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Comparative Study between Pressure Controlled Ventilation and Volume Controlled Ventilation on Hemodynamics in Prone Patients Undergoing Elective Spine Surgeries

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Abstract

Background: As patients turned into prone position experienced change in heamodynamics (heart rate and mean arterial blood pressure) than those on supine position, this prospective, randomized study was designed to compare the effect of PCV and Volume-Controlled Ventilation (VCV) on heamodynamics in the prone position using the Wilson frame during elective lumbar spine surgery.

Patients and Methods: Sixty patients scheduled for elective lumbar spine surgery were randomly allocated to receive mechanical ventilation using either the VCV (n=30) or PCV (n=30) mode.

Hemodynamic variables (heart rate, mean arterial blood pressure).

Results: Heart rate as beat/min. (p-value 1): In volume controlled group during supine position mean ± SD value was (76±12) and during prone position was (69±12) and in pressure controlled group it was (82±17) in supine position and (72±13) in prone position and mean arterial blood pressure as mmHg (p-value 0.6): In volume controlled group mean ± SD in supine position was (80±9) and in prone position it was (77±11), and in pressure controlled group it was (84±14) in supine position and (77±9) in prone position.

Conclusions: PCV provides lower Ppeak compared with VCV when the ventilator is set to deliver the same tidal volume and variable respiratory rate to maintain a constant end-tidal carbon dioxide tension in patients undergoing posterior lumbar spine surgery in the prone position using the Wilson frame.

Key Words: *Prone position – Pressure-controlled ventilation – Volume-controlled ventilation.*

Introduction

PRONE positioning with the patient under general anesthesia elicits hemodynamic changes, which produce decreases in both arterial pressure and tissue perfusion [1-3].

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There have been a limited number of studies investigating the hemodynamic effects of the prone position during general anesthesia [4,5]. A few reports focused on describing changes in central venous pressure and cardiac index, and related most of the hemodynamic changes to alterations in intra-abdominal pressure, resulting in decreases in preload to the heart [6-8].

Other studies compared different prone positioning systems and attempted to correlate increases in central venous pressure with blood loss [9]. Still another study evaluated the hemodynamic effects of prone positioning by Transesophageal Echocardiography (TEE) using a longitudinal bolster prone positioning system [10]. They found a decrease in left ventricular volume and reduced systolic pulmonary venous flow velocity with enhanced diastolic pulmonary flow velocity. They concluded that these changes were caused by a decrease in venous return from inferior vena cava compression and decreased left ventricular compliance secondary to increased intrathoracic pressure.

There are a number of body structures that can be injured these are generally as a result of direct pressure to structures on which body weight would not normally rest e.g. Eyes, nose and nerves [11].

Patients and Methods

This study was done in the Neurosurgical Theater in Kasr El-Aini Hospital including 60 patients suffering from lumber disc prolapse, after obtaining informed written consent from the patients and approval of the Ethical and Scientific Committee of Anesthesia Department in Cairo University. This study was held between 2013 to 2014.

Inclusion and exclusion criteria:

Inclusion criteria:

- Adult patients of both sex (20-50 years old).
- Patients undergoing spine surgeries in prone position.
- Patients of American Society of Anesthesiologists' physical status class I & II.
- Patients with ideal body weight (body mass index 19:25kg/m^2).

Exclusion criteria:

- Patient refusal.
- Patient with obstructive (e.g. chronic obstructive pulmonary diseases, bronchial asthma) or restrictive chest problems (e.g. pulmonary fibrosis, pregnant patients) or deformity.
- Patients with cardiovascular diseases (e.g. uncontrolled hypertention, ischemic heart diseases, mild to moderate valvular disease).

Randomization of study groups:

The patients were randomly allocated into two equal groups each one includes 30 patients by closed envelope chosen by the surgeon.

Group V ventilated by volume controlled ventilation mode with a tidal volume 10ml/kg.

Group P ventilated by pressure controlled ventilation mode, adjusting the peak airway pressure to deliver tidal volume 10ml/kg on supine position and readjusted after turning to prone position to deliver the same tidal volume.

Anesthetic technique:

All patients were fasting from for 6 to 8 hours before surgery. On the day of surgery all patients were premedicated with midazolam 2mg IV, and ranitidine 50mg administered IV (slowly) 30 minutes before arriving into the Operating Room (OR).

