Effects of Desflurane and Sevoflurane on Oxygenation and Shunt Fraction During One-Lung Ventilation and On Recovery Time

Tek Akciğer Ventilasyonunda Desfluran ve Sevofluranın Oksijenizasyon, Şant Oranı ve Uyanma Sürelerine Etkileri

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ABSTRACT Objective: To compare the effects of desflurane and sevoflurane on oxygenation, shunt fraction and hemodynamics during one-lung ventilation (OLV), and recovery characteristics after general anesthesia in patients undergoing pulmonary surgery. **Material and Methods:** Thirty-two American Society of Anesthesiologists (ASA) physical status I-II patients scheduled for elective pulmonary surgery were randomly assigned to one of two groups. Anesthesia was maintained with desflurane in group D and with sevoflurane in group S. Systemic and pulmonary hemodynamics were recorded, and arterial and mixed venous gas analyses were measured four times. Recovery was assessed using the Aldrete score. The patients were asked to state their names, date of birth and names of their 3 close relatives at 5 and 15 minutes after extubation in the recovery room. **Results:** Patient demographics and operative procedures were similar between desflurane and sevoflurane groups. There were no significant differences between the groups with regard to oxygenation, shunt fraction or systemic and pulmonary hemodynamics. In both groups, shunt fraction was significantly increased during OLV. There were no differences between groups in Aldrete score, and correct stating of name, date of birth and three close relative names. The times from cessation of inhalation anesthetic administration to hand squeezing and extubation were significantly shorter in patients given desflurane than in patients given sevoflurane. There was no difference between groups in the period from cessation of anesthetic agent to eye opening. **Conclusion:** We conclude that desflurane and sevoflurane can be used safely in pulmonary surgery and the choice between them is not important in terms of arterial oxygenation, shunt fraction, and hemodynamics. The time from cessation of inhalation anesthetic administration to hand squeezing and extubation were shorter in the desflurane group. Other recovery characteristics were similar between the groups.

Key Words: Desflurane; sevoflurane; pulmonary ventilation; anesthesia recovery period; pulmonary circulation

ÖZET Amaç: Toraks cerrahisinde desfluran ve sevofluranın tek akciğerle ventilasyon sırasında oksijenizasyon, şant fraksiyonu ve hemodinamikler üzerine etkileri ve uyanma sürelerini karşılaştırmak. **Gereç ve Yöntemler:** Çalışma, elektif toraks cerrahisi planlanan Amerikan Anesteziyoloji Topluluğu (ASA) I-II 32 hastanın iki gruba ayrılmasıyla gerçekleştirildi. Anestezi idamesinde grup D'de desfluran ve grup S'de sevofluran kullanıldı. Sistemik ve pulmoner hemodinamikler kaydedildi ve dört farklı zamanda arteriyel ve mikst venöz kan gazı analizi yapıldı. Uyanmanın değerlendirilmesinde Aldrete skoru kullanıldı. Derlenme odasında, hastanın, ekstübasyondan sonra 5. ve 15. dakikalarda ismini, doğum tarihini ve 3 yakın akrabasının isimlerini söyleyebilmesi değerlendirildi. **Bulgular:** Desfluran ve sevofluran grupları arasında demografik özellikler ve ameliyat özellikleri açısından farklılık saptanmadı. Gruplar arasında oksijenizasyon, şant fraksiyonu, sistemik ve pulmoner hemodinamikler açısından istatistiksel olarak anlamlı farklılık yoktu. Her iki grupta şant fraksiyonunun tek akciğer ventilasyonu sırasında anlamlı derecede yükseldiği izlendi. Gruplar arasında Aldrete skoru, isim, doğum tarihini söyleme ve üç yakın akraba ismi söyleme açısından anlamlı farklılık saptanmadı. Desfluran grubunda sevofluran grubuna göre el sıkma süresinin ve ekstübasyon süresinin anlamlı derecede kısa olduğu gözlendi. Gruplar arasında göz açma süresi açısından anlamlı farklılık bulunmadı. **Sonuç:** Desfluran ve sevofluranın toraks cerahisinde güvenlikle kullanılabileceğine ve arteriyel oksijenizasyon, şant fraksiyonu ve hemodinamik değerlere etkileri açısından birbirlerine üstünlükleri olmadığı sonucuna vardık. El sıkma ve ekstübasyon süreleri desfluran grubunda anlamlı derecede daha kısaydı. Ancak gruplar arasında uyanmayı değerlendiren diğer parametreler açısından farklılık saptanmadı.

