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RESEARCH ARTICLE

Comparison of the Effects of Spontaneous and Mechanical Ventilation on Blood Gases During General Anaesthesia in Dogs

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Summary

Spontaneous ventilation during general anaesthesia leads to respiratory depression and atelectasis. Mechanical ventilation increases tidal volume and eliminates atelectasis. The study material consisted of a total of 20 dogs of different breed, age and gender. Dogs were divided into two groups, consisted of 10 dogs. The first group was established as the spontaneous ventilation (SV) group, while the second group was the mechanical ventilation (MV) group. For induction of anaesthesia, propofol was administered to both groups via intravenous injection at a dose of 6 mg/kg. Blood samples were collected from all dogs in 5 minutes after propofol administration. This period was determined as Minute 0 (T_0). In both groups, inhalation anaesthesia was continued with isoflurane. Venous blood samples were collected from dogs in the SV and MV groups at 15 (T_{15}), 30 (T_{30}) and 60 (T_{60}) minutes. Heart rate, respiratory rate, SpO_2, body temperature and blood gases were monitored. Statistical evaluation of the study was carried out using the Repeated Measures Analysis of Variance method. The results obtained showed that there was no statistically significant difference between the SV and MV groups regarding the examined parameters. However, in the assessments within the group, results obtained from the dogs in the MV group were more reliable from the point of view of the patients remaining stable throughout anaesthesia.

Keywords: *Spontaneous ventilation, Mechanical ventilation, Blood gases, Dog*

Köpeklerde Genel Anestezi Sürecinde Spontan ve Mekanik Ventilasyonun Kan Gazları Üzerine Etkilerinin Karşılaştırılması

Özet

Genel anestezide spontan ventilasyon, solunumun baskılanmasına ve atelektaziye yol açar. Mekanik ventilasyon tidal volümü artırır ve atelektaziyi giderir. Çalışma materyalini, farklı ırk, yaş ve cinsiyetteki toplam 20 köpek oluşturdu. Olgular, her grupta 10 köpek olacak şekilde 2'ye ayrıldı. İlk grup spontan ventilasyon (SV), ikinci grup mekanik ventilasyon (MV) grubu olarak belirlendi. Anestezi indüksiyonunda her iki gruba, propofol 6 mg/kg'dan intravenöz enjeksiyonla verildi. Tüm köpeklerden, propofol enjeksiyonunu takip eden 5. dakikada kan örnekleri alındı. Bu süre 0. dakika (T_0) olarak değerlendirildi. Her iki grubun inhalasyon anestezisi izofloranla sürdürüldü. SV ve MV grubundaki olgulardan 15. dakika (T_{15}), 30. dakika (T_{30}) ve 60. dakika (T_{60})'larda venöz kan örnekleri alındı. Kalp atım sayısı, solunum sayısı, SpO_2, vücut ısısı ve kan gazları monitörize edildi. Çalışmanın istatistiki değerlendirmesi Tekrarlı Ölçüm Varyans Analizi metodu ile yapıldı. Elde edilen bulgular, incelenen parametreler yönünden SV ve MV grupları arasında istatistiki anlamda önemli bir fark olmadığını gösterdi. Ancak grup içi değerlendirmelerde, MV grubundaki köpeklerden elde edilen sonuçların, hastaların anestezi süresince stabil kalmaları açısından daha güvenilir olduğu sonucuna ulaşıldı.

Anahtar sözcükler: *Spontan ventilasyon, Mekanik ventilasyon, Kan gazları, Köpek*

INTRODUCTION

General anaesthesia leads to respiratory depression, a decrease in the functional residual capacity and atelectasis. This situation begins with anaesthesia induction. In connection with atelectasis, clearance of airway from secretion becomes more difficult and, in turn, post-operative hypoxia and pneumonia develop [1,2].

