THE COMPARISON OF PRESSURE CONTROLLED VENTILATION AND VOLUME CONTROLLED VENTILATION ON OPERATION DURING GENERAL ANESTHESIA WITH THE USE OF MECHANICAL VENTILATION PEVENT NARAYA

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Abstract: *In general, surgery is performed under the influence of anesthesia, and among others is conducted with general anesthesia. Ventilation Control pressure (PCV) and Volume Control Ventilation (VCV) are modes available Ventilator techniques in the perioperative period. This research compared ventilators perioperative and blood gas variable of the volume-controlled ventilation (VCV) and the ventilation pressure controlled (PCV) in patients undergoing surgery under general anesthesia. After obtaining the approval from the Institutional Ethics Committee and informed consent, sixty patients scheduled for surgery conducted in supine position under general anesthetics were randomly allocated into two groups to receive the VCV or PCV modes with Randomized Controlled Trial (RCT) method. Group V (30 patients) received VCV and Group P (30 patients) received PCV. The main objective was for variable oxygenation FiO2, systolic and diastolic blood pressure, average arterial pressure, pulse rate at different times point, namely T0-12 minutes before induction, T1-12 minutes before induction intubate, T2-12 minutes after intubation and so forth in every 15 minutes until the surgery was complete. The Secondary goals included sedation scale parameter and vomiting scale after extubation. Paired samples t test for overall comparisons and Ramsay scores for sedation and vomiting scales. The main variable and secondary variable were align in the two groups (P>0.05). In clinical, both PCV and VCV groups were suitable for ventilator technique on patients with general anesthesia surgery.*

INTRODUCTION

Coronavirus disease 19 (COVID-19) originated from the city of Wuhan in China in the early of December 2019 has spread fast with confirmed cases in almost every country in the world and has become a new global public health crisis. Etiology Agent is set as a critical syndrome breathing coronavirus 2 (SARS-CoV-2). This virus is originated from bats and is transmitted to humans primarily occur through direct, indirect, or close contacts to the infected person through the infected person's secretions such as respiratory secretions, saliva or through respiratory droplets expelled when an infected person coughs, sneezes, or talks. The World Health Organization created the term of COVID-19and stated that this new corona virus disease as pandemic on 11 March 2020.

Positive pressure ventilation is a respiration therapy form which involves delivery of air or oxygen mixtures combined with other gases with positive pressure to lungs. At the moment the gas enters lungs, pressure interalveolar increases until it changes its flow or pressure detected by machine sending the mixture, or a set volume of gas which is sent to signal the end of the breath. Air expiration occurs passively secondary due to the buildup of pressure in the alveoli which goes out to conductive airduct which is lack of pressure [2]. The goals of the mechanic ventilator installation are for maintaining the alveolar ventilation optimally and fulfilling metabolic needs, repairing hypoxaemia, and maximizing oxygen transport.

Apart from the hopes for mechanically ventilated patients, there are concerns which very fundamental with its application. The ventilation mechanic is a technique which is opposite with physiology ventilation, that is with positive pressure production in lieu of negative pressure to inflate the lungs. Therefore, it is not surprising, in its use can raise problem [2]. Because of that reason, it is important that on every application of mechanic ventilation needs an analysis to the accuracy of the indication, the accuracy of the patient, the accuracy of the application method and is always be alert to the complication which will occur. Moreover, on every mechanic ventilation application must understand physiology respiration.

Mechanic ventilator is very important to support the patients' respiratory functions when they are under the general anesthesia. There are several anesthesia mechanic ventilators [4]. The common modes which are widely used is Volume Controlled Ventilation (VCV) and Pressure Controlled Ventilation (PCV). VCV mode is the most well-known for the perioperative period [5]. VCV is a traditional controlled ventilation mode in anesthesia; tidal volume has predetermined in advanced and is transmitted apart from related pressure which is required [6]. The benefits of VCV are that this technic has been well known and has used minute volume which is controllable [7]. In contrast to VCV, peak inspiratory pressure (PIP) is used to limit the tidal volume which is delivered to patients in PCV [8]. PCV is a ventilation alternative mode and is used primarily in emergency patients and respiratory problem [9]. PCV can increase arterial oxygenation and decrease air duct peak pressure [10] as well as increase alviolar recruitment [11].

LITERATURE REVIEW

Mechanical ventilation is the most common short-term life support technique which is widely used worldwide and applied daily for various spectrum indications, starting from scheduled surgery procedure until acute failure organ. This modern literature gives updating of mechanics breathing-based physiology, working principle, and main ventilation setting, as well as mechanical ventilation potential complication [12].
Mechanical ventilation aims to achieve adequate gas exchange. There are more proofs to avoid ventilation mechanic invasive through endotracheal pipe when possible. The indication for intubation and mechanical invasive ventilation is the severe respiratory failure, as proofed by severe oxygenation impairment and alveolar ventilation, the decrease of respiratory effort, and the blood circulatory failure in certain cases.