Anahtar Kelimeler: Desfluran; sevofluran; akciğer ventilasyonu; anesteziden uyanma süresi; akciğer dolaşımı

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The new generation of thoracic surgeons favors isolation and OLV during intrathoracic operations. The most common indication for OLV is providing the surgeon with a quiet operating field. Thus, for the safe application of anesthesia for thoracic surgery, the anesthesiologist should know well about the physiology of OLV and be skillful in techniques for the isolation of lungs.[1,2]

A unique problem that influences anesthetic management in thoracic surgery is the occurrence of hypoxemia during OLV. Hypoxic pulmonary vasoconstriction (HPV) is an important mechanism by which blood flow is diverted from the hypoxic region of the lung toward a better-ventilated region, thereby reducing venous admixture and minimizing the decrease in arterial oxygenation. Potent inhaled anesthetics inhibit HPV to varying degrees, increasing intrapulmonary shunting and decreasing arterial oxygen pressure.[1-3]

The purpose of the study was to compare the effects of desflurane and sevoflurane on oxygenation, shunt fraction and hemodynamic parameters during one-lung ventilation and recovery characteristics after general anesthesia in patients undergoing pulmonary surgery.

MATERIAL AND METHODS

The investigation was approved by the ethical committee and written informed consent was obtained from each patient. Thirty-two ASA physical status I-II patients who were scheduled for elective thoracotomy for lung resection were randomly assigned to one of the two groups. Anesthesia was maintained with desflurane in group D (n= 16) and with sevoflurane in group S (n= 16).

Exclusion criteria were; history of malignant hyperthermia, neuromyopathic disease, history of cardiac disease or myocardial infarction, renal insufficiency, liver dysfunction, FEV_1/FVC lower than 60% or hemodynamic instability before the study.

For all patients, age, weight, baseline heart rate, blood pressure and spirometry results were recorded one day prior to the operation. Patients were premedicated with oral diazepam (Diazem, DEVA, Turkey) 0.1 mg/kg and oral famotidin (Famodin, İlsan, Turkey) 40 mg six hours before surgery. In the operation room the electrocardiogram, heart rate, and blood pressure were monitored. An 18 F venous canule was inserted into a peripheral vein and a radial arterial canule was inserted under local anesthesia. Additional monitoring included SpO_2, urine output and peak airway pressure.

After breathing 100% oxygen for 5 minutes, anesthesia was induced with remifentanil (Ultiva, Glaxo Smith Kline, UK) 0.2 µg/kg/min and propofol (Diprivan, Astra Zeneca, UK) 2-3 mg/kg. Neuromuscular blockage was achieved with cisatracurium (Nimbex, Glaxo Smith Kline, UK) 0.2 mg/kg, followed by endobronchial intubation with a left-sided double-lumen tube (Portex, U.S.A). Appropriate positioning of the endobronchial tube was confirmed by auscultation before and after the patient was positioned in the lateral decubitis position. Ventilation was controlled (AMS 200, U.S.A) with a 50% oxygen-air mixture. After tracheal intubation, a pulmonary artery catheter (Schwan-Ganz 7 F, Abbot, U.S.A) was inserted via the right internal jugular vein. Radial and pulmonary arterial and central venous pressure transducers were zeroed at the level of the left atrium.

Anesthesia was maintained with desflurane (Suprane, Eczacıbaşı-Baxter, Turkey) or sevoflurane (Sevorane, Abbot, U.S.A) in 100% O_2. An end-tidal concentration of 0.5-1.0 minimum alveolar anesthetic concentration (MAC) was used as the initial dose of desflurane (3-6%) or sevoflurane (1-3%). Tidal volume was designed as follows: respiration frequency 10-12/min. and end-tidal carbon dioxide pressure 30-35 mm Hg. During OLV, the lumen of the tube remained open to the air. Additional doses of cisatracurium 0.03 mg/kg were administered as required to maintain neuromuscular blockage during surgery. Intra-operative arterial blood pressure was maintained within 20% of the baseline measurement with boluses of intravenous fluid or remifentanil as required.