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In spontaneous respiration, inspiration occurs via negative intra-thoracic pressure created by respiratory muscles. With positive pressure ventilation, gas flow is achieved through the airway to the lungs by creating positive pressure against atmospheric pressure in the airway. Expiration takes place passively in both respiration types [1].

In veterinary medicine, patients are mostly encouraged to breathe spontaneously during general anaesthesia. Spontaneous respiration leads to hypoventilation, which causes hypercapnia, hypoxaemia and changes in the acid-base balance [2-5].

Mechanical intermittent positive pressure ventilation (IPPV) is an invasive method providing the patient with respiratory support. It is effective in correcting hypoventilation. It supports lung function by eliminating carbondioxide and allowing oxygenisation of arterial blood. It increases tidal volume and enables atelectatic alveoli to regain their function [2,3,5-7].

The most important complication of IPPV is, the barotrauma and volutrauma occurring in connection with high inspiration pressure. Over-inflation of the alveoli leads to formation of pulmonary interstitial emphysema, pneumomediastinum and pneumothorax [6,8]. Due to increasing thoracic pressure, right ventricular dysfunction, altered left ventricular distensibility and low cardiac output, IPPV decreases venous return to the heart [2,3,5,6,9].

Another side effect of IPPV is oxygen toxication. This condition occurs in the case of the patient breathing 100% oxygen for 18-24 hours. It causes alveolar inflammation, pulmonary oedema and eventually death [5,6] .

Anaesthetic drugs, surgical interventions and body positions lead to blood gas values alteration and hypoxia and acidosis occurring. Anaesthesia affects the oxygen and fluid-electrolyte metabolism by causing hypotension and hypothermia [10].

During spontaneous ventilation, anaesthetic drugs cause a significant increase in arterial carbondioxide pressure ($PaCO_2$) and a significant decrease in pH value. In mechanical ventilation, $PaCO_2$ remains within normal limits and there is no decrease in pH value. Both in spontaneous ventilation and mechanical ventilation, no significant difference occurs in PaO_2. However, in spontaneous ventilation, arterial oxygen pressure (PaO_2) decreases with time [4]. Polis et al.[3] reported that, spontaneous ventilation in dogs increased $PaCO_2$, while mechanical ventilation significantly decreased this value and that the pH level increased. The same authors stated that neither of these two ventilation methods caused a significant difference in PaO_2 values.

Propofol is a short-acting, injectable anaesthetic with rapid effect. Used at high doses, it decreases arterial pressure and heart rate. It leads to respiratory depression and formation of apnoea. In dogs, immediately after propofol injection, PaO_2 values decrease due to hypoventilation [3,11].

All inhalation anaesthetics cause cardiopulmonary depression depending on dosage. They depress alveolar ventilation and cause to significantly decrease in respiratory rate and to increase in $PaCO_2$ values during spontaneous ventilation [3-5].

Blood gas analyses are used to determine patients' ventilation, oxygenisation and metabolic status. Arterial blood samples give important information about lung function, whereas venous blood samples give information about tissue perfusion in the whole body as well as the acid-base balance [9,12].

Attempts at collecting arterial blood may cause bleeding, temporary or permanent arterial thrombosis, haematoma or infection. While difficulties may be encountered during arterial puncture and catheter placement in small breed dogs and obese or hypotensive patients, particularly during surgery, approach to the site may prove to be a challenge. Therefore, before collecting arterial blood, especially in surgical patients, peripheral blood can be collected from the patient allowing blood gases and oxygenisation to be assessed. Venous blood can be collected from a central vein such as the jugular vein, anterior vena cava or pulmonary artery [9,13-17].

Pang et al.[14] have reported that, the values obtained from samples of lingual venous blood can be used instead of arterial blood results and that this is clinically acceptable. Malatesha et al.[18] have compared pH, bicarbonate, PO_2 and PCO_2 values in arterial and venous blood. As a result of the study, they reported that pH, bicarbonate and PCO_2 values were similar to each other, while there was a difference between PO_2 values.

