (Bicakcilar Tibbi Cihazlar AŞ, Istanbul, Turkey) was used to enter the left main auricular artery, and invasive blood pressure was monitored (PETAŞ® KMA 800, Ankara, Turkey). Thirty minutes of general anesthesia was planned for the rabbits and 5 mg/kg xylazine (Rompun®, Bayer Healthcare LLC) and 30 mg/kg ketamine HCL (Ketasol, Richter Pharma AG) was administered in the quadriceps femoris. Pedal and palpepral reflexes were checked and a 26-gauge catheter (Bicakcilar Tibbi Cihazlar AŞ, Istanbul, Turkey) was inserted in the right ear's lateral vein. The rabbits were supported with 50 % O_2 and 50 % air mix through a face mask and Mapleson C pediatric ventilation cycle (Morton Medikal San Tic Ltd, Izmir, Turkey). When spontaneous respiration became shallow, all rabbits had an airway device inserted by the same anesthetist. For the purpose of facilitating the procedure of inserting the airway device, another anesthetist pulled the rabbit's tongue to the lateral side of its mouth (Fig. 1).

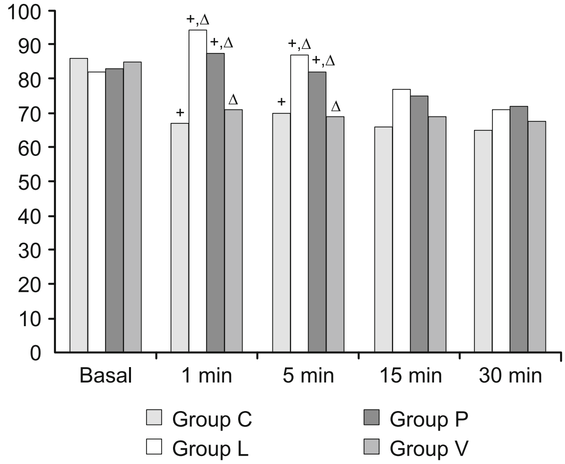

Fig. 2. Mean arterial pressure (MAP) values (mmHg) in groups. †, Δ: It was observed that at minutes 1 and 5, MAP increased in Group L and Group P compared to group C and Group V (p < 0.05).

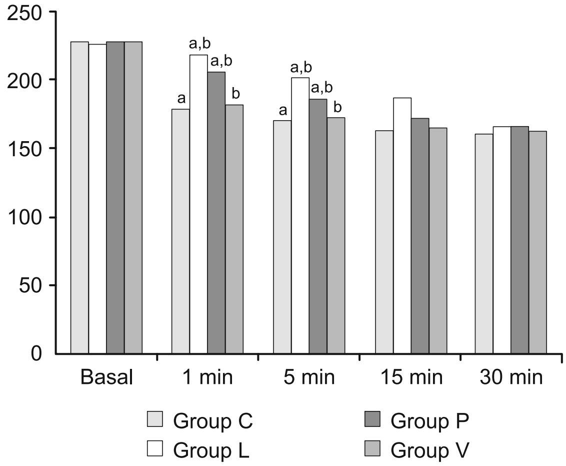

Fig. 3. QTc interval values (msec) in groups. a, b: It was observed that at minutes 1 and 5, QTc intervals increased in Group L and Group P compared to Group C and Group V (p < 0.05).

ECG recordings

Electrocardiogram recordings were completed according to the method reported by Uzun et al (14). Through electrodes on the extremities, measurements were recorded for basal values and repeated at 1, 5, 15 and 30 minutes after the insertion of airway device. ECG recordings were saved in a digital form with 1 mV = 20 mm, speed 50 mm/sn and filter (35 Hz) used to record DI, DII, DIII, aVR, aVL, and aVF derivations. The QT interval was calculated as time from the start of Q wave to the end of T wave. Corrected QT interval (QTc) was calculated according to a formula derived by Bazett (14, 15).

Fig. 1. The V-gel rabbit placed in a New Zealand white rabbit.

Maintenance of anesthesia

All experimental animals were linked to an anesthesia machine (Anesthesia Machine w/O_2 Flush Model M3000PK Parkland Scientific Lab and Research Device. Florida, USA) and breathed with manual assistance. Anesthesia was maintained by providing 50 % oxygen and 50 % air mix with 1 MAC (Minimum alveolar concentration) isoflurane. The rabbits were manually ventilated to a respiration rate of about 40/min, appropriate for rabbit physi-

