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Comparison of Effects of Low-Flow Sevoflurane and Desflurane Anesthesia on Neutrophil and T-Cell Populations

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ABSTRACT

BACKGROUND: Numerous transient effects of anesthesia on postoperative immune status have been documented in the literature.

OBJECTIVE: This study was performed to test the hypothesis that the effects on neutrophil and T-cell populations differ with use of low-flow sevoflurane- and desflurane-induced anesthesia during abdominal surgery.

METHODS: Fifty adult patients (American Society of Anesthesiologists physical status I or II) aged 20 to 60 years were recruited for the study. Patients were randomly assigned to one of two study groups. Anesthesia was induced using fentanyl, propofol, and vecuronium. After intubation, patients in group 1 received sevoflurane, oxygen, and nitrous oxide at a flow rate of 6 L/min, and those in group 2 received desflurane, oxygen, and nitrous oxide at a flow rate of 6 L/min. Ten minutes after induction of anesthesia, the flow rate was decreased to 1 L/min in both groups. Total leukocyte, lymphocyte, and neutrophil counts, percentage of T helper lymphocytes (CD4), cytotoxic T lymphocytes (CD8), natural killer lymphocytes, and active T lymphocyte, CD4/CD8 ratio, and plasma cortisol values were assessed before and at 2 and 24 hours after induction of anesthesia.

RESULTS: In the desflurane group, at 2 hours after induction of anesthesia, a significant decrease was observed in the lymphocyte count, percentage of CD4 cells, and CD4/CD8 ratio, and a significant increase was noted in the neutrophil count and percentage of CD8 cells ($P < 0.05$). At 24 hours after induction of anesthesia, a significant increase was observed in the leukocyte and neutrophil counts, percentage of CD4 cells, and CD4/CD8 ratio ($P < 0.05$). There was no change in the other parameters studied. In the sevoflurane group, a significant decrease was observed in the lymphocyte count and percentage of natural killer cells. In addition, a significant increase was noted in the leukocyte and neutrophil counts at 24 hours after induction of anesthesia ($P < 0.01$). The increase in the neutrophil count in the desflurane group compared with that in the sevoflurane group was statistically significant ($P < 0.05$).

CONCLUSIONS: With use of the low-flow anesthesia technique, compared with desflurane, sevoflurane exerts minimal effects on neutrophil and T-cell populations,

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which supports our hypothesis. (*Curr Ther Res Clin Exp.* 2012;73:41–51)

KEY WORDS: desflurane, low-flow anesthetic, neutrophil, sevoflurane, T cell.

INTRODUCTION

Numerous transient effects of anesthesia on postoperative immune status have been documented in the literature.[1–6] Because infections are a major cause of perioperative morbidity and mortality, prevention of instability of the immune system is important. The extent of the immunologic response parallels the effects of the surgical trauma and anesthesia.[2,3] This impairment increases the risk of developing postoperative complications such as systemic inflammatory response syndrome, sepsis, and multiple-organ failure.[2] Responsible mechanisms include lymphopenia, neutrophilia, suppression of natural killer (NK) and T-lymphocyte subpopulations, dysfunction of NK, T, and B lymphocytes, blastogenic unresponsiveness to mitogenic agents, antibody-mediated lymphocyte cytotoxicity, and delayed hypersensitivity skin reactions. Supplemental drugs administered preoperatively and blood transfusions may result in changes in T-lymphocyte subpopulations.[4]

The cell-mediated immune response is executed by cytotoxic T lymphoctes and helper T cells with $CD8^+$ and $CD4^+$ surface markers, respectively. B lymphocytes are unique immune system cells with $CD9^+$ surface markers, and are responsible for antibody production. Natural killer cells, which contain intracellular granules, produce direct cellular cytotoxicity. CD16 and CD56 molecules are used to identify NK cells with the $CD2^+CD3^-$ phenotype, whereas the CD25 surface marker is unique to activated T lymphocytes.[5]

Hemodynamic, endocrine, and hematologic interactions of the common volatile anesthetic agents have been well documented.[4–7] Cell-mediated immunity is suppressed to a greater extent than is the humoral immune response.[4,8,9]

In the last decade, low-flow anesthetic delivery has been widely used in adult patients. This anesthesia technique significantly reduces waste of expensive volatile anesthetic agents and prevents air pollution.