Normal partial venous oxygen pressure (PvO_2) is 35-50 mmHg. Normal partial venous carbondioxide pressure ($PvCO_2$) is 3-6 mmHg higher than $PaCO_2$ values and may be used instead of $PaCO_2$ values. Low PvO_2 values indicate oxygen insufficiency in tissues, while $PvCO_2$ above 60 mmHg reveals insufficient ventilation and insufficient tissue perfusion [9,17].

Pulse oximetry is a non-invasive method used in the assessment of arterial oxyhaemoglobin saturation. Haemoglobin saturation is closely related to the PaO_2 value. Therefore, pulse oximeter data may be used in the assessment of patients' oxygenisation status. In consequence, this will decrease the need for arterial blood samples. In the case of the patient receiving 100% oxygen, SpO_2 values should be 95-100%. Saturation reducing below 95% during anaesthesia indicates hypoxia [12,19].

The aim of this study is to compare the effects of spontaneous ventilation and mechanical ventilation during general anaesthesia induced with propofol and maintained using isoflurane in dogs, on heart rate, respiratory rate, pulse oximeter data, blood gases and body temperature.

MATERIAL and METHODS

The study material comprised a total of 20 dogs of different breed, age and gender, brought to the Istanbul University Veterinary Faculty Surgery Department Clinics and operated on for various reasons.

Prior to anaesthesia, routine physical examination of the dogs was performed. Haemogram (Erythrocyte-RBC, Haemoglobin-HGB, Hematocrit-HCT, Leucocyte-WBC) and various biochemical blood analyses (AST, ALT, glucose, urea, creatinine and total protein) were evaluated.

The dogs were divided randomly into two groups, consisted of 10 dogs. The first group was established as the spontaneous ventilation (SV) group, while the second was the mechanical ventilation (MV) group. Anaesthesia was induced by intravenous injection of propofol at a dose of 6 mg/kg. Injections were administered via a 22G intravenous catheter (Vasofix; B. Braun Melsungen AG, Germany) placed into the antebrachial cephalic vein. Following relaxation of the jaw muscles, endotracheal intubation was carried out (endotracheal tube 6-10 mm internal diameter, Rüsch, Germany) in each dog.

Five minutes after propofol administration, blood samples were taken from the jugular vein from all dogs in both groups. The time was established as Minute 0 (T_0). These measurements were used as baseline values.

Inhalation anaesthesia was maintained in all dogs using 100% oxygen with isoflurane at an initial concentration of 4-5% and maintained at 2-3%. In the SV group, anaesthesia was maintained spontaneous ventilation throughout general anaesthesia, those in the MV group were attached to a mechanical ventilator (SAV 2500 Anaesthesia ventilator, Surgivet, Waukesha, WI, USA) following propofol induction and continued to breathe via controlled ventilation for the duration of inhalation anaesthesia. The mechanical ventilator was re-calibrated for each case. Calibrations were made for tidal volume to be 10 ml/kg, inspiration/expiration rate (I/E) 1:3 and respiratory rate 12 breaths/min. Accuracy of the automatic ventilator calibration was first tested on an artificial lung before being applied to the patient.

During isoflurane anaesthesia, venous blood samples were taken from the jugular vein from all dogs in both the SV and MV groups at 15 (T_{15}), 30 (T_{30}) and 60 (T_{60}) min.

Heart rate (HR), respiratory rate (RR), haemoglobin oxygen saturation (SpO_2), body temperature (BT) and blood gases [pH, pCO_2 (partial pressure of CO_2), pO_2 (partial pressure of O_2), HCO_3 (bicarbonate)] were monitored at every measurement time in all dogs.

Heart rate was determined with an ECG monitor (Advisor V9212 AR; Surgivet, Waukesha, WI, USA) using the IInd derivation.

Haemoglobin oxygen saturation (SpO_2) was taken using a pulse oximeter (Advisor V9212 AR; Surgivet, Waukesha, WI, USA)with the probe placed on the tongue.