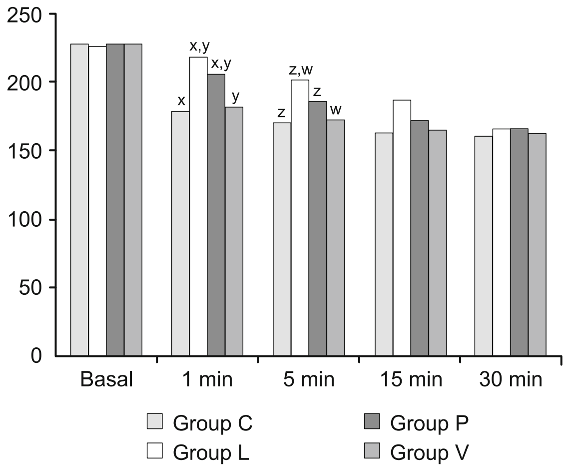

Fig. 4. Heart rate (HR) values (bpm) in groups. x,y: It was observed that at minute 1, HR increased in Group L and Group P compared to Group C and Group V ($p<0.05$), z: It was observed that at minute 5, HR increased in Group L and Group P compared to Group C ($p < 0.05$), w: It was observed that at minute 5,HR increased in Group L compared to Group V ($p < 0.05$).

ology, and pressure of 15 cmH_2O (about 10 ml/kg) by the same anesthetist. MAP, HR, and I, II, III, aVR, aVL and aVF derivations of ECG were recorded at basal values and at 1, 5, 15 and 30 minutes after supraglottic airway device had been inserted. At the end of 30 minutes, the rabbits with sufficient respiration effort were extubated, while those without sufficient respiration were assisted for a little longer.

Statistical analysis

The data obtained were evaluated using SPSS 16 statistical program (SPSS Inc. Chicago USA) and significance was accepted at $p < 0.05$. To compare the groups in terms of the initial HR, MAP, blood gas values and QTc interval, at 1, 5, 15 and 30 minutes after insertion of the airway device, one-way ANOVA (Tukey's T-test) was used.

Results

The average weight of the rabbits included in the study was similar. During the study at minutes 1 and 5 after the insertion of supraglottic airway device in the 4 groups of rabbits (none inserted in the control group), the MAP values in the control group and V-gel group were similar. At same intervals, the difference between the control and V-gel rabbit groups and cobraPLA and classic LMA groups in terms of MAP was found to be similar ($p < 0.05$). Additionally at minutes 1 and 5 while the MAP values of the classic LMA and cobraPLA groups were increased compared to basal values, there was no significant difference between the two groups. At minutes 15 and 30 after the insertion of supraglottic device there was no significant difference seen in MAP values compared to basal values (Fig. 2).

The basal QTc intervals and those at 1, 5, 15 and 30 minutes after intubation in the 4 groups were compared. There was no significant difference between the basal QTc values in all groups. At minutes 1 and 5 after the insertion of supraglottic airway device, the QTc values of the control group and V-gel rabbit group were seen to be similar. At same intervals, there was a significant difference between the control and V-gel groups and cobraPLA and classic LMA groups in terms of QTc interval ($p < 0.05$). Additionally while the QTc intervals at minutes 1 and 5 in the classic LMA and cobraPLA groups were increased compared to basal values, there was no significant difference between the two groups. In all groups at minutes 15 and 30 after the insertion of supraglottic airway device, there was no significant difference between QTc values (Fig. 3).

The basal HR values and those at 1, 5, 15 and 30 minutes after intubation in the 4 groups were compared. In the rabbits in the four groups there was no significant difference observed between basal HR values. At minute 1 after the insertion of supraglottic airway devices, HR in the control and V-gel groups were similar. Again there was a significant difference observed between control and V-gel groups and cobraPLA and classic LMA groups at minute 1 ($p < 0.05$).

At minute 5, there was a significant difference between the classic LMA group and control and V-gel rabbit groups ($p < 0.05$). Again at minute 5 while the difference between the control group and cobraPLA group was significant in terms of HR ($p < 0.05$), there was no significant difference observed between the cobraPLA group and V-gel rabbit group. Additionally at minute 5, the HR values for the classic LMA and cobraPLA groups were similar. In all groups there was no significant difference in terms of HR 15 and 30 minutes after the insertion of supraglottic airway device (Fig. 4).

Discussion

In this study we observed that out of supraglottic airway devices, the classic LMA and cobraPLA increased the MAP and HR, and lengthened the QTc interval compared to V-gel rabbit. We determined that the V-gel affected the MAP, HR, and QTc intervals less than cobraPLA and classic LMA, almost to the level of the control group.

Supraglottic airway devices have been used for nearly 30 years in surgical interventions in outpatients, patients requiring short-term general anesthesia or in those requiring emergency airway (16, 17). Within this time, many different supraglottic airway de-

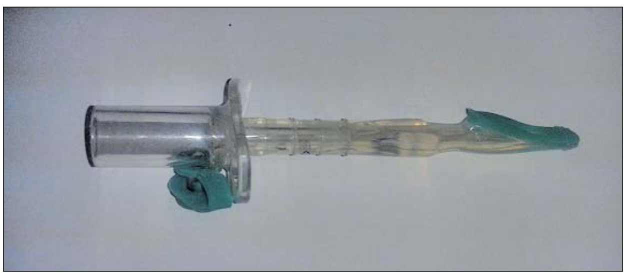

Fig. 5. V-gel rabbit.