Compared with all previously used volatile anesthetic agents, sevoflurane and desflurane are less soluble in blood and tissues.[10] Sevoflurane suppresses cell-mediated immunity to a lesser extent than the other agents do.[11,12] Desflurane is considered the ideal agent for delivery of low-flow anesthetic because of its short wash-in period and, thus, its rapidly stabilizing alveolar concentration.[13] Because the concentration in inspired gas can be titrated easily and rapidly, Hargasser et al[14] have suggested that desflurane is the volatile agent of choice for delivery of low-flow inhalation anesthetic.The effects of desflurane and the low-flow anesthesia technique, however, have not yet been investigated. The objective of the present study was to investigate and compare the effects of desflurane and sevoflurane on neutrophil and T-cell populations.

METHODS

Consent for this study was obtained from the ethics committee at our institution. Fifty patients were recruited for the study. Inclusion criteria were fitness grade I or II using the American Society of Anesthesiologists physical status classification, age 20 to 60 years, and scheduled elective upper or lower abdominal surgery. Patients were randomly assigned to one of two treatment groups using a computer-generated random number table (MedCalc version 10.1; MedCalc Software BVBA, Meriakerke, Belgium). Exclusion criteria were presence of diabetes, renal or hepatic insufficiency, malignant disease, cardiac disease, respiratory disorders, recent infections, or any endocrine or metabolic dysfunction, history of taking immune system–modulating drugs, and abnormal routine laboratory test results.

On the day before surgery, patients were informed about the procedure, and all gave written consent. Patients were treated equally except for the inhalation anesthetic they were given. No premedication was administered. Electrocardiography, pulse rate, peripheral oxygen saturation, systolic arterial pressure, diastolic arterial pressure, and mean arterial pressure were all recorded. Inspired and expired oxygen fractions, nitrous oxide (N_2O), and end-tidal carbon dioxide values were continuously monitored. Before induction of anesthesia, all patients received pure oxygen for 5 minutes. For induction, 1 to 2 mg propofol and 1 to 3 μg/kg fentanyl were given intravenously until paralysis of the eyelash reflex, followed by intravenous administration of 0.1 mg/kg vecuronium; then orotracheal intubation was performed. For maintenance, the volatile agents sevoflurane (Sevorane; Abbott Laboratories, Abbott Park, Illinois) and desflurane (Suprane; Baxter Healthcare Corp., Deerfield, Illinois) were used in groups 1 and 2, respectively. Ventilation parameters were adjusted so that end-tidal carbon dioxide was 30 to 40 mm Hg (tidal volume, 7 to 10 mL/kg, and respiratory frequency, 12 breaths/min).

In group 1 (n = 25), at the beginning of anesthesia, 4 L/min N_2O, 2 L/min oxygen (O_2), and 2% to 2.5% sevoflurane in combination was given for 10 minutes.[15,16] Then 50%O_2, 50% N_2O, and 2.5% to 3 % sevoflurane was given as 1.5 minimal alveolar concentration total fresh gas flow at 1 L/min using a vaporizer (model 19.3; Dräger Medical GmbH, Lübeck, Germany).

In group 2 (n = 25), at the beginning of anesthesia, 4 L/min N_2O, 2 L/min O_2, and 4% to 6% desfluran in combination was given for 10 minutes.[15,16] Then 50%O_2, 50% N_2O, and 3% to 5% desflurane was given as 1 minimal alveolar concentration total fresh gas flow at 1 L/min using a vaporizer (Devapor; Dräger Medical GmbH).