Systemic and pulmonary hemodynamics was recorded and arterial and mixed venous gas analysis was done four times: (1) after intubation and the

insertion of the pulmonary artery catheter during two-lung ventilation in the supine position (T_1); (2) during two-lung ventilation in the lateral decubitis position after 20 minutes (T_2); (3) 20 minutes after the initiation of one-lung ventilation (T_3); (4) 20 minutes after the initiation of two-lung ventilation in the supine position (T_4). Mean arterial blood pressure (MABP), heart rate (HR), central venous pressure (CVP), pulmonary arterial pressure (PAP), and pulmonary capillary wedge pressure (PCWP) were measured. The following formulas were used to calculate shunt fraction and oxygen consumption:

Q_s/Q_t (shunt fraction)= $(CcO_2-CaO_2)/ (CcO_2 - CvO_2)$

CaO_2 (oxygen content)= $(PaO_2 \times 0.0031) +(Hb \times 1.34 \times SaO_2)$

CvO_2 (venous oxygen consumption)=$(PvO_2 \times 0.0031)+(Hb \times 1.34 \times SvO_2)$

PAO_2 (alveolar oxygen tension)= $FiO_2 \times (PB-PH_2O) - (PCO_2 / RQ)$

CcO_2 (pulmonary capillary O_2 content)= $PAO_2 \times 0.0031+(Hb \times 1.34)$

RQ is the respiratory quotient assumed to be 0.8.

Remifentanil was stopped at the first skin suture; the inhalation agent was ceased at the last skin suture. The trachea was extubated when a regular spontaneous breathing pattern was reestablished. At 5 and 15 minutes after extubation, recovery was assessed using the Aldrete score and mental recovery was assessed by asking patients to state their names, date of births, and names of their 3 close relatives.[4]

Statistical Analysis

All data were expressed as mean ± SD. Changes were considered statistically significant when p value was <0.05. Statistical analyses were performed using the Chi-square test, the Fisher's Exact test, analysis of variance with repeated measures and the Student's t-test. A power analysis (α= 0.05, β= 0.20) was performed before the onset of the study to detect a shunt fraction change greater than 0.04 with a standard influence quantity of 0.90; minimum 15 patients were included in each group.

RESULTS

All patients underwent identical procedures by the same group of surgeons and anesthetists. Thirty-two patients were enrolled in this study. Two patients were eliminated from the study; one patient in the desflurane group because he could not be extubated and one patient in the sevoflurane group because of prolonged OLV period. Demographic characteristics, preoperative lung function tests and operative procedures were similar for both groups. Intraoperative remifentanil requirements, duration of operation and OLV were similar between the groups (Table 1 and 2).

Hemodynamic parameters, and arterial and mixed venous gas values were not significantly different between the groups (p> 0.05). The systemic and pulmonary hemodynamic effects of desflurane and sevoflurane before, during and after OLV were summarized in Table 3 and 4.

The arterial oxygen pressure was less in T_3 than that in T_1, T_2 and T_4 in both groups (Group D, F= 167.06; p< 0.001 and Group S, F= 115.69; p< 0.001). There was no significant difference between the two groups in T_1, T_2 and T_4 values. Similarly, we found no significant differences between

TABLE 1: Patient demographics and preoperative lung function tests.

	Grup D (n=15)	Grup S (n=15)	p
Age (yr)	57 ± 12.86	56 ± .33	0.872
Sex M/F (n)	14/1	14/1	NS
Weight (kg)	66 ± 14.51	68 ± 10.81	0.225
ASA status (I:II)	2:13	1:14	0.659
FVC (%)	75.7 ± 13.47	74.2 ± 19.29	0.803
FEV_1 (%)	82.64 ± 12.0	79 ± 18.8	0.530
FEV_1/FVC	84.6 ± 7.05	85.7 ± 7.36	0.676

Group D: Desflurane group, Group S: Sevoflurane group, FVC: Forced vital capacity, FEV_1: Forced expired volume in one second, ASA: American Society of Anesthesiologists, NS: Not significant.

