The investigation of airway management capacity of v-gel and cobra-PLA in anaesthetised rabbits[1]

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ABSTRACT

PURPOSE: To evaluate the applicability and airway management capacity of v-gel® and Cobra PLA in rabbit anaesthesia during assisted (AV) or controlled ventilation (CV).

METHODS: This study was carried out in 44 adult New Zealand white rabbit. Baseline arterial pH, $PaCO_2$ and PaO_2 values were recorded. Anaesthesia was induced with 5 mg/kg xylasine and 35 mg/kg ketamine HCI combination. AV rabbits were assigned as; control (CG-AV; n=5), LMA (LMA-AV; n=5), cobra PLA (PLA-AV; n=5) and v-gel (v-gelAV; n=5). Rabbits have CV were also assigned as; ET (ET-CV; n=6), LMA (LMA-CV; n=6), cobraPLA (PLA-CV; n=6) and v-gel (v-gelCV; n=6). All measurements were repeated 1st, 5th, 15th and 30th mins during anaesthesia.

RESULTS: The less insertion time, number of attempt and complications are recorded in v-gel applied rabbits compared to other apparatus. For arterial pH values significant differences are recorded in especially at 15th and 30th min between groups of CV ($p<0.005$ or $p<0.001$). All groups had similar results with each other during anaesthesia for $PaCO_2$ except for LMA-CV group.

CONCLUSION: The v-gel may be used as airway device in rabbit anaesthesia undergoing AV or CV and also can be a suitable alternative to endotracheal tubes and laryngeal mask airway.

Key words: Anaesthesia. Intubation, Intratracheal. Laryngeal Masks. CobraPLA. Rabbits.

Introduction

Rabbits are not only frequently used in experimental research but also most commonly anesthetised pet species. But anaesthesia of rabbits have high risk of mortality rate due to respiratory complications such as airway maintenance and inadequately ventilation. These are also the most common reasons of anaesthetics-related deaths in small mammals[1].

The intramuscular (IM) or intravenous (IV) application of ketamine/xylazine combination has been used in rabbits' anaesthesia and remains popular[2,3]. However, the changes of respiratory rate under ketamine in rabbits' anaesthesia should be taken into account is reported[4]. Mechanical ventilation would increase the safety of ketamine/xylasine combination anaesthesia and reduces the respiratory changes[5]. Endotracheal tubes (ET) are often used for maintenance of ventilation. However this technique usually becomes a challenge in rabbits due to physiology and anatomy of the larynx and upper airways[6]. On the other hand sublaryngeal tracheal injuries, ulcerations and post anaesthetic tracheal strictures are reported in rabbits when using ET[7,8].

To find a method for airway management in rabbits without using of ET is essential. For that purpose, face mask (FM) and laryngeal mask airway (LMA) were used. The FM is frequently used but it has some disadvantages such as insufficient in airway obstruction, is not convenient for rabbit face, inhalation of room air and anaesthetic gas pollution[9,10]. The LMA was introduced as an alternative to ET and FM. [11]. LMA was tested and found to be superior in airway management compared to FM[9].

CobraPLA is an another suppraglottic airway apparatus (SGA) has been using in infants and paediatric population[12]. However the usage of cobraPLA in rabbit anaesthesia is not clarified, yet.

The v-gel is veterinary species-specific SGA and easy to place and allows maintenance of anaesthesia without or low airway resistance especially used in rabbits and cats. Also v-gel can be easily sterilised after use to prevent cross infection between patients[13,14]. However the knowledge about using of v-gel in rabbit anaesthesia is scarced and not fully documented.

In the present study, we aimed to evaluate whether cobraPLA and v-gel provides adequate ventilation and oxygenation in anesthetised AV and CV rabbits and comparing them with ET and LMA.

Methods

This study was approved by the Çanakkale Onsekiz Mart University Animal Care and Use Committee (No: 2013/02-21).