Systolic, diastolic, and mean arterial pressures, pulse rate, peripheral O_2 saturation, and end-tidal gas values were measured before induction of anesthesia and during surgery. After induction, these values were recorded every 5 minutes for the first 30 minutes of the operation, every 15 minutes to minute 90 of the operation, and every half hour until completion of the operation. Volatile anesthesic concentrations were also recorded in the samples obtained via a side-stream method and using infrared analysis.[9] In the respiratory circuit, peak levels of sevoflurane and desflurane were set to 3% to 3.5% and 8% to 10%, respectively. Opioids are well-known immune system

modulators.[16] Fentanyl, propofol, and vecuronium consumption was assessed intraoperatively.

In the termination phase of anesthesia, the vaporizer was turned off 10 to 15 minutes before the end of surgery, and low flow (50% O_2 and 50% N_2O) was maintained at a rate of 1 L/min. With the recovery of spontaneous ventilation, 100% O_2 at a rate of 5 L/min for 5 to 10 minutes was administered before extubation.[17] Residual neuromuscular blockade was reversed via administration of 0.06 mg/kg neostigmine and 0.02 mg/kg atropine. Blood loss and transfusions were recorded intraoperatively. Calculation of blood loss was based on the amount measured in the suction drain and the weight gain of the sponges. Patients who lost more than 500 mL blood and who received transfusions were excluded from the study. Postoperatively, all patients in both groups were observed for 24 hours to record hypertension, hypotension, bradycardia, tachycardia, and hypoxemia (defined as peripheral o_2 saturation $\leq$90%). A vital monitor (model PM 8040) and anesthetic device for mechanical ventilation (Cato M33010) (both from Dräger GmbH) were used during the study.

Thirty minutes before and at 2 and 24 hours after induction of anesthesia, 3 mL peripheral venous blood was obtained from each patient and preserved in EDTA tubes (Vacutainer; BD Biosciences, Franklin Lakes, New Jersey). Simultaneously, 3 mL blood in conventional tubes was delivered to the laboratory in 20 minutes for determination of cortisol concentration. Total leukocyte, lymphocyte, and neutrophil counts, percentage of total T lymphocytes (CD3), B lymphocytes (CD19), helper T lymphocytes (CD4), cytotoxic T lymphocytes (CD8), NK lymphoctes (CD16, 56), and activated T lymphocytes (CD25), the CD4/CD8 ratio, and plasma cortisol concentration were documented. Initial values were considered as those obtained 30 minutes before induction of anesthesia.

An HMX device (Beckman Coulter, Inc., Fullerton, California) was used for the leukocyte, lymphocyte, and neutrophil counts. For determination of the lymphocyte subgroups, 100 μL blood sample was mixed with 15 μL monoclonal antibodies. After incubation for 30 minutes, lysing solution was added, and the mixture was incubated for another 10 minutes in the dark, and subsequently was centrifuged at 1200 rpm for 10 minutes. The precipitate was treated with phosphate-buffered saline solution and centrifuged at 1200 rpm for another 10 minutes. Cytometry (FACSort Flow Cytometer; BD Biosciences) was used to define T-lymphocyte subgroups. Two types of antibody stains, fluorescein isothiocyanate (FITC) and phycoerythrin (PE), were used: for the lymphocyte subgroups, CD3 FITC, CD4 PE, CD8 PE, CD 19 PE, CD25 FITC, and CD 16/56 PE antibodies, and for the control group, IgG1 and IgG2a monoclonal antibodies. Plasma cortisol concentration was determined using a radioimmunoassay kit (Immunotech; Beckman Coulter, Inc.).

Dependent variables were compared using the paired-sample *t* test, and independent groups using the *t* test. Continuous variables are given as mean (SD), and categorical variables as frequency. Statistical significance was considered at $P < 0.05$. Statistical analyses were performed using SPSS for Windows (version 10.0; SPSS, Inc., Chicago, Illinois).