TABLE 2: Operative procedures.

		Grup D (n= 15)	Grup S (n= 15)	p
Procedures	Right pneumonectomy	1	2	
	Left pneumonectomy	-	-	
	Right lobectomy	6	7	NS
	Left lobectomy	6	5	
	Wedge resection	2	1	
Duration of operation (min)		183.3 ± 24.68	188 ± .73	0.602
Duration of one-lung ventilation (min)		66.3 ± 12.02	68.3 ± 13.58	0.673
Intraoperative remifentanil (μg)		50 ± 13.75	49 ± 16.60	0.859

Group D: Desflurane group, Group S: Sevoflurane group
NS: not significant

the groups in arterial oxygen pressure (F= 0.641; p= 0.671) (Table 4).

The arterial oxygen saturation during T_3 was significantly lower than the arterial oxygen saturation during T_1, T_2 and T_4 (Group D, F= 15.69; p< 0.001 and Group S, F=18.04; p< 0.001). There were no significant differences between the T_1, T_2 and T_4. We found no significant differences between the groups in arterial oxygen saturation (F= 0.382; p= 0.856) (Table 4).

Intrapulmonary shunt fraction during T_3 was significantly higher than the ones during T_1, T_2 and T_4 (Group D, F= 81.702; p< 0.001 and Group S, F= 69.092; p< 0.001). Shunt fraction increased significantly after initiation of OLV in both groups, but did not differ significantly between the groups (F= 1.572; p= 0.213) (Figure 1).

Five minutes (group D/group S: 8.3 ± 1.04/8 ± 1.09, F= 0.376; p= 0.502) and 15 minutes (group D/group S: 9.7 ± 0.59/9.8 ± 0.56, F= 0.376; p= 0.754)

TABLE 3: Comparison of hemodynamic values (mean ± SD) within- and between-groups.

Heart Rate (HR, bpm)				
	T_1	T_2	T_3	T_4
Desflurane	79 ± 13.58	78.9 ± 12.44	77.7 ± 13.53	81.1 ± 14.45
Sevoflurane	71.9 ± 12.98	71.9 ± 16.01	75.6 ± 13.15	75.5 ± 10.7
Mean Arterial Blood Pressure (MABP, mm Hg)				
	T_1	T_2	T_3	T_4
Desflurane	92.6 ± 17.48	95.9 ± 17.5	84 ± 15.7	93.1 ± 14.49
Sevoflurane	92.1 ± 17.58	98.9 ± 13.03	86 ± 14.3	91 ± 13.79
Central Venous Pressure (CVP, mm Hg)				
	T_1	T_2	T_3	T_4
Desflurane	10.6 ± 3.77	10.4 ± 2.94	10 ± 3.58	10.2 ± 3.05
Sevoflurane	10.2 ± 3.34	10.7 ± 3.61	10.4 ± 3.54	11.2 ± 2.9
Pulmonary Arterial Pressure (PAP, mm Hg)				
	T_1	T_2	T_3	T_4
Desflurane	23.1 ± 2.03	23.6 ± 3.01	24.2 ± 1.98	24.4 ± 3.29
Sevoflurane	21.8 ± 3.96	21.8 ± 3.31	22.8 ± 3.11	23.4 ± 2.87
Pulmonary Capillary Wedge Pressure (PCWP, mm Hg)				
	T_1	T_2	T_3	T_4
Desflurane	11.8 ± 2.06	11.7 ± 1.53	12.4 ± 1.24	12.1 ± 1.24
Sevoflurane	11.6 ± 1.63	11.9 ± 2.18	12.2 ± 1.42	11.8 ± 1.61

TABLE 4: Comparison of arterial and mixed venous gas values (mean ± SD) within- and between-groups.