Forty four adult New Zealand white rabbit (male; aged between 6-8 months), weighing between 2,0-3,50 kg, were used. Rabbits were not fasted prior to experiments for 12 hours.

Temperature of the operation and blood-gas analyser room is stabilized at 22C°. A temperature probe was inserted rectally for the recording of body temperature in rabbits. Rabbits are holded on a 39 C° heated blanked during anaesthesia. A 24 gauge catheter (Bıçakçılar Tıbbi Cihazlar AŞ, İstanbul, Turkey) was placed in the left main auricular artery to obtain arterial blood samples. Arterial blood samples analysed immediately upon collection with using blood gas analyser system (Blood Gas Analyzer-Gastat 600 Series, Techno Medica Co., Ltd. Yokohama, Japan). The baseline values for $PaCO_2$, PaO_2 and arteriel pH values were recorded. After recording of baseline values, anaesthesia was induced with 5 mg/kg xylazine (Rompun®, Bayer Healthcare LLC.) and 35 mg/kg ketamine HCl (Ketasol, Richter Pharma AG) combination injected IM in all groups. After this stage, two different experiments were designed according to AV or CV status of anesthetised rabbits.

Experiment 1

Each rabbit was assigned to four groups; control (C-AV; n=5), LMA (LMA-AV; n=5), cobraPLA (PLA-AV; n=5) and v-gel (v-gel AV; n=5). All measurements were repeated 5th, 15th and 30th min during anaesthesia.

Airway apparatus were inserted when induction of anaesthesia is determined without C group. A LMA (Size 1, La Premiere Plus, Amstrong Medical Ltd. Colerine, North Ireland) cobraPLA (Size ½, Pulmodyne Inc., Indianapolis, IN 46241 USA) and v-gel rabbit R-3 (Docsinnovent® Ltd. London, UK) were inserted in LMA-AV, PLA-AV and v-gel AV groups, respectively. Intubation was done with the same pediatric laryngoscope having miller type blade no:1 size. Immediately after LMA and cobraPLA insertion, the cuffs were inflated to the pressure of 30 mmHg with 4 cc air. Following the insertion of airway apparatus in all AV groups except for C group, ventilation was supported with AMBU device (Mapleson C Pediatric Ventilation Apparatus, Morton Medikal San Tic Ltd, Izmir, TURKEY) under approximately 10 ml/kg (15 mmH_2O pressure; % 50 oxygen/ % 50 air combination) with delivering totally about 30-35 breaths/min assisted ventilation which is applied by the same anaesthetist during all procedure. The end tidal CO_2 ($ETCO_2$) concentration were obtained from a cannula added to the port of type L connector to the distal end airway apparatus, connected to a monitor (PETAŞ® KMA 800, Ankara, Turkey) and recorded at 5th, 15th and 30th min.

Experiment 2

Each rabbit was assigned to four groups; ET (ET-CV; n=6), LMA (LMA-CV; n=6), cobraPLA (PLA-CV; n=6) and v-gel (v-gelCV; n=6). All mesurements were repeated 1st, 5th , 15th and 30th mins during the anaesthesia except for $ETCO_2$ values which determined at 5th , 15th and 30th min. After anaesthesia induction, rocuronium bromure (Esmeron 50 mg/5 ml, Organon İlaç A.Ş. İstanbul-Turkey) was injected at 1 mg/kg (iv) for neuromuscular blockage. ET (Size 3; Bıçakçılar Tıbbi Cihazlar A.Ş. İstanbul, Turkey), LMA, cobraPLA and v-gel airway devices were inserted in ET-CV, LMA-CV, PLA-CV and v-gelCV groups, respectively. Following the insertion of airway apparatus, ventilation was maintained with AMBU device under approximately 10 ml/kg oxygen (15 mmH_2O pressure; 50 % oxygen 50 % air combination) with delivering 30-35 breaths/min. Insertion of airway apparatus was accepted as starting point of experiment.

In both experiments insertion time of device, bleeding, edema, cyanosis, number of attempt and number of person.