Table I. Demographic data of patients receiving low-flow anesthetic using desflurane or sevoflurane.*

Variable	Group 1 Sevoflurane (n = 25)	Group 2 Desflurane (n = 25)
Age, y	37.22 (11.2)	38.90 (10.3)
Sex, M/F	13/12	12/13
Height, cm	167.73 (6.81)	166.23 (6.55)
Weight, kg	73.53 (11.43)	72.12 (11.21)
ASA physical status I/II	16/9	17/8
Surgery, No. of patients		
Cholecystectomy	8	7
Ureterolithotomy	5	6
Pyelolithotomy	7	8
Hysterectomy	5	4
Duration of surgery, min	76.74 (30.12)	79.63 (31.12)
Duration of anesthesia, min	88.91 (33.53)	90.44 (33.63)
Blood loss, mL	300.55 (85.65)	285.45 (95.53)

ASA, American Society of Anesthesiologists.
*Unless otherwise indicated, values are given as mean (SD).

RESULTS

No statistical significance was noted between the demographic properties, operative time, duration of anesthesia, and perioperative blood loss in the two groups (Table I). Perioperatively, no hypertension, hypotension, bradycardia, or tachycardia was recorded according to pulse rate and mean arterial pressure. No patient received a blood transfusion or had blood loss more than 500 mL; therefore, no patient was excluded from the study. No patient was receiving ephedrine, β-adrenergic blockers, or antihypertensive drugs. End-tidal sevoflurane and desflurane concentrations did not differ significantly within groups. Inspired total gas was maintained at greater than 92%, and inspired O_2 concentration did not decrease to less than 30%. No loss occurred in total circulating gas volume. Total fentanyl, propofol, and vecuronium consumption was similar between groups ($P > 0.05$).

In both groups, mean (SD) total leukocyte counts at 2 and 24 hours after induction of anesthesia (9.43 [3.42] $\times 10^{-3}/\mu$L vs 9.87 [2.42] $\times 10^{-3}/\mu$L in group 1, and 11.83 [3.91] $\times 10^{-3}/\mu$L vs 12.42 [5.76] $\times 10^{-3}/\mu$L in group 2) were significantly different within groups ($P < 0.01$). Similarly, neutrophil counts at 2 and 24 hours after induction (6.65 [3.32] $\times 10^{-3}/\mu$L vs 7.14 [2.13] $\times 10^{-3}/\mu$L in group 1, and 8.27 [3.9] $\times 10^{-3}/\mu$L vs 9.7 [5.5] $\times 10^{-3}/\mu$L in group 2) were significantly different within groups ($P < 0.01$). Neurophil count at postoperative hour 24 showed a significant increase in group 2 (7.14 [2.13] $\times 10^{-3}/\mu$L) compared with group 1 (9.7 [5.5] $\times 10^{-3}/\mu$L) ($P < 0.05$). At 2 hours after induction, a significant increase in lymphocyte count was noted in group 2 (1.81 [0.62] $\times 10^{-3}/\mu$L vs 1.91 [0.73] $\times$

Table II. Total leukocyte, neutrophil, and lymphocyte counts and plasma cortisol values.*

	Time Relative to Induction of Anesthesia					
	Group 1 Sevoflurane			Group 2 Desflurane		
Variable	30 Minutes Before	2 Hours After	24 Hours After	30 Minutes Before	2 Hours After	24 Hours After
Leukocytes, $10^{-3}/\mu L$	7.12 (2.33)	9.43 (3.42)†	9.87 (2.42)†	7.36 (2.12)	11.83 (3.91)†	12.42 (5.76)†
Neutrophils, $10^{-3}/\mu L$	4.33 (2.45)	6.65 (3.32)†	7.14 (2.13)†,‡	4.31 (1.96)	8.27 (3.9)†	9.7 (5.5)†,‡
Lymphocytes, $10^{-3}/\mu L$)	1.81 (0.62)§	1.91 (0.73)†,§	1.37 (0.42)†,§	2.28 (0.61)	2.56 (0.71)†,‡,§	1.63 (0.51)†
Cortısol, $\mu g/dL$	16.33 (5.96)†	25.74 (11.23)†	15.78 (7.12)	17.62 (3.63)†,§	25.81 (4.83)†	13.45 (7.87)§

*Values are given as mean (SD).
†$P < 0.01$, compared with initial values within groups.
‡$P < 0.05$, compared with values between groups.
§$P < 0.05$, compared with initial values within groups.