Respiratory rates were determined in the SV group at every measurement time by observing thoracic movements during respiration. In the MV group, thoracic movement was observed at T_0, while the respiratory rate adjusted by the automatic ventilator was recorded at T_{15}, T_{30} and T_{60}.

Throughout the anaesthesia period body temperature was measured rectally using a digital thermometer (Omron, The Netherlands).

Blood samples were collected using heparinized 2 ml syringes. pH, pCO_2 pO_2 and HCO_3 were measured with a blood gas analyzer (ITC Edison, NJ 08820, USA) at 37°C. These measurements were corrected for each dog's temperature.

Statistical analysis was carried out by the Istanbul Univ. Veterinary Faculty Animal Husbandry Department.

Repeated measurements of ANOVA in SPSS 10.0 statistical package (SPSS, 1999) was used to analyse data for heart rate, respiration rate, pulse oxymetry, body temperature, pH, pCO_2, pO_2 and HCO_3. The model included measurement time (T_0, T_{15}, T_{30} and T_{60}) as a within-subject effect and group (SV and MV) as a between-subject effect, and also measurement time x group interaction. Significance control was assessed by using the least significant difference procedure. In order to determine the effect of group on investigated parameters in the specific measurement time, independent samples t-test were also performed. Furthermore, one-way repeated ANOVA included measurement time (T_0, T_{15}, T_{30} and T_{60}) as a within-subject effect was assessed in order to compare means for different sampling times for a specific group (Group SV or MV).

RESULTS

The dogs were divided into two groups, consisted of 10 dogs. Age, sex and bodyweight of the cases are shown in *Table 1*.

Table 1. *Means and (standard deviations) for age and body weights of dogs in Spontaneous Ventilation (SV) and Mechanical Ventilation (MV) groups and distribution of groups according to gender*

Tablo 1. *Spontan Ventilasyon (SV) ve Mekanik Ventilasyon (MV) gruplarındaki köpeklerin yaş ve vücut ağırlığı ortalamaları ve cinsiyete göre grup dağılımları*

Parameter	SV (n = 10)	MV (n = 10)
Age (month)[a]	43.80±16.24	41.60±13.37
Body weight (kg)[b]	20.20±5.19	23.58±4.64
Distribution of groups		
Female (number)	4	3
Male (number)	6	7

[a] Difference between SV and MV groups in terms of age was not significant (P>0.05), [b] Difference between SV and MV groups in terms of body weight was not significant (P>0.05)

The age of dogs in the SV group was determined as 43.80±16.24 months and of those in the MV group as 41.60±13.37 months. Bodyweight was recorded as 21.40±4.82 kg in the SV group and 23.58±4.64 kg in the MV group. The difference between the SV and MV groups regarding age and bodyweight was found to be statistically insignificant (P>0.05).

Following propofol injection, rapid anaesthesia induction was achieved in all cases. No apnoea or any other complication was encountered at this stage. Following relaxation of the jaw muscles and loss of the swallowing reflex, endo-tracheal intubation was performed with ease.

The means values for heart rate, respiration rate, pulse oximetry, body temperature, pO_2, pCO_2, pH and HCO_3 in SV and MV groups at different measurement times are presented in *Table 2* and *Table 3*.

The heart rate differences between the SV and MV groups in different measurement times was found to be insignificant (P>0.05). The effect of measurement time on heart rate was found to be significant in both the SV (P<0.01) and MV groups (P<0.05). In the MV group, it was observed that no statistically significant decrease occurred in the T_{15} and T_{30} measurements, only that the heart rate measured at T_{60} was lower than the heart rate at T_0. In the SV group, however, a significant decrease compared to the initial measurement was observed at T_{30} and, furthermore, an additional drop was seen to occur at T_{60}.