Statistical analysis

Data were analyzed with MINITAB statistical software 12.1 (Minitab Inc., Pennsylvania, USA). Within group comparison of arteriel pH, $PaCO_2$ and PaO_2 were made at baseline and 1st, 5th, 15th and 30th mins using ANOVA (Tukey's test). Same statistical methods was used to compare groups $ETCO_2$ values but 5th, 15th and 30th mins in AV groups except for C-AV and 1st, 5th, 15th and 30th mins in CV groups. All of the data are expressed as means ± SEMs. The level of significance was set at $p < 0.05$.

Results

All rabbits finished the experiment healthy except one rabbit from ET-CV groups.

AV Groups

The results obtained from AV groups are given in Table 1 and Figure 1. The longest insertion time was recorded in LMA group however v-gel has the shortest period. The complications of airway apparatus are shown in Table 1.

TABLE 1 - The insertion time, number of attempt, blood staining, edema, cyanosis and person values in AV groups.

Groups (n=5)	Time of insertion (min)		Number of attempt		Blood staining		Edema		Cyanosis		Person
	min	max	1	2	yes	no	yes	no	no	slightly	
LMA	30	60	+++	++	1	4	1	4	0	5	2
CobraPLA	15	25	+++++	-	0	5	0	5	0	5	2
v-gel	8	14	+++++	-	0	5	0	5	3	2	2

For all groups any pH level difference is not detected. CO_2 levels are started to increase by the 5th min after anaesthesia in CV and the levels remained constant during anaesthesia. The LMA-AV and PLA-AV groups CO_2 values were lower compared to C-AV during anaesthesia. On the other hand, PLA-AV groups CO_2 levels were less according to C-AV group values at 5th and 15th min of anaesthesia however significantly high in 30. min ($p<0.001$). Arterial O_2 levels has decreased during anaesthesia in C-AV. These values are found significantly different in other groups that were intubated with LMA, cobraPLA and v-gel ($p<0.001$). $ETCO_2$ values during anaesthesia are found significantly high in PLA-AV and v-gel AV groups according to LMA-AV group ($p<0.005$ or $p<0.001$). $ETCO_2$ value is not recorded in control group due to any airway device is not used (Figure 1).

