

The Effect of Mechanical Ventilation Mode on Blood Loss in Endoscopic Sinus Surgery, A Randomized Clinical Study

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Abstract

Background: One of the important problem during endoscopic sinus surgery is bleeding. Bleeding causes disruption of the surgical field and damages the base of the skull and the eye cavity and consequently increases the duration of surgery vasopressor drugs may cause instability of hemodynamic, specially, in hypertension patients or patients with ischemic heart. Hypotension induction with various drugs causes to use a greater amount of anesthetic drugs and its side effects. Therefore, it is necessary to find a treatment for this complication. We decided to do a study on two modes of ventilation to reduce bleeding and increasing surgery satisfaction.

Methods: This investigation was performed on 134 patients. They were candidates of endoscopic sinus surgery 67 in volume mechanical ventilation group and 67 in pressure mechanical ventilation group. Patients were divided randomly in two groups and were recorded vital signs, complications, and bleeding. We used ANOVA and Chi-square tests to compare the data.

Results: The findings indicated that there is not significant difference between VCV and PCV in duration of surgery, intraoperative bleeding, heart rate, mean arterial blood pressure and surgeon satisfaction ($P>0.05$).

Conclusion: Various methods of ventilation did not show significant difference in bleeding and due to inconsistencies in the results of the current study and some studies and due to the limitations of the studies, further studies with higher numbers of specimens are recommended.

Keywords: Volume Mechanical Ventilation, Pressure Mechanical Ventilation, Bleeding, Endoscopic Sinus Surgery.

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INTRODUCTION

Rhinosinusitis is inflammation of the paranasal and nasal sinuses. It is diagnosed by clinical manifestations, CT scan changes and endoscopic findings (1). The best method of treatment is endoscopic sinus surgery (2). Endoscopic sinus surgery is an operation in which, with the help of an endoscope, only the areas of the nose and sinuses that are involved in the disease are operated and the sinus opening is widened, thus is prevented of damage to healthy tissues and instead of making an incision in the skin, the endoscope is inserted into the patient's nose, and the specialist is able to access all the sinuses, including of frontal sinuses, around the eyes, below the base of the skull, and in the jaw area.

Endoscopic sinus surgery is performed currently with minimal need for nasal dressing, mild pain, and a short

recovery period after surgery. By performing endoscopic surgery, the accumulated secretions in the sinuses are removed and the air flow through the nasal passages improves. Endoscopic sinus surgery is used to treat recurrent or chronic sinus infections and nasal polyps and to enhance the sense of smell caused by nasal obstruction, and it is the best choice among sinus surgery procedures. One of the most common problems during surgery is bleeding. Bleeding disrupts the surgical field and causes to increase damage to skull base and eye socket and increasing the surgery time because of multiple interrupts to suction and packing during surgery (3).

Today, we use various techniques to reduce bleeding of intraoperative and the desirability of surgical field. Mechanical ventilation increases the pressure of

intrathoracic and reduces the blood vessels return and increases the venous pressure and consequently increases the bleeding. Limited studies have shown that reducing of intrathoracic pressure in mechanical ventilation by maintaining of spontaneous respiration has been effective in reducing of bleeding versus controlled respiration (4, 5).

Due to the few studies have been performed in spinal surgery about the effect of respiratory ventilation mode on the reduction of intraoperative bleeding and the positive effects on the outcome of operation and to reduce transfusion of blood and blood products during surgery, we decided to evaluate the blood loss rate and the surgeon's satisfaction of the operation field using volume and pressure ventilation methods, also to compare the hemodynamic parameters and side effects of these two methods (6, 7). In Pressure-Controlled Ventilation (PCV) a tail with positive pressure is given the patient until the maximum pressure is created in the airways, then operation of the tail is stopped (8). Maximum pressure is adjusted in such a way to prevent barotraumas (air pressure injury). The given air volume to the patient is determined by the strength of the airways and the capacity of the lungs. The maximum pressure is adjusted usually with the considered current volume by the treating physician. This method improves ventilation of gas exchanges and increases lung acceptance. Volume-controlled ventilation (VCV) is a mechanical mode of ventilation in which the ventilator provides predetermined volume waveform. The airway pressure waveform depends on the flow waveform and the resistance and adaptation of the respiratory system (9).

