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Effect of Intravenous Propofol and Inhaled Sevoflurane Anesthesia on Postoperative Spirometric Indices: A Randomized Controlled Trial

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Abstract

Background: Anesthetic drugs may directly or indirectly affect respiratory function. We investigated the effects of intravenous propofol and inhaled sevoflurane anesthesia on postoperative spirometric indices in patients undergoing inguinal herniorrhaphy surgery.

Methods: We randomly assigned 111 patients, aged 18 - 65 years, undergoing inguinal herniorrhaphy surgery, to receive either intravenous propofol or inhaled sevoflurane. Forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), and FEV1/FVC were measured before and after anesthesia. Comparisons between the two groups were made using the *t*-test and ANOVA.

Results: There were no significant differences between the two groups in terms of age, sex, height, body weight, BMI, pain score, ASA class, operation duration, and received analgesics. The FEV1 and FVC values significantly decreased after the operation in the sevoflurane group.

Conclusions: Both intravenous propofol and inhaled sevoflurane can decrease postoperative spirometry parameters. However, it seems that patients receiving propofol have less decreased spirometric indices.

Keywords: Propofol, Sevoflurane, Respiratory Function Tests, Spirometry

1. Background

The induction of general anesthesia leads to changes in the respiratory system including the reduction of tidal volume (TV), forced expiratory volume in the first second (FEV1), and functional residual capacity (FRC) (1-3). Moreover, decreases in respiratory parameters have been shown after awakening from general anesthesia, especially in patients undergone intra-abdominal surgery (4). Researchers investigating postoperative pulmonary function have focused on the effects of surgery type (5-9), anesthesia type (10), positioning during surgery (11, 12), and some anesthetic techniques, interventions, and drugs (13-16).

Propofol that is commonly used in total intravenous anesthesia (TIVA) has anti-oxidant and inflammatory inhibition properties (17-19). It is known that TIVA can decrease postoperative nausea and vomiting (PONV) (20) with little effects on pulmonary functions (21).

Sevoflurane is an inhaled anesthetic with no irritation of the upper respiratory tract and low inhibition of respiration (22). Erturk suggests that sevoflurane may offer protection against reperfusion injury after one-lung ventilation in thoracic surgery (23). However, some studies have shown that inhalational anesthesia may cause perioperative pulmonary edema, thus affecting oxygen diffusion function (24) and it may inhibit or decrease the synthesis of pulmonary surfactants (25).

Some researchers have preferred TIVA to inhalational anesthesia for the prevention of PONV or chronic pain relief after anesthesia (20) while others found no significant differences between propofol-based TIVA and inhalational sevoflurane anesthesia in terms of postoperative pain, PONV, narcotic administration, and recovery time (17). Mensil et al. in a study on ICU patients concluded that long-term sedation using inhaled sevoflurane was safer and more effective than intravenous propofol, as it significantly reduced wake-up and extubation times and increased awakening quality (26).

2. Objectives

In the current study, we evaluated the effects of intravenous propofol and inhaled sevoflurane on postoperative spirometry indices in patients undergoing inguinal herniorrhaphy surgery. The patients in the two groups were matched for position during surgery, premedication, intubation, mechanical ventilation, and received analgesics.

3. Methods

After obtaining the ethics committee approval and patient informed consent, a double-blind randomized controlled trial was carried out on 111 patients aged between 18 and 65 with ASA class I or II, undergoing inguinal herniorrhaphy surgery at Naqavi University Hospital in Kashan, Iran, in 2018. Patients with severe cardiovascular diseases, CHF, COPD, chest deformity, drug abuse, BMI > 35, and history of anticonvulsant agent consumption were excluded from the study. Considering a 95% confidence interval, 80% power, and based on a similar study (27), the minimum sample size in each group was calculated as 55 patients. Using a permuted block randomization, the enrolled patients were divided into two groups of propofol and sevoflurane.

A standard spirometry test was done for all patients by a trained technician prior to the operation. The test was done at least three times for each patient and the best measurement was recorded. Routine monitoring consisted of pulse oximetry, NIBP, ECG, and capnography. All patients were placed in the supine position during the surgery. Also, the surgeon and the method of surgery were the same for all patients.