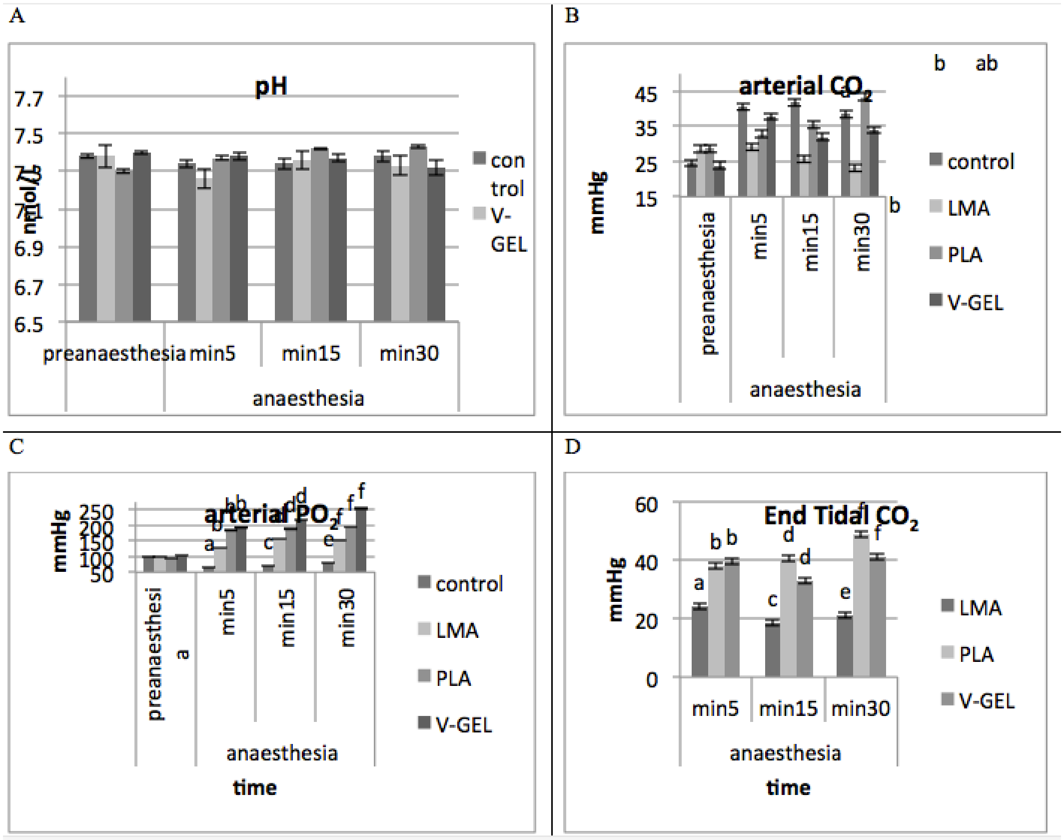

FIGURE 1 - The arterial pH (**A**), arterial $PaCO_2$ (**B**), arterial PaO_2 (**C**) and $ETCO_2$ (**D**) values in AV rabbits (values are different to each other with different superscript in same sample time; $p<0.05$ or $p<0.001$).

CV Groups

The insertion time, number of attempt and complication values of airway device are shown in Table 2.

Significant differences are recorded in terms of arterial pH especially in 15th and 30th min between groups ($p< 0.005$ or $p<0.001$). All groups had similar results with each other during anaesthesia for $PaCO_2$ except for LMA-CV group showed significantly high $PaCO_2$ levels at 1st , 5th , and 30th min ($p<0.05$). Any significant difference is not observed in terms of PaO_2 values between groups. The statistically significant change was observed only in 15th min ($p<0.05$; Figure 2).

TABLE 2 - The insertion time, number of attempt, blood staining, edema, cyanosis and person values in CV groups.

Groups (n=6)	Time of insertion (min)		Number of attempt			Blood staining		Edema		Cyanosis		Person
	min	max	1	2	3	Yes	No	Yes	No	No	Slightly	
ET	35	150	+	++	++	4	1	3	2	0	6	2
LMA	10	25	+++++	+		3	3	2	4	0	6	2
Cobra PLA	18	45	++++++			0	6	0	6	0	6	2
v-gel	4	11	++++++			0	6	0	6	2	4	2