Arterial Oxygen Pressure (PaO_2, mmHg)					
	T_1	T_2	T_3	T_4	p
Desflurane*	259.2 ± 26.56[b]	244.3 ± 24.97[b]	176.7 ± 36.73[a]	237.8 ± 24.79[b]	<0.001
Sevoflurane*	250.9 ± 33.56[b]	247.1 ± 23.75[b]	189.9 ± 30.53[a]	246.2 ± 29.22[b]	<0.001
Arterial Carbondioxide Pressure ($PaCO_2$, mmHg)					
	T_1	T_2	T_3	T_4	
Desflurane	31.3 ± 5.31	32.7 ± 4.5	33.1 ± 6.79	39 ± 5.83	>0.05
Sevoflurane	31.6 ± 4.94	33.9 ± 6.07	35.1 ± 6.44	35.1 ± 6.65	>0.05
Arterial Oxygen Saturation [SaO_2 (%)]					
	T_1	T_2	T_3	T_4	
Desflurane*	99.8 ± 0.12[a]	99.7 ± 0.24[a]	98.9 ± 0.71[b]	99.7 ± 0.24[a]	<0.05
Sevoflurane*	99.8 ± 0.09[a]	99.7 ± 0.1[a]	99 ± 0.79[b]	99.8 ± 0.11[a]	<0.05
Venous Oxygen Pressure (PvO_2, mmHg)					
	T_1	T_2	T_3	T_4	
Desflurane	58.4 ± 11.62	56.1 ± 10.26	51.7 ± 7.69	61.5 ± 9.98	>0.05
Sevoflurane	58.2 ± 12.56	57.7 ± 11.02	53.8 ± 11.06	62.1 ± 10.3	>0.05
Venous Oxygen Saturation [SvO_2 (%)]					
	T_1	T_2	T_3	T_4	
Desflurane	87.2 ± 4.44	86.8 ± 4.04	84.5 ± 3.76	87.5 ± 4.34	>0.05
Sevoflurane	87.6 ± 4.34	87.5 ± 4.15	85.1 ± 5.54	88.3 ± 2.83	>0.05
Shunt Fraction (Qs/Qt)					
	T_1	T_2	T_3	T_4	
Desflurane*	0.08 ± 0.043[b]	0.1 ± 0.048[b]	0.37 ± 0.072[a]	0.12 ± 0.054[b]	<0.001
Sevoflurane*	0.08 ± 0.046[b]	0.09 ± 0.35[b]	0.33 ± 0.065[a]	0.09 ± 0.043[b]	<0.001

*No difference in time was observed between the groups. Time differences within a group defined with different letters. Times with same letters exhibited no difference.

after tracheal extubation, recovery, as assessed by the Aldrete score was similar between the groups (Figure 2). Although return of the cognitive functions was earlier in the desflurane group, there was no significant difference in the 5 and 15 minutes values between the groups (Fisher's Exact Test; p> 0.05).

The time from the cessation of anesthetic agent to hand squeezing (10.1 minute versus 11.5 minute, t-test=-2.076; p= 0.047) and extubation (7.6 minute versus 9.1 minute, t-test=-2.465; p= 0.02) were significantly shorter in the desflurane group compared to the sevoflurane group. The time for eye opening was 8.9 minutes for desflurane and 10.2 minutes for sevoflurane; the difference was not significant (t-test= -1,912, p= 0.66) (Figure 3).

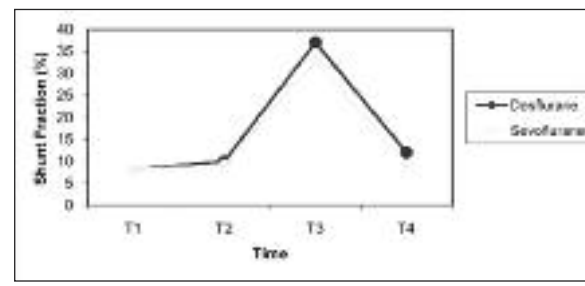

FIGURE 1: Time course for changes in shunt fraction.

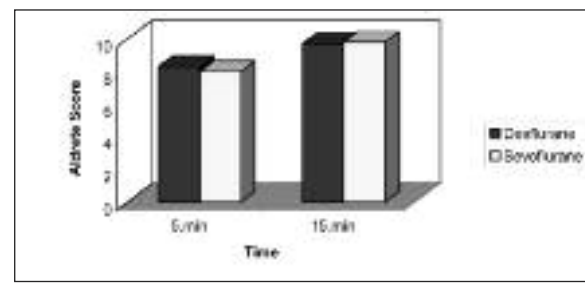

FIGURE 2: Proportion of patients who achieved an Aldrete recovery score of 10.