On arrival to operating room ideal body weight estimated from the following equation: 50 + 0.91 X (height in cm-152.4) for men and 45.5 + 0.91 X (height in cm-152.4) for women [12].

On the operating table monitors were applied to the patients for continuous measuring of the heart rate and rhythm by ECG, oxygen saturation using pulse oxymetry and non invasive blood pressure by oscillometry.

For all patients, IV induction using propofol of 2mg/kg, fentanyl of 2 μg/kg and atracurium 0.5mg/kg. Muscle relaxation was confirmed 3-5 minutes after administering atracurium.

A wire-reinforced endotracheal tube was used, its site was confirmed by auscultation and continuous monitoring of end tidal CO_2 using capnogram. Anesthesia was maintained by O_2 2L/min (Fio_2 100%), isoflurane 1% inspired concentration, continuous IV infusion of atracurium at a rate of 0.5 mg/kg/hr. Morphine 0.1mg/kg was given.

Mechanical ventilation was set to deliver the tidal volume (VT) in the Volume Controlled Ventilation (VCV) group and the Ppeak (peak airway pressure) in the Pressure Controlled Ventilation (PCV) group was set initially to deliver a VT of 10mL/kg of ideal body weight, the RR in both groups adjusted to maintain an end tidal carbon dioxide tension ($ETCO_2$) between 33 and 36mmHg, and the inspiratory to expiratory time (I/E) ratio was set to 1:2.

Radial artery cannulation using a 20 gauge arterial catheter to allow for arterial blood sampling. A urinary catheter inserted to measure hourly urine output.

After positioning patients in the prone position on the Wilson frame, the Ppeak was reset to match the initial expired VT in the PCV group.

At the end of the operation and repositioning the patient to supine position emergence and reversal of muscle relaxant using Atropine 0.2mg/kg and neostigmine 0.04mg/mg.

After extubation, patients remained one hour in the recovery room then plain postero-anterior chest X-ray done to detection occurrence of any basal atelectasis in both groups.

Measured variables:

Hemodynamic variables:

- Heart rate (continously displayed and recorded after induction of anesthesia in the supine position (Tsupine) and 30 minutes after the prone positioning (Tprone) then every 30 minutes).
- Mean arterial blood pressure (measured every 5 minutes but recoded after induction of anesthesia in the supine position (Tsupine) and 30 minutes after the prone positioning (Tprone) then every 30 minutes).

Results

Sixty patients were enrolled in the study.

Only 57 patients completed the study there were 26 male and 31 female patients with a mean age of 53.17±7.27 years, all patient were ASA 1 and 2.

There were no statistical differences in age (p-value 0.056), male to female ratio (p-value 0.435), and BMI between the two groups (p-value 0.595).

Table (1): Patient characteristics. Data are presented as mean ± Standard Deviation (SD).

	Volume controlled ventilation	Pressure controlled ventilation
Age (year)	53.71±7.27	45.78±7.45
Weight (Kgm)	65.25±7.87	64.11±9.45
Hight (Cm)	165.38±11.94	161.11±10.54
BMI (kgm/m^2)	23.87±1.68	24.59±1.17
Duration of surgery (hours)	2.36±0.42	2.44±0.38

Table (2): Gender distribution in both groups.

	Group			
	Volume controlled ventilation		Pressure controlled ventilation	
	Count	%	Count	%
Sex:				
Female	13	50.0	18	66.6
Male	15	50.0	11	33.3

- *Hemodynamic variables were comparable between the 2 groups throughout the study period including:*

1- *Mean arterial blood pressure as mmHg (p-value 0.6):*

In volume controlled group mean ± SD in supine position was (80±9) and in prone position it was (77±11), and in pressure controlled group it was (84±14) in supine position and (77±9) in prone position.