$10^{-3}/\mu L$) ($P < 0.05$). In addition, there was a significant increase in the lymphocyte count in group 2 (2.56 [0.71] $\times$ $10^{-3}/\mu L$) when compared with group 1 (1.91 [0.73] $\times$ $10^{-3}/\mu L$) ($P < 0.05$). At 24 hours, a significant decrease in both groups was noted (1.91 [0.73] $\times$ $10^{-3}/\mu L$ vs 1.37 [0.42] $\times$ $10^{-3}/\mu L$ in group 1, and 2.56 [0.71] $\times$ $10^{-3}/\mu L$ vs 1.63 [0.51] $\times$ $10^{-3}/\mu L$ in group 2) ($P < 0.01$) (Table II).

Cortisol concentrations were elevated in both groups at 2 hours after induction of anesthesia (16.33 [5.96] μg/dL vs 25.74 [11.23] μg/dL in group 1, and 17.62 [3.63] μg/dL vs 25.81 [4.83] μg/dL in group 2) ($P < 0.01$). At 24 hours, values returned to baseline preanesthesia levels in group 1, whereas a significant decrease in preoperative baseline levels was observed in group 2 (13.45 [7.87] μg/dL vs17.62 [3.63] μg/dL) ($P < 0.05$) (Table II).

At 24 hours after surgery, CD19 rates were significantly elevated in both groups compared with rates at 2 hours (13.73% [4.61%] vs 10.72% [4.31%] in group 1, and 13.12% [4.92%] vs 9.12% [4.92%] in group 2) ($P < 0.01$) (Table III).

The percentage of CD4 cells did not change in group 1. However, in group 1, a significant decrease at 2 hours (31.93% [6.65%]) ($P < 0.05$) and a significant increase at 24 hours was documented after induction of anesthesia (39.52% [8.01%]) when compared with baseline levels (36.41% [6.92%]) ($P < 0.01$). In group 1, the percentage of CD8 cells was similar, whereas in group 2, there was a significant increase at the 2 hours after induction (26.31% [8.35%] vs 28.52% [8.13%) ($P < 0.05$). In group 1, the CD4/CD8 ratio showed no change at any time, whereas in group 2, there was a significant decrease at 2 hours (1.22 [0.43]) ($P < 0.01$) and an increase over baseline at 2 hours and 24 hours after induction (1.51 [0.52] and 1.82 [0.72], respectively) ($P < 0.05$).

In both groups, the percentage of CD16 and CD56 cells showed a statistically insignificant increase at 2 hours. However, at 24 hours, the percentage of CD16 cells had declined significantly when compared with baseline (17.76% [9.42%] vs 12.86% [6.54%] in group 1, and 17.12% [7.42%] vs 11.42% [6.03%] in group 2) ($P < 0.01$). Similarly, at 24 hours, the percentage of CD56 cells had declined significantly

Table III. Total B (CD19), T (CD3), T helper (CD4), cytotoxic T (CD8), natural killer (CD16,56), and active T (CD25) lymphocyte values and CD4/CD8 ratio.*