We studied difference between the two modes of ventilation in the effect on bleeding. Volume (VCV) and pressure (PCV) mechanical ventilation were compared based on the rate of blood loss in endoscopic sinus surgery.

MATERIAL AND METHODS

The hypotheses of this study were as follows: 1.the rate of blood loss during endoscopic sinus surgery in the pressure ventilation group is lower than volume ventilation group, 2. The amount of HR and mean arterial pressure are different in the two study groups, (before induction, after induction and at the end of operation after exit of endotracheal tube) 3. The surgeon is more satisfied of the operation field in the pressure ventilation group. This study was performed by interventional method. We research patients who referred to Kashan Matini Hospital and Kashan Parsian Limited Surgery Center in 2018 and 2019 and they underwent endoscopic sinus surgery.

Study inclusion criteria were patients with ASA 1 and 2, at ages of 15 to 75 years old, to have hemoglobin more than 10g/dl, to consent entering to study. Exclusion criteria were patients with chronic hypertension, to have respiratory problems such as asthma and COPD, to undergo repeated surgery, to undergo emergency surgery, to have bleeding diseases, taking anticoagulants and patients did not consent

entering to study. For patients was prepared a checklist containing demographic information, mean arterial pressure, heart rate, hemoglobin level before and after of surgery, and ASA class.

All patients with supine position lay down and vital signs including heart rate, blood pressure, ECG, pulse oximetry and capnography were evaluated by a monitor model (Pooyandegan Rah Saadat). In both groups, a model of anesthesia machine (Pendleton) was used for mechanical ventilation. Both devices were calibrated at the end of each year by the backup company. The patients in both groups were inducted with Fentanyl 2 μ g/kg and Midazolam 0.03 mg/kg and Atracurium 0.5 mg/kg and Sodium Thiopental 5mg/kg and were intubated with appropriate size of endotracheal tube based on the patient's age and sex by an anesthesiologist. Patients of the first group received volume ventilation cmv with current volume 7ml / kg / IBW, respiratory rate 12 cycles per minute and ratio I / E1: 2 (inspiratory to expiratory) without peep and then respiratory rate changed until Etco₂ (End tidal CO₂) was equaled 35-40mmHg. Patients in group 2 received pressure ventilation pcmv with initial pressure 15cm / H₂O, respiratory rate 12 c / m and ratio I / E1: 2 without peep, then with changing of pressure, current volume reached to 7 ml / kg / IBW and with changing of respiratory rate the Etco₂ was equaled 35-40 mmHg. During of anesthesia, Propofol 100-200Mic / Kg /min with N₂O 4lit / min, O₂ 4lit / min (50% ratio) and Morphine 0.1 mg / kg continued until MAP was equaled 60-70 mmHg. If necessary in addition to adjusting of the anesthetic preservative (Propofol) to control blood pressure, Labetalol (hypertension) and Ephedrine (hypotension) were used because changes of patient's blood pressure in during of surgery were not more than 20%.

Patients were reversed with Neostigmine 0.04 mg/kg and Atropine 0.02 mg/kg at the end of operation. During of operation, used therapy fluid was Ringer's serum with the calculation of Maintenance and Deficit and based on weight and fasting time. The amount of bleeding was calculated and recorded based on the lost blood volume of the suction and number of completely impregnated gauzes of blood (each gauze 4 * 4 cm², 15cc and each large gauze 30* 30 cm², 50 cc). Also the amount of blood and blood products transfusion in during surgery in addition mean arterial pressure (MAP), heart rate (HR), peak inspiratory pressure (PIP), tidal volume (TV), end tidal carbon dioxide (ETCO₂) was recorded before induction, immediately after endotracheal intubation, during the surgery (every 15 minutes) and at the end after exiting endotracheal tube. Surgeon satisfaction from the surgery field for surgical bleeding was recorded based on Boezaart scoring system. Patients' information was collected by anesthesia technician who was blind to our study (uninformed of ventilation type). After data collecting and with using of descriptive statistics and measures of dispersion of quantitative variables and central tendency and absolute and relative frequency for qualitative variables, analysis was performed by SPSS

software (version 16).