The effect of group on respiration rate was significant (P<0.01). When each measurement time data was examined with respect to respiratory rate, while no significant difference (P>0.05) between groups was found at T_0, at later measurements (T_{15}, T_{30} and T_{60}) the respiratory rates of dogs in the SV group were determined to be higher than the MV group (P<0.01). In this study, the respiratory rate recorded at the T_0 measurement in both groups was observed to be higher than the respiratory rates recorded at subsequent measurements. However, there was no statistically significant difference between respiratory rates obtained at T_{15}, T_{30} and T_{60} in the MV group.

The effect of the group as the main influence for pulse oximeter was determined to be insignificant. On the other hand, while the effect of measurement time on pulse oximeter was found to be insignificant in the SV group (P>0.05), a significant increase (P<0.001) was observed at T_{15} compared

Table 2. *Means and (standard deviations) for heart rate (HR), respiration rate (RR), pulse oximeter and body temperature (BT) for spontaneous ventilation (SV) and mechanical ventilation (MV) groups (G) at different measurement times*

Tablo 2. *Spontan ventilasyon (SV) ve mekanik ventilasyon (MV) grupları (G) için farklı ölçüm zamanlarında kalp atım sayısı (HR), solunum sayısı (RR), pulse oksimetre ve vücut sıcaklığı ortalamaları*

Parameter	Measurement Time (MT)	SV	MV	t-Test	Significance of Main Effects		
					G	MT	G x MT
HR (beats/minute^{-1})	0th min	155.10±6.32^{a}	144.60±8.95^{a}	NS	NS	***	NS
	15th min	147.40±7.01^{ab}	135.70±7.59^{ab}	NS			
	30th min	130.70±4.98^{b}	125.90±5.48^{ab}	NS			
	60th min	125.20±5.49^{c}	118.40±5.14^{b}	NS			
	Significance	**	*				
RR (breaths/minute^{-1})	0th min	29.90±2.85^{a}	28.20±3.85^{a}	NS	**	***	NS
	15th min	22.50±2.90^{ab}	12.00±0.00^{b}	**			
	30th min	19.30±2.52^{b}	12.00±0.00^{b}	**			
	60th min	18.20±1.85^{b}	12.00±0.00^{b}	**			
	Significance	**	***				
Pulse Oximeter (%)	0th min	94.00±0.83	87.20±2.01^{b}	**	NS	***	***
	15th min	96.10±0.74	94.70±1.34^{a}	NS			
	30th min	94.40±1.36	95.40±0.92^{a}	NS			
	60th min	92.90±1.44	95.00±0.82^{a}	NS			
	Significance	NS	***	NS			
BT (°C)	0th min	38.79±0.13^{a}	38.97±0.14^{a}	NS	NS	***	NS.
	15th min	38.18±0.19^{b}	38.32±0.30^{b}	NS			
	30th min	37.69±0.19^{c}	37.98±0.32^{c}	NS			
	60th min	37.29±0.28^{d}	37.55±0.35^{d}	NS			
	Significance	***	***				

a,b,c,d*:** *Difference between the means of measuremnet times carrying various letters in the same line are significant, * P<0.05, ** P<0.01, *** P<0.001,* ***NS: *Not Significant (P>0.05)*

Table 3. *Means and (standard deviations) for pH, HCO_3^- partial pressure of CO_2 (pCO_2) and O_2 (pO_2) for spontaneous ventilation (SV) and mechanical ventilation (MV) groups (G) at different measurement times*

Tablo 3. *Spontan ventilasyon (SV) ve mekanik ventilasyon (MV) grupları (G) için farklı ölçüm zamanlarında pH, HCO_3^-, CO_2 (pCO_2) ve O_2 (pO_2) parsiyel basıncının ortalamaları*