	Time Relative to Induction of Anesthesia					
	Group 1 Sevoflurane			Group 2 Desflurane		
Variable	30 Minutes Before	2 Hours After	24 Hours After	30 Minutes Before	2 Hours After	24 Hours After
CD19	10.21 (2.82)	10.72 (4.31)†	13.73 (4.61)†	9.42 (3.61)	9.12 (4.92)†	13.12 (4.92)†
CD3	62.21 (9.41)	62.81 (5.56)	65.63 (7.74)	66.21 (7.72)	65.42 (8.33)	68.94 (6.62)
CD4	35.77 (8.63)	35.01 (9.42)	35.22 (9.55)	36.41 (6.92)†,‡	31.93 (6.65)†	39.52 (8.01)‡
CD8	24.38 (6.13)	26.14 (9.43)	24.35 (7.23)	26.31 (8.35)‡	28.52 (8.13)‡	24.42 (7.53)
CD16	17.76 (9.42)†	18.22 (8.43)	12.86 (6.54)†	17.12 (7.42)†	18.92 (8.11)	11.42 (6.03)†
CD56	24.63 (8.65)†	27.62 (8.35)	19.13 (7.42)†	24.31 (6.73)	28.12 (7.31)	16.23 (6.24)†
CD25	11.96 (4.82)	10.23 (3.74)	12.21 (4.52)	10.41 (4.82)	9.94 (4.04)	12.12 (4.73)
CD4/8 ratio	1.61 (0.72)	1.52 (0.81)	1.64 (0.82)	1.51 (0.52)†,‡	1.22 (0.43)†	1.82 (0.72)‡

*Values for the various lymphocytes are given as percent, and for time and CD4/8 ratio are given as mean (SD).
†$P < 0.05$, compared with initial values within groups.
‡$P < 0.01$, compared with initial values within groups.

when compared with baseline (24.63% [8.65%] vs 19.13% [7.42%] in group 1, and 24.31% [6.73%] vs 16.23% [6.24%] in group 2) ($P < 0.01$) (Table III).

Postoperatively, systolic, diastolic, and mean arterial pressures, pulse rate, and peripheral O_2 saturation values did not change markedly. No significant change was observed in O_2 saturation levels in the two groups ($P > 0.05$, data not shown). Postoperative nausea, vomiting, pruritus, and sedation were not significantly different between the groups. No patient in either group was severely sedated, and no instances of respiratory depression were observed.

DISCUSSION

Recently, studies of the effects of anesthetic agents on the immune system have gained great popularity. Hemodynamic, endocrine, and hematologic interactions of the common volatile anesthetic agents have been well documented,[4,6,7] and cell-mediated immunity is suppressed to a greater extent than is the humoral immune response.[4,8,9] Anesthesia leads to inhibition of cell-mediated immunity, which is temporary and reversible but with the considerable postoperative complications of morbidity and mortality.[18] Sevoflurane interferes the least with immunity when used with the high-flow fresh gas anesthetic technique.[6,12,19] Effects of desflurane on the immune response have been rarely investigated in the literature. Low-flow anesthesia has also been widely used in adult patients in the last decade because of economic and ecologic concerns. However, we could not find any study in the literature reporting use of desflurane or sevoflurane with the low-flow gas anesthesia technique.

In a recent study, it was reported that reduced numbers of CD8 cells due to surgical stress was most likely responsible for the increased risk of infection at 24 hours after surgery.[20] Hori et al[21] used 66% N_2O plus 33% O_2 and 0.5% to 1.0 % enflurane in a study in patients who had undergone neurosurgery. They concluded

that CD3 and CD4 cells and the CD4/CD8 ratio decreased to less than the preanesthesia level at 1 to 2 hours after surgical incision, and CD8 and NK subpopulations showed a tendency to increase. In the control group who underwent minor surgery using the same anesthesia technique, however, no remarkable change was noted. Our study results seem to parallel those of Hori et al[21] insofar as the CD4 and CD8 cells and the CD4/CD8 ratio at 2 hours after incision. The number of CD4 cells, decrease in the CD4/CD8 ratio, and increase in percentage of CD8 cells were significant at 2 hours in the desflurane group, whereas the reverse was true in the sevoflurane group. In the present study, immune suppression at 2 hours was similar to that reported by Hori et al[21]; however, this suppression was minimal with sevoflurane at within-group analysis.

A limited number of studies in humans are available that document long-term anesthesia without surgery. In in vitro experiments using volatile anesthetic agents, the number of peripheral lymphocytes tended to decrease due to apoptosis.[22] However, alterations in the concentration of the agent and duration of anesthesia may lead to different conclusions in clinical practice.