DISCUSSION

Inhalation anesthetics are popular maintenance agents during thoracic surgery, because they are

FIGURE 3: Time from the cessation of anesthesia to opening eyes, squeezing hand or extubation of the trachea.

bronchodilators and can be titrated rapidly. There have been several reports describing that inhalation anesthetics inhibit HPV and induce hypoxemia during OLV. In this study, the effects of desflurane and sevoflurane on oxygenation, shunt fraction, systemic and pulmonary hemodynamics were similar during OLV. The period between the cessation of anesthetic inhalation and squeezing hand and extubation was shorter in the desflurane group. The remaining recovery characteristics of desflurane and sevoflurane groups were similar.

During OLV, the lung area involved in gas exchange decreases by 50%. There is an increase in intrapulmonary shunt and deterioration of arterial oxygenation. Hypoxic pulmonary vasoconstriction, which is an important defense mechanism against hypoxia, decreases the intrapulmonary shunt during OLV and thus makes the decrease in oxygenation less than expected. [5-8] There are many factors which change the intrapulmonary shunt and oxygenation by affecting HPV. Inhalational anesthetics are among these. In 1977, Bjertnaes was the first investigator who proposed that inhalational anesthetics inhibited HPV response. [9]

In isolated, perfused lung specimens, HPV was inhibited by sevoflurane and desflurane, which are the most common anesthetics in practice. Ishibe et al. compared the effects of sevoflurane and isoflurane in rabbit lungs and found that they had similar effects on HPV. [10] Both of the agents inhibited HPV and the inhibiting concentration for sevoflurane was determined as 1 MAC.

In vitro studies have shown that desflurane reduces HPV response as well. Loer et al showed the dose dependent inhibition of HPV by desflurane in rabbit lungs. [1] The concentration of desflurane and MAC needed to reduce blood flow by 50% were 14.5% and 1.6, respectively. In vitro studies show the effectiveness of HPV; however, clinical studies are more valuable than vitro studies, since they include all the factors (pH, PCO_2, temperature) that can affect oxygenation.

No specific HPV measurements could be made in our study because it was a clinical study. The factors that could confound the results were standardized in each group, so the intrapulmonary shunt fraction was attributed to their effects on HPV. For both groups, the shunt fraction values during OLV were significantly higher than those before and after OLV. Arterial oxygen pressure values, which indicate oxygenation decreased remarkably during OLV.

In a clinical study, Wang et al changed the initial isoflurane into sevoflurane and vice versa at 30 minutes of OLV. [11] When the results were compared, no significant difference was found in arterial oxygen pressure, heart rate and mean arterial pressure between the groups. Reports in the literature have stated that a 20-minute period is needed for the occurrence of HPV response. Accordingly, we assessed the values of PaO_2 and shunt after 20 minutes.

Abe et al compared the effects of isoflurane and sevoflurane on twenty patients who underwent lobectomy. [12] They reported that there were no significant differences between the groups in $PaCO_2$, PaO_2, SaO_2, PvO_2, SvO_2 values and hemodynamic parameters. They also reported that application of 4 cm H_2O positive end-expiratory pressure (PEEP) was effective in the regulation of arterial oxygenation. In our study, PaO_2 was never under critical value so no PEEP application was needed.

Beck et al studied the effects of sevoflurane and propofol on oxygenation and hemodynamic values during OLV. [13] In their clinical study, they found that the effect of sevoflurane on shunt fraction was similar to that of propofol at 1 MAC.

Pagel et al compared the effects of desflurane and isoflurane clinically. They concluded that both agents induced similar effects on systemic and hemodynamic changes and observed no difference

between desflurane and isoflurane values during OLV.[14]

Wang et al compared the effects of desflurane and isoflurane on arterial oxygenation, heart rate and mean arterial pressure. [15] After 30 minutes of OLV the mean arterial pressure decreased considerably but no difference between the groups was detected. They found that desflurane caused no change in the cardiac output without causing a marked hypertension and tachycardia. In our study, we determined no hypertension or tachycardia and we believe that this can be attributable to the use of remifentanil and the use of desflurane at the fixed 0.5-1 MAC.