vices have been developed (17). The classic LMA was the first supraglottic airway device used (18). The classic LMA is a short silicon rubber tube similar to an endotracheal tube and linked to its tip is a flat mask with an ellipsoidal inflatable cuff (19). During the insertion, the epiglottis enters the tube, and in order to prevent airway obstruction the classic LMA has two vertical rubber grills (19). CobraPLA has a balloon structure and has completely different properties compared to the classic LMA in terms of the place of insertion (20). The inflated cuff is placed in the perilaryngeal region a little above the airway; the distal grated cobra head sits fully on the soft tissue and epiglottis and opens the airway (21). I-gel is made of high-quality medical thermoplastic elastomer similar to soft gel and is not inflatable (1). When inserted, the soft gel-like part takes a shape appropriate to the human pharynx, larynx, and perilaryngeal region (1, 17). V-gel rabbit, similar to I-gel, is produced from medical thermoplastic elastomer appropriate for rabbit anatomy (Fig. 5) (13).

At different stages of anesthetic applications, different hemodynamic responses may be seen. Especially during general anesthesia the lengthened QT interval may be seen as being linked to the increase in activity of autonomic nervous system and sympathoadrenergic reaction (22). The changes in the sympathoadrenergic activity, along with the development of hemodynamic response due to fear of surgery, agents used for anesthesia induction maintenance, intervention to provide reliable airway, the incision, and postoperative pain can enhance the rhythm disorders observed on electrocardiography (23, 24).

The hemodynamic response to the provision of reliable airway by means of supraglottic airway device in general anesthesia is minimal when compared to the response to laryngoscopy used for endotracheal intubation, insertion of the tube and inflation of the cuff within the trachea (25). While the hemodynamic response to the insertion of classic supraglottic LMA airway device is weaker than that due to intubation, there may be a partial hemodynamic response linked to catecholamine discharge (26).

When compared with endotracheal intubation, the supraglottic airway devices have advantages, such as reduced use of anesthetic agents, more stable hemodynamic response, reduced cough during revival, and less intense throat pain and irritation (1).

In their study on supraglottic airway devices, Dahaba et al determined that the hemodynamic response was proportional to cuff pressure and amount of air given. For example, while a size 5 laryngeal tube-suction cuff is inflated by 80 ml air, again a size 5 Proseal-LMA is inflated with 40 ml of air (4). Studies comparing cobraPLA and classic LMA have found that although the cobraPLA cuff is inflated by a nearly twice greater volume (27, 28), the increase in hemodynamics is minimal compared to classic LMA (27). Although not significantly different in our study, the HR, MAP and QTc values for classic LMA were higher than those for cobraPLA. In spite of high volume, similar hemodynamic effects may be due to the location of the cuff of the airway device, namely the oropharynx for cobraPLA and pharyngolaryngeal region for classic LMA.

To prevent air leaks in many supraglottic airway devices like classic LMA and cobraPLA, the cuff pressure should be around 60 cmH_2O (29, 30). In a study using silicon microchips on the supraglottic airway devices where they touch the oropharyngeal wall, Brimacombe et al showed that when mucosal perfusion pressure is higher than 34 cmH_2O there is a reduction in capillary blood flow (30, 31). Tissue damage occurs with a reduction in capillary blood flow (2). Here the tissue damage and throat pain appearing with hemodynamic response may be explained by the cuff pressure and capillary perfusion pressure in the pharyngeal mucosa.

In our study, at minutes 1 and 5 after the insertion of classic LMA and cobraPLA we observed a lengthened QTc and increased MAP and HR, while in the V-gel rabbit group no change was observed. This situation may be explained by the the facts that V-gel rabbit fits the anatomy of the perilaryngeal region and it lacks the cuff.

This study is the first to compare the effects of supraglottic airway device on QTc interval. In our study, the classic LMA and cobraPLA caused greater sympathetic stimulation and the QTc intervals were significantly longer than in the other groups. This situation may be related to greater difficulty encountered when inserting the classic LMA and cobraPLA supraglottic devices due to their mismatch with rabbit anatomy. However we observed that the V-gel rabbit, produced to fit the rabbit anatomy, affected both the hemodynamic response and QTc interval to an extent that is too little to be important. Additionally the effect of cuff pressure of classic LMA and cobraPLA on part of the mucosa in the perilaryngeal region may cause an ischemic situation causing a greater release of catecholamine. In V-gel rabbit there is no cuff and thus we believe the minimal pressure exerted on oropharyngolaryngeal tissues may result in a weaker sympathetic response.

Conclusion

Although in general, the endotracheal intubation is considered to be the most reliable device for providing airway safety during anesthesia, we recommend to use supraglottic airway devices in patients with cardiovascular disease, namely in order to minimize the unwanted hemodynamic responses (lengthened QTc interval). Among these, the supraglottic airway devices, namely the non-cuff I-gel in humans and V-gel rabbit in rabbits may induce minimal stress response.

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