Anesthesia was induced with intravenous 2 μg/kg fentanyl, 2 mg midazolam, 2.5 mg/kg propofol, and 0.5 mg/kg atracurium. An endotracheal tube with suitable size and high-volume, low-pressure cuff was inserted for each patient. Anesthesia was maintained either with propofol 100 μg/kg/min (in one group) or with sevoflurane 2% - 2.5% (in the other group). Both groups received 30/70 % of the O_2/N_2O mixture during the operation. Mechanical ventilation was adjusted to achieve 35 - 45 mmHg of end-tidal carbon dioxide ($ETCO_2$) concentration. All patients received 30 mg intravenous ketorolac 15 minutes before the end of anesthesia for postoperative pain control. After the completion of the surgery, all anesthetic agents discontinued. When spontaneous respiration was observed, the residual block was reversed by neostigmine 0.04 mg/kg and atropine 0.02 mg/kg. Extubation was performed when the patient could open the eyes or lift the head for five seconds. After extubation, the patients were routinely transferred to the recovery room. The duration of surgery and any episode of laryngospasm, bronchospasm, or drop in SpO_2 were recorded. When the patient was completely alert, postoperative spirometry was done with the same technique and by the same technician who was blind to the type of intervention.

The data were analyzed by SPSS V. 16 software. The frequency, mean, and standard deviation were used to describe the data. To compare the two groups in terms of independent variables, the chi square test and Independent *t*-test were used for qualitative and quantitative data, respectively. The Independent *t*-test was also used to compare pain scores and operation duration between the two groups. The ANOVA test was used to determine differences between the groups. All P values were two-sided and $P < 0.05$ was considered statistically significant.

4. Results

Of 111 patients participating in the study, 56 patients were assigned to the propofol group and 55 patients were assigned to the sevoflurane group. No statistically significant differences were found between the two groups with respect to patient characteristics including sex, age, weight, height, BMI, ASA class, anesthesia time, pain score, and received analgesics (Table 1).

Postoperative FEV1 and FVC significantly decreased ($P = 0.03$ and $P = 0.02$, respectively) in the sevoflurane group while the change in postoperative FEV1/FVC was not significant ($P = 0.52$). In the propofol group, decreases in postoperative FEV1 and FVC were not statistically significant ($P = 0.179$); however, FEV1/FVC significantly decreased ($P = 0.004$) (Table 2).

5. Discussion

This study showed reductions in postoperative FVC and FEV1 with both TIVA and inhalational sevoflurane anesthesia. However, these reductions were significant only in patients who had received inhaled sevoflurane. Previous studies have also reported reductions in FVC and FEV1 with TIVA and inhalational anesthesia, but the degree of FVC postoperative reduction was larger following TIVA than following sevoflurane anesthesia (4). Some other studies did not find significant decreases in FEV1 (16, 28). The probable reason for this difference may be the position of patients. Our patients were in the supine position during the

Table 1. Demographic and Perioperative Variables[a]

Variables	Groups		P Value
	Propofol (N = 56)	Sevoflurane (N = 55)	
Sex			0.485
Male	47 (85.5)	49 (87.5)	
Female	8 (14.5)	7 (12.5)	
Age	43.75 ± 8.57	41.84 ± 11.31	0.32
Weight	72.64 ± 9.61	73.91 ± 10.44	0.58
Height	168.32 ± 7.06	170.96 ± 8.65	0.082
BMI	25.8 ± 4.39	25.41 ± 3.98	0.62
ASA classification			
Class I	36 (65.5)	40 (71.4)	
Class II	19 (34.5)	16 (28.6)	
Operation duration (min)	32.73 ± 5.34	34.11 ± 6.95	0.244
Pain score	2.71 ± 0.81	2.70 ± 0.87	0.973
Rescue analgesics (mg)	1.31 ± 1.67	1.11 ± 1.44	0.498

[a]Values are expressed as No. (%) or mean ± SD.