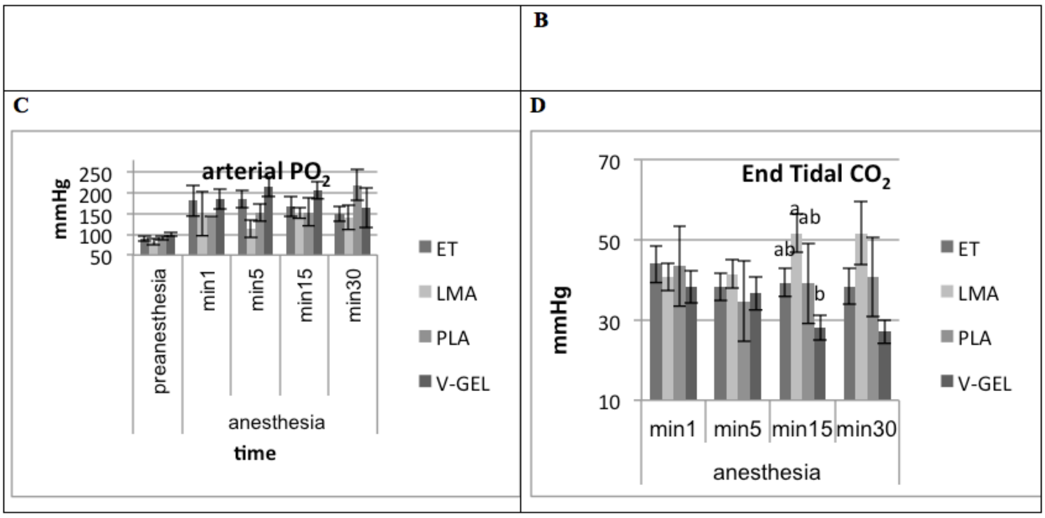

FIGURE 2 - The arterial pH (**A**), arterial $PaCO_2$ (**B**), arterial PaO_2 (**C**) and $ETCO_2$ (**D**) values in CV rabbits (values are different to each other with different superscript in same sample time; $p<0.05$ or $p<0.001$).

Discussion

In this study, v-gel and cobraPLA are firstly experienced in rabbit anaesthesia. V-gel found easy and fast applicable which has mild side effects compared to ET, LMA and cobraPLA and can be used for effective airway management in anaesthetised rabbits have AV and CV.

Respiratory complications such as problematic airway maintenance and inadequately ventilation are most commonly occurred in anaesthesia[1,15]. Depressed or inadequate ventilation related death can be obtained in rabbit anaesthesia but ventilation support can prevent this complication[16]. Rabbits have at least seven times more risks of anaesthetics-related death compared to dogs and cats[1]. ET are often used as airway apparatus for maintaining of ventilation. However this technique usually becomes a challenge in rabbits due to physiology and anatomy of the larynx and upper airways such as narrow oropharynx with restrictive mandibular excursion, a relatively large tongue for their size, the small glottis and the larynx hidden behind the tongue[6]. Also, a lot of tracheal lesions such as sublaryngeal tracheal injury and ulceration are reported in rabbits when ET is used[7]. Because of this complication, finding of methods of airway management without using of ET is essential in rabbits anaesthesia, so that FM or some supraglottic airways were used. The FM is frequently used but it has some disadvantages such as insufficiency in airway obstruction, not convenient for rabbit face and cause of anaesthetic gas pollution[9,10].

Due to some disadvantages of both ET and FM, experiencing the usage of perilaryngeal airways in rabbits is required. LMA is one of the firstly experienced perilaryngeal airway apparatus in rabbit anaesthesia[17,18]. When using an airway apparatus in anaesthesia, several criteria are considered such as easiness or duration of insertion process, edema, bleeding and cyanosis in tongue[13,19]. Also arterial blood gas values such as PaO_2, $PaCO_2$ and arterial pH are other parameters that required to be investigated during anaesthesia[3,5,20]. In this study, ET, LMA cobraPLA and v-gel rabbit are evaluated in terms of mentioned two topics and compared with each other.

According to our results, v-gel rabbit has easy application procedure and short application time compared to ET and other perilaryngeal airway apparatus used in AV and CV anesthetised rabbits. These results correlate with Crotaz's findings[13,14] about v-gel as a supraglottic airway device for rabbit perilaryngeal and veterinary use. Cobra PLA is accepted as also easy and fast applicable apparatus but still hard when compared to v-gel (Tables 1, 2). The cobraPLA is a relatively new supraglottic airway device for human. The cobraPLA was introduced into clinical practice in 2003 as a disposable extraglottic airway device. Several reports have shown the usefulness of the Cobra PLA in adults, pediatric patients and infants[21-3]. We evaluated cobraPLA in rabbits because of size similarity with infants but they have different anatomical forms. According to our results cobraPLA can also be used in rabbit anaesthesia on the other hand v-gel is found as most advantageous one compared to cobraPLA, and this is the first attempt in this field. LMA is seen as the most disadvantaged one in three different supraglottic airways There are notifications about the quite effectiveness and easiness of LMA applications in rabbit anaesthesia without any complication except cyanosis [9]. Unlike these results, LMA is defined as the hardest applicable supraglottic airway compared with the others and had some complications such as edema, mild cyanosis and haemorrhage in our study. We have inflated LMA cuff and this can be shown as the reason of complications. On the other hand, the reason for differences in LMA insertion may be the sizes of rabbits used because they have used 4 kg rabbits but our rabbits were in between 2-3 kg body weights[9]. Also we observed cyanosis in PLA and v-gel groups except for two rabbits in CV group. It can be accepted that none occurrence of edema is the most important advantage of v-gel and cobraPLA compared to LMA. In terms of ET insertion, our findings were similar to literature. In fact, the aim of this study was not to test ET applications because there are a lot of reports about the usage of ET in rabbit anaesthesia. We have applied ET just to make a comparison with other apparatus in CV group. Thus, complications arising and difficulties in insertion of ET as reported in the literature, also has been found a reason of high failure rate for rabbits[6,7]. According the these reports we have also encountered with complications and high failure rate in ET group (Table 2).