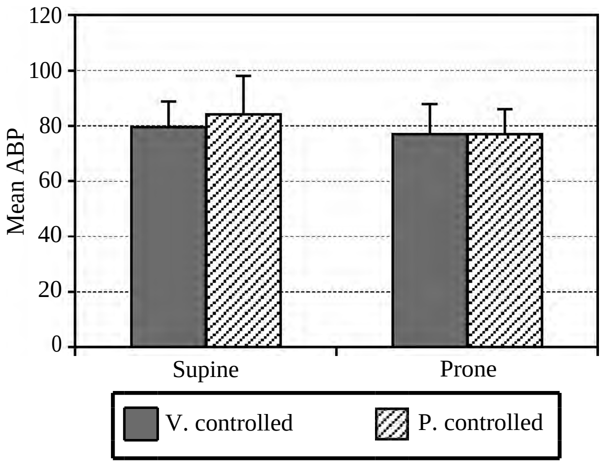

Fig. (1): Mean arterial blood pressure changes in mmHg during supine and prone position in both groups.

2- *Heart rate as beat/min. (p-value 1):*

In volume controlled group during supine position mean ± SD value was (76±12) and during prone position was (69±12) and in pressure controlled group it was (82±17) in supine position and (72±13) in prone position.

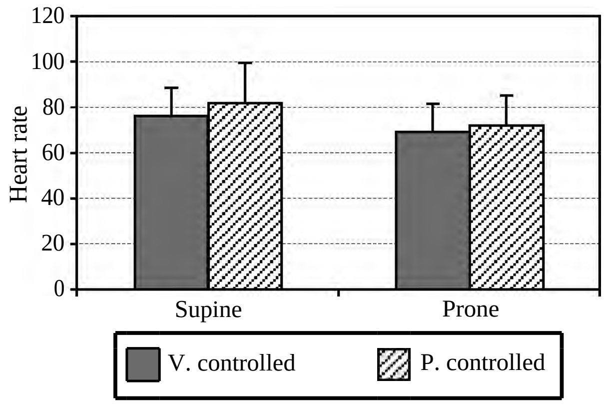

Fig. (2): Heart rate changes in beat/min during supine and prone positions in both groups.

Discussion

Prone positioning decreases blood pressure and cardiac function. Several studies have evaluated changes in cardiac function after prone positioning, and linked them to reduced venous return and ventricular compliance.

Therefore, this study was designed to compare the effect of PCV and VCV on lung mechanics in the prone position using the Wilson frame during posterior lumbar spine surgery.

As regard hemodynamics in this study there was no significant differences between supine and prone position in mean arterial blood pressure (mean ± SD supine position was (84±14) mmHg and in prone position it was (77±9) mmHg, and heart rate (during supine position mean ± SD value was (76±12) beat/min. and during prone position was (69±12) beat/min.; which is agree with Yoontae Nam et al., **[13]**. Who did their study on twenty five patients scheduled to undergo lumbar spine surgery. Patients were ventilated mechanically with a tidal volume of 10ml/kg and a respiration rate of 10/min. Heart rate and arterial blood pressure were measured at 10 minutes after the induction of anesthesia. These parameters were measured again 10 minutes after placing the patient in the prone position. They found that the prone position did not significantly affect blood pressure (systolic mean ± SD 102.9±2.5mmHg in supine position and 103.4±2.8mmHg in prone position, diastolic was 58.4±2.5 and 62.7±2.2mmHg in supine and prone positions respectively) and heart rate mean ± SD: 74.7±2.7mmHg in supine position and 73.4±2.4mmHg in prone position.

Also study done by Mirum Kim et al., [14] that twenty adult patients scheduled for debridement of back wounds under general anesthesia. Patients who were neurologically stable (quadriplegia and high level [above T4] paraplegia) for more than 2 years were included. found that there were no statistical differences in HR (mean ± SD 86±16.7 beat/min. in supine position and 89.8±9.5 beat/min. in prone position) and MBP (mean ± SD 79±13.4 mmHg and 87.3±14mmHg in supine and prone position respectively) in both groups [14].

Limitations:

- All the patients included were have ideal body weight.
- Limited no. of patients.
- Limited time of the operation.

Conclusion:

Finally from this study we can conclude that prone position provides insignificant heamodynamic changes in healthy patients undergoing lamber disc surgeries on Wilson frame, further studies are needed including larger number of patients to prove such results.

References

1- PEARCE D.J.: The role of posture in laminectomy. Proc. R. Soc. Med., 50: 109-12, 1957.