Table 2. Values of Pre- and Postoperative Spirometric Indices[a]

	FEV1	FVC	FEV1/FVC
Propofol (n = 56)			
Before	3.49 ± 0.61	4.25 ± 0.85	79.96 ± 1.71
After	3.44 ± 0.6	4.20 ± 0.82	80.17 ± 2.82
P value[b]	0.03	0.024	0.52
Sevoflurane (n = 55)			
Before	3.79 ± 0.53	4.63 ± 0.22	79.96 ± 2.53
After	3.74 ± 0.67	4.52 ± 0.68	79.11 ± 2.76
P value[b]	0.52	0.179	0.004
Postoperative changes			
Sevoflurane	0.05 ± 0.18	0.05 ± 0.16	-0.21 ± 2.40
Propofol	0.05 ± 0.59	0.11 ± 0.64	0.85 ± 2.14
P value[c]	0.464	0.967	0.464
P value[d] adjusted	0.976	0.536	0.976

[a]Values are expressed as mean ± SD.
[b]Paired *t*-test.
[c]Independent *t*-test.
[d]Effect of group in the analysis of covariance.

surgery. Some researchers showed that changes in lung function were greater in the prone position (4, 11).

Decreased respiratory capacity after TIVA or inhalational anesthesia could be the result of changes in the contractility of respiratory muscles. Zhang et al. argued that propofol had inhibitory effects on diaphragmatic contractility in patients during general anesthesia. They found a decline in twitch diaphragmatic pressure in humans following a single bolus of propofol 2 mg/kg (29). It seems that anesthetic-induced decreases in respiratory muscles strength, especially the loss of diaphragmatic tone, can cause the occurrence of atelectasis with subsequent changes in FVC (4).

The postoperative pulmonary function has shown to be affected by surgery type and location. The literature emphasizes that decreased lung function is more obvious following abdominal surgery than following the peripheral operation (30). In this study, we tried to minimize the effect of surgery type and confounders by selecting lower abdominal surgery, in the supine position, using LMA.

The administration of narcotic drugs, before, during, or after the operation may affect pulmonary function (28, 31). Therefore, we restricted the narcotic agents at the operation time and used non-narcotic agents as alternatives for pain control.

Propofol-based TIVA has been associated with improved recovery profile and lower costs compared to sevoflurane for office-based anesthesia. This resulted in shorter recovery room stay, earlier discharge, and more patient satisfaction (20).

Rothen et al. argued that the reduction in FVC or FEV1 was strongly related to the development of atelectasis after the induction of general anesthesia (32). Kim et al. conducted a randomized study to compare the effects of propofol and desflurane on postoperative spirometry in the elderly after knee surgery. They concluded that the reduction in FVC was greater after TIVA with propofol-remifentanil than after sevoflurane-fentanyl-nitrous oxide anesthesia. However, TIVA had advantages such as less PONV, cough, and bronchoconstriction than inhalational anesthesia (33). We found reductions in postoperative FEV1/FVC in patients who had received propofol-based TIVA for their herniorrhaphy surgery.

Although statistically significant, the observed changes in postoperative pulmonary function test results were in the normal range, without clinical importance. Decreased lung function and compliance of the respiratory system could be attributed to atelectasis (11).

5.1. Conclusions

Although the present study confirmed previous findings of reductions in post-anesthesia spirometric indices, it showed that patients receiving propofol had less decreased pulmonary function. However, further studies are needed to evaluate the pulmonary effects of different

anesthetics. Although the lung function is affected by decreased spirometric indices, the decision making on the selection of anesthesia depends on the particular clinical situation, other possible disorders, and surgical requirements and demands. This study showed that reductions in FVC and FEV following anesthesia were not very different using the two anesthetics. It seems that we should consider other factors such as the type of surgery, patient position, postoperative medications, and tracheal intubation with mechanical ventilation.

Footnotes

Authors' Contribution: Study concept and design: Mohammad Hajijafari and Leila Mehrzad; analysis and interpretation of data: Hossein Akbari and Fatemah Asgarian; drafting of the manuscript: Mohammad Hajijafari and Mohammad Hossein Ziloochi; critical revision of the manuscript for important intellectual content: Mohammad Hajijafari and Mohammad Hossein Ziloochi; statistical analysis: Hossein Akbari and Fatemah Asgarian.

Clinical Trial Registration Code: The clinical trial registration code was IRCT20180108038263N1 (https://en.irct.ir/trial/28756).

Conflict of Interests: The authors declare that there is no conflict of interest in this study.

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