Once the decision for invasive mechanical ventilation is taken, the steps for minimizing the lungs injury must be considered by selecting appropriate ventilation mode and modality and its fit setting [14]. The type and intensity of ventilator support required by patients vary during treatment. Modern mechanical ventilators can be customized as the patients' needs. In a commercial aspect, there are available devices for controlling volume, pressure, or flow gas and breathing cycle time. They support patients who have difficulty in breathing and who still can trigger mechanical cycles with the spontaneous inspiration effort. At this moment, the mechanical ventilator is a complex machine, consists from many specific component equipment and displays several ventilation modes. There are two basic ventilation modes, namely Pressure Controlled Ventilation (PCV) and Volume Controlled Ventilation ((VCV). Pevent Naraya is a ventilator that can be operated in both two modes, PCV and VCV.

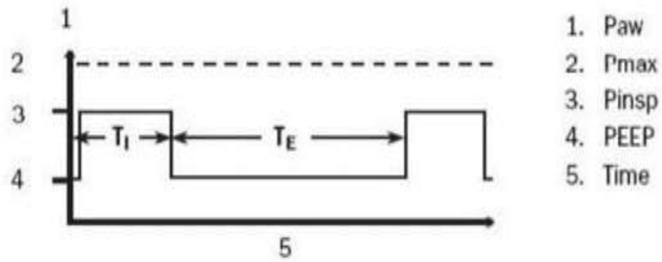
Pressure Controlled Ventilation

As the name suggests, "pressure" is a parameter which is targeted ventilator. The ventilator will produce inspiration pressure which has been arranged by clinician. The tidal volume which is produced will become a breathing mechanical function. In addition, the clinician prescribes PEEP which is desired, rate respiration, FiO2, and inspiration time or ratio I:E, and trigger mode. It should be noted that the doctor does not control the waveform or flow of peak inspiration. It is as in the case of volume targeted ventilation.

Pressure controlled ventilator is a ventilator that generates a preset pressure during inspiration time which has been determined on the respiration level which has been established. Its pressure is constant during inspiration and the flow slows. PCV provides an advantage over volume-controlled breathing: lower the peak airduck pressure to deliver the same volume, volume distribution which is better in lungs, better oxygenation, less barotrauma risks, leakage compensation without interfering volume delivery to the patients and ability for ventilation for every type patient.

The only significant drawback of ventilation pressure control is that tidal volume delivery will increase and it will decrease with the change of patients' compliance, and this is not guaranteed. The extra clinical alert is needed when the use of pressure-controlled ventilation to avoid in lower or in upper of patients' ventilation in which obedience is altered. The compliance alternation can occur due to the underlying diseases, surgical position, surgical package or retractor presence, and the change of relaxation or insufflation degrees.

Parameters for PCV include Pinsp in cmH2O, Inspiration Time (Ti) in second or I:E Ratio determines cycling time from inspiration to expiration, Respiration Level in breath/minute determines the beginning time inspiration, PEEP in cmH2O and Pmax-Maximum airway pressure, at that time the ventilator will sound the alarms and end the inspiration.



Volume Controlled Ventilation

Volume Controlled Ventilation (VCV), has become a controlled ventilation mode in anesthesia. In the VCV, the ventilator delivers a preset tidal volume (TV) with a constant flow during a preset inspiratory time (Ti) at the preset breathing level. The benefit of VCV is it is a well-known technique and controllable Volume Minute.

The worries of VCV is that its constant flow can high peak pressure and thus can expose the patients to the risk of barotraumas [1]. However, its high peak pressure can be limited by setting the tolerable pressure to the patients in accordance to the patients' conditions.

The main parameters are for VCV[13]: Tidal Volume (TV) – is set in ml, Breathing level (BPM), I:E Ratio -inspiratory time ratio setting (TI) over the time expiration (TE), PEEP-positive end expiratory pressure, Tp% = inspiratory pause (0-50% of Ti) and Pressure Limit, Pmax (cmH2O).