Chi-square test was used to compare qualitative variables between the groups and Kruskal-Wallis test or one-way ANOVA test was used to compare quantitative variables between the groups. Due to consecutive measurements with considering confusing variables, repeated measurement analysis was used to control their effect.

RESULTS

The study was performed to compare of effects of volume and pressure mechanical ventilation on blood loss in endoscopic sinus surgery. In this research, 134 people were investigated, in the volume mechanical ventilation group, 67 patients were and 67 patients were in the pressure mechanical ventilation group. In the whole of study population, 87 (64.9%) patients were male and 47 patients (35.1%) were female. The mean of age was 35.62 ± 8.45 years (16-55 years). There was no significant difference in the mean of age and frequency of sex in two groups. In the mean of duration of surgery in the patients of two groups there was not statistically significant difference ($P > 0.05$).

By investigation in the table 1 and figure 1, there was no significant difference in the mean of height, weight and BMI

in patients of the two groups ($P > 0.05$). As can be seen in the table 2 and figure 2, there was not statistically significant ($P > 0.05$) in the mean of bleeding volume in two groups. There was no significant difference in mean of hemoglobin level before and after surgery in patients of two groups. In the regression model, significant difference was not observed between the two groups in the level of bleeding ($p = 0.856$). There was not statistically significant difference in the mean of heart rate during surgery in patients of two groups ($P > 0.05$). In total, the two groups did not differ significantly in repeated measurements of heart rate despite changes over time. It is clear that the heart rate had changed significantly at frequent times. The two groups as a whole did not show a significant difference in heart rate and in addition the heart rate did not change between two groups over time.

There was no statistically significant difference in the mean of blood pressure during surgery in the patients of two groups ($P > 0.05$). In total, the two groups did not differ significantly in repeated MAP measurements despite changes over time. As it is observed in table 3 and figure 3, there was no significant difference in frequency of bleeding grade in two groups ($P = 0.092$)

Table 1: Standard deviation and mean of height, weight and BMI in patients of the two groups

	Group	Number	Average	Standard deviation	P-value
Height (cm)	Volume Ventilation	67	171.63	7.483	0.223
	Pressure Ventilation	67	169.91	8.712	
Weight (kg)	Volume Ventilation	67	69.76	12.169	0.571
	Pressure Ventilation	67	71.00	13.076	
BMI	Volume Ventilation	67	23.76	4.40962	0.269
	Pressure Ventilation	67	24.58	4.17573	

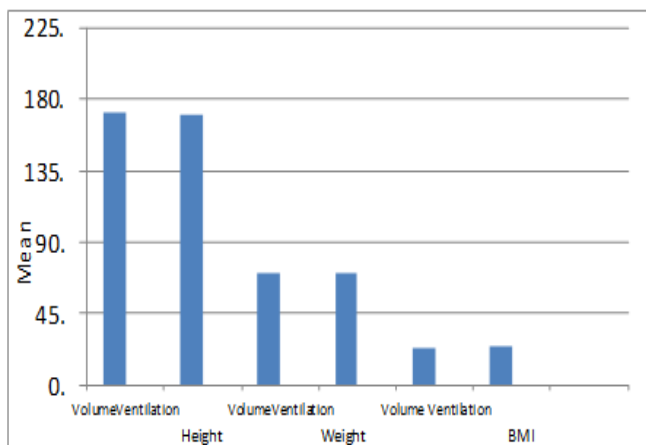


Figure 1: Mean and standard deviation of height, weight and BMI in patients of the two groups

	Group	Number	Mean	Standard deviation	P-value
Bleeding volume	Volume Ventilation	67	324.62	168.247	0.637(cc)
	Pressure Ventilation	67	312.23	133.198	

Table 2: Mean and standard deviation of bleeding volume in patients of two groups (Independent t test)