Volatile agents impose variable and complicated effects on lymphocytes and neutrophils. In an in vitro study conducted by Hiroshi et al,[8] isoflurane, compared with sevoflurane, caused a higher percentage of apoptotic lymphocytes. Delogu et al[20] reported an increased incidence of apoptosis of CD4 and CD8 lymphocytes at 24 hours after administration of isoflurane and fentanyl anesthesia.

Short-term anesthesia using a high concentration of sevoflurane increases lymphocytes and decreases neutrophils.[11] Dagan and Segal[23] documented that 2% to 6% sevoflurane caused peripheral lymphocyte apoptosis that was dose and time dependent. In the same study, N_2O was proved to block neutrophil activity and concentration. In vivo data show that anesthesia and surgery tend to increase the number of circulating neutrophils.[24] In particular, surgical procedures performed with the patient under general anesthesia affect the immune-competent cell concentrations to a greater extent. The change usually is manifested as lymphopenia and neutrophilia.[21] Suppression of lymphocytes is proportional to the dosage of the anesthetic agent and the duration of anesthesia.[25]

In the present study, the circulating neutrophil count was elevated at 2 and 24 hours after induction of anesthesia in both the sevoflurane and desflurane groups. At 2 hours, lymphocytes were also increased in both groups, but significantly only in the desflurane group ($P < 0.05$). At 24 hours, the lymphocyte count declined significantly in both groups when compared with initial values. Our results support those of Rem et al,[22] Dagan and Segal,[23] and Perttila and Salo.[24]

Sevoflurane proved nongenotoxic and had a minimal effect on immunity in a study in a pediatric population who received short-term 2.5% to 3% sevoflurane anesthesia in 3 L of fresh gas.[26] In our study, we were convinced that longer sevoflurane anesthesia (89 minutes) using a low-flow technique may be safe, with minimal immunologic adverse effects.

In an experimental study using sevoflurane, a 3% concentration in 6 L/min fresh gas flow and a 40-minute single application per week for 3 weeks resulted in a

significant decrease in peripheral lymphocyte and leukocyte counts. In the same study, sevoflurane had no effect on the percentage of lymphocyte subpopulations in the spleen leukocyte composition.[9]

In a similar study, Puig et al[27] reported a significant increase in lymphocytes, decreased CD19 ratio in spleen composition, and increased CD4 cell count. The effect of sevoflurane on T lymphocytes in that study corroborates our results.

In addition to the volatile agents, intravenously administered anesthetics may have immunosuppressive interactions at high dosages and lengthy applications, which may be secondary to increased cortisol concentration, blockade of NK cell activity, decreased CD4 cell count, and/or lymphocyte proliferation.[28,29]

Costa et al[4] documented a perioperative increase in cortisol concentration and decreased CD4 cell counts during surgery with the patient under general anesthesia. This explains the postoperative immunosuppression. CD8 and CD16 cells were not affected to the same degree. We measured the cortisol concentration to evaluate the role of neuroendocrine response on immunity. Our study was in concordance with the relevant studies in the literature.

The CD4/CD8 ratio is a widely used measure of immunosuppression. Our levels were similar to those of Hori et al[21] and Costa et al.[4] However, in the sevoflurane group, CD4 and CD8 cell counts and the CD4/CD8 ratio showed little difference when compared with the desflurane group.

It should be noted that due to methodologic imperfections such as lack of blinding and preliminary nature, the results of our study may be limited.

CONCLUSIONS

In this preliminary report of the effects of the low-flow anesthesia technique on neutrophil and T-cell populations during abdominal surgery, sevoflurane seemed to have less effect than did desflurane. There is an evident need for further studies to assess the clinical significance of these effects on the immune system in terms of infection and length of hospital stay.

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CONFLICTS OF INTEREST

The authors have indicated that they have no conflicts of interest regarding the content of this article.

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