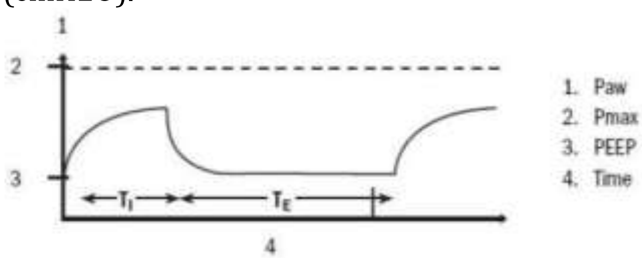


Figure 2. VCV graph

METHODE

This research was conducted by testing the Pevent Naraya ventilator to the clinic patients using general anesthesia with RCT (Randomized controlled Trial) method, with 60 participants aged 18-55 years. On this stage the conducted steps were as following:

a. The tests were conducted on two group patients, the first group first consisted of 30 persons with general anesthesia on patients with Volume Controlled Ventilation (VCV). The second group consisted of 30 persons with General anesthesia testing on patients with the pressure controlled ventilator (PCV) mode. All patients before conducting the

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general anesthesia were required to fill in informed consent form.

b. Screening inclusion, surgery with general anesthesia ASA I-II with the surgery time was for 1-2 hours,
c. The action of general anesthesia with:
   - Induction with propofol, fentanyl and relaxant
   - Anesthesia maintenance with sevoflurane, N2O, O2:
d. The group of Ventilator Setting group on mode VCV was VT=6ml/kg RR=12, FiO2=50%. The second settings ventilator on PCV mode was pressure support 10-15 for reach VT=6ml/kg RR=12, FiO2=50%.
e. Anesthesia monitoring with research variables: blood pressure, pulse, saturation, waking duration and complication (additional data).

RESULT AND DISCUSSION

The study was conducted on 60 patients with ASA I and II physical status undergoing surgery with general endotracheal anesthesia. The subjects were divided into two groups, namely the Volume Controlled Ventilation (VCV) group of 30 people and the Pressure Controlled Ventilation (PCV) group of 30 people. The research subject characteristic data can be seen on the table below:

Table 1 The average comparison and standard deviation of the research general subject characteristics

Perlakuan

Characteristics	VCV (n=30)	PCV (n=30)	t Uji	p Nilai
1. Age	41,1 (7,2)	42,2 (10,1)	0,33	0,732
2. Weight (kg)	55,7 (6,8)	54,8 (9,6)	0,31	0,748
3. Systolic pressure (mmHg)	128,1 (5,5)	127,2 (6,2)	0,41	0,673
4. Diastolic pressure (mmHg)	78,1 (7,9)	76,6 (19,8)	0,44	0,652
5. Average artery pressure (mmHg)	95,0 (11,8)	93,2 (8,6)	0,47	0,631
6. Pulse rate (x/mnt)	87,5 (5,5)	84,3 (8,5)	1,10	0,276
7. SaturationO2 perifer (%)	96,9 (2,9)	96,7 (3,3)	0,74	0,458
8. Duration Operation (Minutes)	164,5 (10,2)	155,6 (15,3)	1,81	0,081

Remark: p value is calculated based on t test, p ≤ 0,05 = meaningful, p ≤ 0,01 = very meaningful p > 0,05 = not meaningful.

The average arterial pressure from T0 to T12 statistically was not different meaning between VCV and PCV (p>0.05) groups. The second group experienced increment of average arterial pressure for one minute after intubation. The average arterial pressure was maintained between 78 mm Hg up to 98 mm Hg. The pulse rate started T0 to T12 in statistics was not different in meanings between VCV and PCV (p>0,05) groups. Both groups experienced the increment of pulse rate for one minute after the incubation. The pulse rate was maintained between 78 x/minute to 92 x/minute. Peripheral oxygen saturation started from T0 until T12 in statistical was not different in meanings between VCV and PCV (p>0,05) groups. The peripheral oxygen saturation was maintained between 98 % to 100 %.

Sedation scale started in the minute of 15 until 120 in statistical was not different in meanings between VCV and PCV (p>0,05) groups. Both groups have risen (scale 3) in the minute of 31 after extubation. VCV group reached scale 2 (conscious, calm) in the minute of 44 while PCV reached scale 2 in the minute of 48. Vomiting scale started in the minute of 15 until120 in statistical was not different in meaning between tramadol and fentanil (p>0,05) groups. Both groups respectively found two patients suffered with vomits but did not find any complaints about vomiting.