Parameter	Measurement Time (MT)	SV	MV	t-Test	Significance of Main Effects		
					G	MT	G x MT
pH	0th min	7.31±0.02[a]	7.33±0.01	NS	NS	**	NS
	15th min	7.30±0.01[a]	7.34±0.02	NS			
	30th min	7.26±0.18[b]	7.32±0.03	NS			
	60th min	7.24±0.02[b]	7.30±0.03	NS			
	Significance	***	NS				
HCO_3 mM	0th min	23.65±0.92	24.26±0.58	NS	NS	NS	NS
	15th min	24.46±0.93	23.63±0.63	NS			
	30th min	24.42±0.93	23.38±0.71	NS			
	60th min	24.16±0.98	23.40±0.81	NS			
	Significance	NS.	NS				
pCO_2 mmHg	0th min	48.23±1.79[c]	47.38±2.02	NS	NS	*	NS
	15th min	50.38±1.36[bc]	45.58±3.00	NS			
	30th min	55.64±2.44[ab]	48.41±3.90	NS			
	60th min	56.98±2.16[a]	50.84±4.52	NS			
	Significance	***	NS				
pO_2 mmHg	0th min	124.19±22.36	64.49±2.33[c]	*	NS	NS	**
	15th min	148.53±1.36	116.02±19.53[ab]	NS			
	30th min	123.99±20.82	122.82±23.53[ab]	NS			
	60th min	95.09±11.59	165.40±44.93[ac]	NS			
	Significance	NS	*				

*[a,b,c,d]: Difference between the means of measuremnet times carrying various letters in the same line are significant, * P<0.05, ** P<0.01, *** P<0.001,* ***NS:*** *Not Significant (P>0.05)*

to the beginning, and this increased level was seen to continue until T_{60} in the MV group.

In the study, body temperatures of the SV and MV groups were found to be similar. Significant decreases in body temperature in relation to time were observed in both groups.

The mean values for blood pH difference was found to be insignificant between the groups (P>0.05). While the effect of measurement time on pH value was found to be significant in the SV group (P<0.001), similar blood pH values at various measurement times were observed among the animals in the MV group (P>0.05). Blood pH value measured at T_{30} in the SV group was seen to be lower than at the beginning, and this low level continued at T_{60}.

With respect to blood HCO_3 values, the effect of the group and measurement time was determined to be insignificant (P>0.05).

With respect to blood CO_2, the difference between the groups was found to be insignificant (P>0.05). On the other hand, in the MV group while the change in pCO_2 related to measurement time was found to be insignificant (P>0.05), in the SV group the effect of measurement time was found to be significant (P<0.001). In the SV group, an important increase was determined in the pCO_2 level compared to the beginning, and this increase continued at T_{60}.

In the study, the difference between the SV and MV groups with respect to pO_2 was found to be insignificant (P>0.05). While the difference relating to time in the SV group was found to be insignificant, a trend of pO_2 level increasing with time emerged in the MV group.

DISCUSSION

In veterinary practice, patients are enabled to breathe spontaneously during general anaesthesia. General anaesthesia creates atelectasis in the lungs and leads to respiratory depression, oxygen deficiency in tissues and disruption of the body's acid-base balance. This puts the patient's life at risk.

In this study, the effects of spontaneous and controlled ventilation during general anaesthesia on heart rate, respiratory rate, pulse oximeter data, body temperature and blood gas values have been investigated.

While Polis et al.[3] stated that, in comparison to spontaneous respiration, mechanical ventilation increased heart rate, Cecen et al.[4] reported that neither spontaneous respiration nor mechanical ventilation had any significant effect on heart rate. In the present study, heart rate in the SV group significantly decreased at the T_{30} measurement compared to the beginning and an additional decrease occurred at the T_{60} measurement. In the MV group, however, lower values compared to the initial level were encountered only at the T_{60} measurement. Nevertheless, no significant difference was observed between the groups with regard to heart rate. The time-related decrease in heart rate in both groups suggested that this had occurred due to the cardiopulmonary depressing properties of inhalation anaesthetics [3,5].

With respect to respiratory rate, no significant difference was found between the T_0 measurements in either group. In contrast to literary sources [3,11] reporting propofol to cause respiratory depression and apnoea formation, no such complications were encountered in either group, and results were found to be similar.