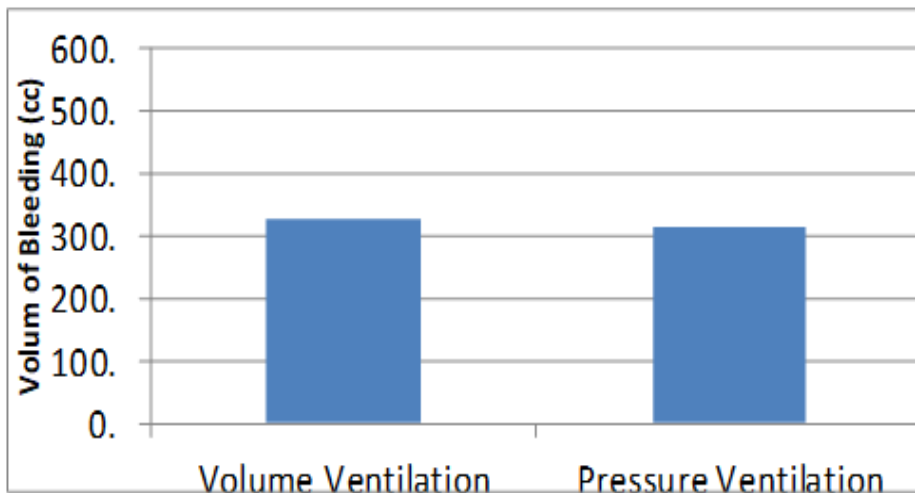


Figure 2: Mean and standard deviation of bleeding volume in patients of two groups

Table 3: Frequency of bleeding grade in patients of the two groups

Group Grade		Volume Ventilation	Pressure Ventilation	Total	P-value
II	Number	25	33	58	0.092
	Percent	37.3%	49.3%	43.3%	
III	Number	19	22	41	
	Percent	28.4%	32.8%	30.6%	
IV	Number	23	12	35	
	Percent	34.3%	17.9%	26.1%	
Total	Number	67	67	134	
	Percent	100.0%	100.0%	100.0%	

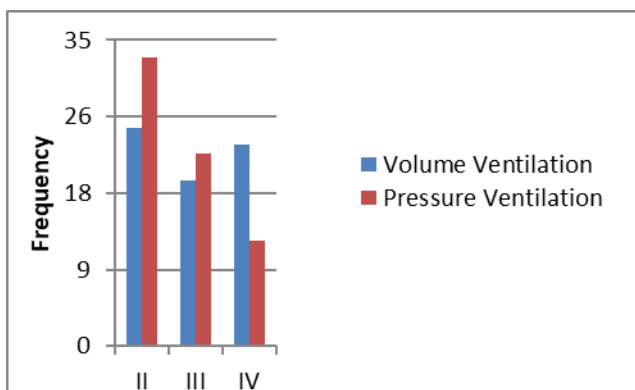


Figure 3: Frequency of bleeding grade in patients of the two groups

DISCUSSION

The findings of study showed that, there was no significant difference between modes of VCV and PCV in duration of surgery, intraoperative bleeding, heart rate, mean of arterial blood pressure, hemoglobin changes, hemodynamic changes and the surgeon's satisfaction of the surgical field. A study in 2016 was conducted by Kang WS et al. with the aim of investigating of mechanical ventilation type on bleeding during spinal surgery (10).

That was a randomized, prospective, single-blind, parallel study involving 56 patients of undergoing PLIF with using PCV or VCV mechanical ventilation. Respiratory and

hemodynamic parameters were studied after induction in supine position, 5 minutes after changing from supine position to prone position, at the time of skin closing and 5 minutes after changing from prone position to supine position.

Intraoperation bleeding, fluids prescription, urine output and need of blood transfusion were measured at the end of the surgery. Postoperative bleeding and need of blood transfusion, were recorded every 24 hours for 72 hours. The main result was the amount of surgical bleeding during the operation. The rate of bleeding in PCV group was significantly lower than VCV group. in the PCV group, mean was 253.0ml [range, 179.0 to 316.5] versus 382.5 ml [328.0 to 489.5] in VCV group; $P < 0.001$). With comparing other parameters between groups, only the peak inspiratory pressure in PCV group was significantly lower than VCV group and no harmful events have been reported.