The only study in the literature in which desflurane and sevoflurane were compared is an experimental animal study by Lesitsky et al. [16] They studied the effects of these two agents on pulmonary vasoconstriction in awake animals. Both in anesthetized and in awake dogs, they determined that the degree of HPV was related to the pulmonary blood flow and that the HPV which occurred in awake animals was maintained by desflurane and sevoflurane anesthesia. They concluded that HPV interference was not a general feature of inhalational anesthetics.

In our study, during OLV a decrease in arterial oxygen pressure, a decrease in arterial oxygen saturation and an increase in intrapulmonary shunt fraction were observed but the values did not differ between the groups. In agreement with all the clinical studies discussed above, no significant differences were observed in heart rate, mean arterial pressure, central venous pressure or pulmonary arterial pressure between the groups.

In our clinical study, recovery times were also compared and the extubation and hand squeezing times in the desflurane group were significantly shorter than those in the sevoflurane group were. No significant difference was detected in the time of eye opening. The results were similar to those of the study by Dupont et al, in which sevoflurane, desflurane and isoflurane were compared in patients undergoing pulmonary surgery.[17] In their study, the extubation time in the desflurane group was two-fold shorter than that in the sevoflurane group. However, in our study, although the extubation time in the desflurane group was considerably shorter, the difference was not so great.

During the extubation phase, recovery was significantly faster in the desflurane group than in the sevoflurane group; however, there were no significant differences in the recovery criteria. In their study, Dupont et al stated that to keep the mean arterial pressure at the level of 20%, 0.9 MAC sevoflurane and 0.6 MAC desflurane were required and the delayed recovery due to sevoflurane could be the result of its concentration.[17] In our study, all inhalation agents were applied at a fixed concentration of 0.5-1 MAC. No statistical difference was identified between the dosages of remifentanil used for either group.

Dupont et al found that the Aldrete score at 5 minutes was high in the desflurane group. [17] They also determined that desflurane group scored better in stating name, date of birth and naming three objects at 5 minutes but the scores were similar at 15 minutes. As for our study, no significant difference was found between the 5 and the 15 minutes scores.

The 5 minutes scores were similar in many studies. Song et al administered 1 MAC sevoflurane or desflurane with propofol in N_2O/O_2 mixture and established that recovery after anesthesia, the time up to tracheal extubation and orientation were significantly shorter in desflurane than those in sevoflurane. [18] Additionally, when compared with propofol administered patients, sevoflurane or desflurane administered patients were delivered to the recovery room with criteria which were very close to the discharge criteria. Three minutes after cessation of the anesthetic agent administration, desflurane group achieved higher Aldrete scores compared to the sevoflurane group. No significant difference was identified between the 5 minutes scores of the groups and the 5 minutes scores in our study were similar to theirs. In two other studies whose 5 minutes scores were similar, the recovery characteristics of sevoflurane and desflurane were compared in patients undergoing outpatient surgery and no significant difference could be detected.[19,20]

Turan et al determined that recovery from desflurane anesthesia was faster than sevoflurane anesthesia. They reported that aminophylline shortened recovery from these inhalational agents and that this might be an advantage in geriatric patients.[21] Welborn et al compared the recovery characteristics of sevoflurane, halothane and desflurane in children.[22] Although they observed a shorter extubation time and faster orientation with desflurane, no difference was detected between the agents in leaving the recovery room. Both their and our recovery scores were similar.

In our study, we compared the effects of the two most commonly used anesthetic agents on the intrapulmonary shunt fraction and arterial oxygenation. No difference was observed between the agents in causing an increase in intrapulmonary shunt or a decrease in arterial oxygenation. No decrease below the critical level was observed and no treatment (CPAP, PEEP) was practiced to increase the arterial oxygen pressure values. Hemodynamic parameters in both patient groups were stable and no significant difference was detected. In this study, which also compared the recovery times, the extubation and hand-squeezing times of the desflurane group were considerably shorter than those of the sevoflurane group were, but there were no significant differences between the 5 and 15 minutes recovery scores. In summary, we suggest that desflurane and sevoflurane can be used safely in pulmonary surgery.

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