Respiratory rates measured at T_{15}, T_{30} and T_{60} were found to be higher in cases in the SV group compared to the MV group. While the SV group continued spontaneous respiration throughout general anaesthesia, in order to maintain respiratory rate and the normal haemodynamic state in the MV group, the settings were adjusted to12 breaths per minute and an I/E ratio of 1:3 [5,6]. The difference between groups originated from this adjustment. The reason for the T_0 measurements in both groups being higher compared to the 3 other measurement times appeared to be due to the cardiopulmonary depressing properties and respiratory rate decreasing effects [3,6] of inhalation anaesthetics.

Cecen et al.[4] reported that spontaneous and mechanical ventilation had similar effects on SpO_2. Likewise, in the present study, the difference between groups with respect to pulse oximeter data was found to be insignificant. While the difference between measurement times for pulse oximeter data was found to be insignificant in the SV group, it was concluded that the decrease in respiratory rate after T_0 was not at a level to affect the oxygen carrying capacity of haemoglobin (SpO_2).

Pulse oximeter data began to increase starting from T_{15} in the MV group and continued to do so until the T_{60} measurement. This finding was found to support the opinion that mechanical ventilation sustained lung function and encouraged return of function of atelectatic alveoli that had occurred due to general anaesthesia [3,6,7]. The authors also thought that the ventilation provided during anaesthesia, at the tidal volume determined according to the bodyweight of patients, was effective in this increase in pulse oximeter data.

In the study, no difference was observed between the SV and MV groups regarding body temperature, however, in relation to time, decreases in body temperature were seen in both groups. This finding was similar to Simeonova [10] in which general anaesthesia has been reported to create time-related hypothermia.

With regard to blood pH, the difference between the groups was found to be insignificant. In the SV group, blood pH exhibited a decrease over time and this decrease appeared to be significant. However, the values obtained were not enough to change the patient's acid-base balance. In the MV group, the cases were seen to have similar pH values at all measurement times. The results obtained in the study were found to be compatible with the study carried out by Cecen et al.[4] On the other hand, results obtained from the MV group were different to Polis et al.[3] stating that mechanical ventilation increased blood pH.

With respect to blood HCO_3 values, the difference between groups was found to be insignificant. There was not any significant difference between measurement times within groups. This result showed that there was no pCO_2 increase enough to cause the bicarbonate increase in either group.

The difference between the groups with respect to blood pCO_2 level was found to be insignificant. In the SV group, the pCO_2 level had significantly increased at the T_{30} measurement compared to the beginning, and this increase was seen to continue at T_{60}. However, the values did not rise high enough to lead to respiratory acidosis and remained within normal limits. This finding is compatible with literatures [3,4,17].

In the MV group, the change in pCO_2 in relation to time was found to be insignificant. While being in contrast to Polis et al.[3] reporting that mechanical ventilation significantly decreased pCO_2 levels, this result is compatible with the study carried out by Cecen et al.[4]

In the present study, with respect to pO_2 values, a time-related decrease was established in the SV group, whereas there was an increase in the MV group. However, the difference between the groups was found to be insignificant. This result was thought to have occurred due to there being no respiratory complication in any of the patients and provision of 100% oxygen respiration with sufficient tissue perfusion.

During the study, no complication in relation to barotrauma or volutrauma [6,8] was encountered in patients in the MV group. This kind of complication was prevented by recalibrating the mechanical ventilator for each patient and testing on an artificial lung before use.

Oxygen toxication [5,6], which had been reported to occur in the case of patients inhaling 100% O_2 for 18-24 h, was not observed due to the duration of anaesthesia being limited to 60 min. Removal of the ventilator from patients was also carried out without any problems.

Results obtained at the end of the study showed that there was no statistically significant difference between the SV and MV groups regarding the parameters examined. However, in the within-group evaluations, it was concluded that results obtained from cases in the MV group were more reliable for patients to remain stable during anaesthesia.

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