2- RELTON L.E.S. and CONN A.W.: Anesthesia for the surgical correction for scoliosis by the Harrington method in children Can. Anaesth. Soc. J., 10: 603-15, 1963.

3- KANEDA K., FUJITANI M., HONMA S., et al.: Posture and frame for spinal surgery [in Japanese]. Orthop. Surg. (Seikeigeka), 12: 695-703, 1977.

4- WAYNE S.J.: The tuck position for lumbar disc surgery. J. Bone Joint Surg., 49-A: 1195-98, 1967.

5- BACKOFEN J.E. and SCHAUBLE J.F.: Hemodynamic changes with prone position during general anesthesia [abstract]. Anesth. Analg., 64: 194, 1985.

6- WADSWORTH R., ANDERTON J.M. and VOHRA A.: The effect of four different surgical prone positions on cardiovascular parameters in healthy volunteers. Anaesthesia, S1: 819-22, 1996.

7- YOKOYAMA M., UEDA W., HIRAKAWA M., et al.: Hemodynamic effect of prone position during anesthesia. Acta Anesthesiol. Scand., 35: 741-4, 1991.

8- HATADA T., KASUNOKI M., SAKIYAMA T., et al.: Hemodynamics in the prone jackknife position during surgery. Am. J. Surg., 55-8, 1991.

9- McNULTY S.E., WEISS J., AZAD S.S., et al.: The effect of the prone position on venous pressure and blood loss during lumbar laminectomy. J. Clin. Anesth., 4: 220-5, 1992.

10- TOYOTA S. and AMAKI Y.: Hemodynamic evaluation of prone position by transesophageal echocardiography. J. Clin. Anesth., 10: 32-5, 1997.

11- EDGCOMBE H., CARTER K. and YARROW S.: Anaesthesia in the prone position. Br. J. Anaesth., 100 (2): 165-83, 2008.

12- ANDREW J. DIONNE: The Little Black Book of Hospital Medicine (Little Black Book) (Jones and Bartlett's Little Black Book) ch. inflamatory lung disorders, p. 425, 2010.

13- NAM Y., YOON A.M., KIM Y.H. and YOON S.H.: The effect on respiratory mechanics when using a Jackson surgical table in the prone position during spinal surgery. Korean J. Anesthesiol., 59 (5): 323-8, 2010.

14- KIM M., KIM J., KWON S.H. and KIM G.H.: Pressure controlled vs. volume controlled ventilation during prone position in high-level spinal cord injury patients: A preliminary study. Korean J. Anesthesio l., 67 (Suppl): S43-S45, 2014.

دراسة مقارنة بين التهوية الميكانيكية عن طريق التحكم بالضغط والتهوية الميكانيكية عن طريق التحكم بالحجم وتأثيرهما على ديناميكية الدم فى المرضى الموضوعين على الوجه والذين يخضعون لعمليات العمود الفقرى الإختيارية

عند وضع المريض على الوجه تحت تأثير المخدر فإن سرعة ضربات القلب ومتوسط ضغط الدم قد يتأثرا نتيجة لتغير وضع المريض من وضعه على الظهر لوضعة على الوجه.

إن الهدف من هذه الدراسة هو المقارنة بين التهوية الميكانيكية للرئة عن طريق التحكم بالحجم والتهوية الميكانيكية للرئة عن طريق التحكم بالضغط وتأثيرها على ديناميكية الرئة فى مرضى عمليات العمود الفقرى الإختيارية عند وضعهم على الوجه.

أدرج فى هذه الدراسة ٦٠ من المرضى أجريت لهم جراحات العمود الفقرى الإختيارية وتم توزيعهم عشوائيا على مجموعتين المجموعة VCV وتضم ٣٠ مريضا وإستخدمت فيها التهوية الميكانيكية للرئة عن طريق التحكم بالحجم والمجموعة PCV وتضم ٣٠ مريضا وإستخدمت فيها التهوية الميكانيكية للرئة عن طريق التحكم بالضغط.

\النتائج: ٥٧ مريض إستكملوا الدراسة وأظهرت الدراسة عدم وجود فروق واضحة فى كلا من سرعة ضربات القلب ومتوسط ضغط الدم بين المجموعتين أثناء وضع المريض على الضهر أو الوجه.