Arterial gas values are accepted as gold standards for anesthetised rabbits in terms of pulmonary function, blood oxygenation and pH[24]. In addition rabbits have central and superficial ear artery and this artery is visible and easy to collect blood. In rabbit anaesthesia, PaO_2, $PaCO_2$ and pH values could be easily determined compared to other laboratory animals [20]. Analysing arterial blood gas values at anesthetised rabbits is important due to some anaesthetics can cause depression of ventilation[15,25,26]. In our study, any significant change in terms of arterial pH values is not found in AV rabbits. In C-AV group $PaCO_2$ value was 24,56 mmHg and it reached to 38,42 mmHg at 30th min however no significant change is observed in LMA-AV group during anaesthesia. Similar results are observed in cobraPLA and v-gel groups. According to PaO_2 values in all groups that have all three apparatus during anaesthesia the PaO_2 values remained above 150 mmHg. These results show that all three apparatus provide sufficient oxygenation. However, in C-AV PaO_2 value is decreased from 99,46 mmHg basal level to 78,82 mmHg in 30th min of anaesthesia which any supraglottic airway is not inserted. The reason for this decline is thought the ventilation depressant effects of used anaesthetics and similar results are reported[4].

The airway management capacity of devices is also evaluated by a second trial in rabbits have depressed ventilation by rocuronium. Rocuronium is a neuromuscular blocking agent and can be used in rabbits under anaesthesia[27]. In this trial, LMA, PLA and v-gel are compared with ET as differently from first experiment. For ABG values more remarkable changes are observed in CV groups compared to AV groups. We observed that all device can supply adequate oxygen in CV rabbits. LMA provides a better airway than FM in rabbits anesthesia and 39-41 mmHg $PaCO_2$ and 7,36-7,34 pH values in 15th and 30th mins of anesthesia is reported[9]. However we obtained 40-52 mmHg $PaCO_2$ and 7,20-7,25 pH values in 1st, 5th, 15th and 30th mins of anaesthesia. The reason of the lower pH values can be explained by high PCO_2 values. We had ideal pH (7,31-7,41) and $PaCO_2$ (26,3-37,8 mmHg) results in v-gel group when compared to other groups. All of the apparatus in terms of PaO_2 values to have similar activity, and has been proved that can supply adequate oxygen.

Ventilation was done manually which can be accepted as a restricting factor in our study. To minimize this disadvantage same person experienced in this field has made application for all study. As a matter of fact according to our results we can claim that any individual application error is not occurred. Also, we conclude that application is performed successfully according to obtained blood gas analysing values.

According to our results, v-gel may be used as airway device in rabbit anaesthesia undergoing AV or CV also suggesting that this apparatus is a suitable alternative to other airway devices. We obtained these results by using manual ventilation and short duration time. We can suggest that v-gel must be investigated in long time period in automatically ventilated rabbits under anaesthesia.

Conclusion

v-gel is accepted as the appropriate airway device in rabbit anaesthesia undergoing AV or CV. The v-gel also can be used as an alternative airway apparatus to endotracheal tubes and laryngeal mask airway.

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