The findings of their study contradict the findings of our study. The reason may be due to differences in the type of surgery, differences in inclusion and exclusion criteria, differences in demographic indicators, differences in controlling of confounder effects. Another study was conducted by Srilata Moningi et al, in 2017 with the aim of investigating volume and pressure control ventilation in patients undergoing spinal surgery (11). After obtaining the permission of the Ethics and Conscious Consent Committee, 60 patients underwent general anesthesia in supine position for planned surgery. In group V, 30 patients received VCV

and in group P, 30 patients received PCV. The initial objective was oxygenation variable $\text{PaO}_2 / \text{FiO}_2$ at different points of time, T1-20 min after the institution of ventilation and T2-20 min after placement of retractors and T3-20 min after removal of retractors. Secondary objectives were to study other arterial blood gas parameters, respiratory and hemodynamic parameters. Main variable $\text{PaO}_2/\text{FiO}_2$ was comparable in both groups ($P = 0.08$). There were statistically significant in variables of respiratory, PAP and C_{dyn} in PCV group compared to VCV group ($P < 0.05$), although there were insignificant clinically.

Another secondary variables, especially bleeding rate and hemoglobin changes, did not show significant difference between two groups ($P > 0.05$). The findings of this study show no difference in the amount of bleeding between volume and pressure methods and that was similar with findings of our study. Amir Abouzkry El-Sayed et al investigated ventilation with pressure and volume control on the rate of bleeding in patients undergoing spinal surgery in 2019 (12). Patients were using tidal volume (TV) of 8–10 ml/Kg in volume-controlled ventilation (VCV), in patients of pressure-controlled ventilation (PCV) peak inspiratory pressure (PIP) was adjusted to provide the same TV according to ideal body weight. Respiratory and hemodynamic parameters were reported in supine (T1), on turning to prone (T2), and on returning to the supine position (T3). Initial result included amount of IO blood loss, Secondary result included need for blood transfusion, IO hemodynamics, airway pressure changes.

Heart rate and blood pressure decreased in the prone position. IO blood loss and increasing of central venous pressure (CVP) in patients of VCV group were significantly higher than PCV group while PCV reduced these effects and significantly improved airway pressure. The findings of this study are contrary of our study findings. The reason of this difference may be due to differences in the type of surgery, differences in sampling, differences in inclusion and exclusion criteria, differences in demographic indicators, differences in controlling the effect of confounders. A study was conducted by HajiJafari et al. with the aim of comparing the effects of volume and pressure ventilation methods on the rate of blood loss in posterior spinal fixation surgery in 2017 (13). The study was prospective, randomized, single-blind, and parallel. 78 patients underwent posterior spinal fixation surgery and were investigated with volume and pressure mechanical ventilation. Randomization with random block was performed with a created list by the computer. Hemodynamic parameters were measured after induction.

The amount of intraoperative bleeding and the need of blood transfusion were measured at the end of the surgery. The mean bleeding was $361.04 \text{cc} \pm 431.28 \text{cc}$ in PCV group and $338.16 \text{cc} \pm 465.26 \text{cc}$ in VCV group ($P = 0.669$). Blood transfusion rates were respectively in PCV and VCV groups 0.40 ± 0.74 and 0.43 ± 0.78 pack cell ($P = 0.836$). Surgeon satisfaction was higher in PCV group (82.1% vs. 74.4%, $P =$

0.548). Finally, it was found that the mean of bleeding volume due to surgery in VCV group was higher than PCV group, but no significant difference was observed between the two groups.

Hemoglobin levels in patients before and after surgery showed that two groups had a similar condition. The findings of the study showed no differences in bleeding, surgeon satisfaction and hemoglobin level between VCV and PCV methods and that is similar to our findings (14). Therefore, it can be seen that there was no difference significant in ventilation methods on bleeding rate and due to inconsistencies in the result of current study and some other investigations and due to the limitations of studies, further investigations with more samples are recommended. Commenting on the role of ventilation type on the rate of bleeding depends on several of other variables also as an independent variable needs further studies. According to the results of the present study and other studies, the following is suggested:

1. Not to use different ventilation methods to reduce bleeding during endoscopic sinus surgery.
2. Also, the results of the present study should be the introduction of more comprehensive research based on more samples.
3. Carrying out a review and systematic study on the aims of the present study.

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