Discussion

From the general description of the research subject characteristics, it can be seen that age, body weight, arterial blood pressure for systolic, diastolic and arterial pressure mean, oxygen saturation, and pulse rate at the time before induction of the two treatment groups, did not show any significant difference, so the subject study was homogeneous and worthy for the comparison. The real cardiovascular response marked with existing increment of blood pressure and pulse rate are conditions that are often encountered during the laryngoscopy and intubation actions. This thing has been researched for about 30 years. Laryngoscopy and intubation will cause a reflex in the increment of sympathetic activity which results in hypertension and tachycardia.[16] Laryngoscopy and intubation also cause enhancement rate of catecholamine plasma, which are part of the stress response resulting from the act, and will eventually strengthen the increment of arterial blood pressure.[17]

Barak et al. in his research found that laryngoscopy and intubation, both with an ordinary laryngoscope and a fiberoptic laryngoscope resulted in the increase of blood pressure which was meaningful in the minute of 1, 2, and 3 after intubation compared with preintubation.[17] In this research both groups experienced an increase in arterial blood pressure one minute after intubation. The systolic blood pressure of the tramadol group increased from 120.7 (17.3) mmHg to 126.3 (16.2) mmHg, diastolic blood pressure and average artery were less affected enhancement after intubation.

The systolic blood pressure of the fentanyl group increased from 115.4 (17.6) mmHg to 129.6 (18.1) mmHg, the mean diastolic and arterial blood pressure decreased after intubation. The increase in arterial blood pressure after intubation was not much different from before induction because arterial blood pressure decreased initially after induction. After anesthesic induction until the preintubation time, the average rate pulse decline on the tramadol group was not significantly different from the fentanyl group. This also happened in the study of Kulka et al. that the decline in pulse rate at the time of anesthesic induction to preintubation occured due to the direct depressant effect of anesthetic induction drugs. The rate pulse increment occured after laryngoscopy and intubation actions because of sympathetic excitatory.[18] After laryngoscopy and intubation, there was an increase in the average pulse rate for all groups. In the tramadol group, the average postintubation pulse rate increased in the minute of 1 from 86.4 (12.6) x/minute to 89.9 (18.7) x/minute compared to preintubation. In the fentanyl group, the average postintubation pulse rate increased in the minute of 1 from 80.4 (12.1) x/minute to 91.9 (15.4) x/minute compared to preintubation. There was a correlation between oxygen saturation (SpO_2) and the oxygen partial pressure in blood (PaO_2). 100% oxygen saturation was equal to PaO_2 90 mmHg or more; 90% oxygen saturation was equal to PaO_2 60 mmHg; 60% oxygen saturation was equal to PaO_2 30 mmHg; and 59% oxygen saturation was equal to PaO_2 27 mmHg.[19] If after giving premedication and anesthetic induction as well as laryngoscopy and intubation were performed significantly meaningful desaturation or hypoxaemia, it could occur initial response in the form of sympathetic nervous system stimulation. Hypoxaemia would activate the chemoreceptors in body of carotid and aorta, which next would activate central respiration and vasomotor in stem brain. The cardiovascular response occurred due to the existing peripheral chemoreceptors stimulation which would raise the possibility of peripheral vasoconstriction development.[20] All observed peripheral oxygen saturation values based on time and treatment group in this study were all within the normal value range and there was no difference meaning. The peripheral oxygen saturation was maintained between 98 % until 100 %. There was not any decrease in oxygen saturation occurrence during observation started from the induction until the performed surgery, so that the existing hypoxaemia which could stimulate central vasomotor and result in the existence of cardiovascular system response could be removed.

The postoperative sedation degree which was expected was not too deep, so that it would not lead to dangerous complications such as hypoxia or aspiration. For patients who were not intubated, the ideal target for sedation was the Ramsay sedation scale of 2-3 in which the patient was calm, sleepy but easily awakened to a full conscious level, and was calm when being alone.[21] In this research the VCV and PCV groups reached scale 3 (awake) in the minute of 30. This proved that VCV and PCV do not have any differences in length of waking up time. The reasons of postoperative nauseous and vomit are multifactorial and have certain predispositions which cover some factors which relate with patient, surgery type and anesthesia. Therefore, the predicted patients who would be suffered with nauseous and vomit should be given antiemetic drugs for prevention.[22] Both researched groups were given antiemetics at the end of the surgery. The tramadol and fentanyl groups respectively found that there were two patients with complaints of nausea (scale 1) and there was not any obtained complaint of queasy (scale 2) or vomit (scale 3).

CONCLUSION

In general, VCV was compared to PCV as a ventilator support with general anesthesia brings similar effects for blood pressure, pulse rate,saturation and wake time. Based on the Mann-Whitney test the difference of average values of pressure blood, pulse rate, saturation and wake time between the VCV and PCV groups showed that there was no any significant difference ($p>0.05$). Clinically the use of the VCV and PCV methods for perioperative ventilation was equally suitable for the ventilator technique to the anesthesia surgery patients, despite the valid data of the long-term parameters results for different ventilation method still must be applied.

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Declaration Of Interests

The authors have no competing interests to declare that are relevant to the content of this article.

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