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Original Research Article

EFFECTS OF PRESSURE CONTROLLED AND VOLUME-CONTROLLED VENTILATION ON RESPIRATORY MECHANICS AND SYSTEMIC STRESS RESPONSE DURING PRONE POSITION SURGERIES

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ABSTRACT

Background: Mechanical ventilation is crucial during general anaesthesia for gas exchange and haemodynamic stability. Prone spine surgery affects cardiopulmonary physiology, making the choice of ventilation strategy vital. Pressure-controlled and volume-controlled ventilation have different effects on the respiratory system. This study compared the impact of these two positions on respiratory mechanics and systemic stress response during prone spine surgery. **Materials and Methods:** This prospective study included 60 patients undergoing elective spine surgery, who were divided into pressure-controlled and volume-controlled groups. Standard anaesthesia and invasive arterial monitoring were used. The ventilation parameters were standardised. Haemodynamic variables, airway pressures, arterial blood gases, and stress markers (such as cortisol, insulin, and glucose) were recorded in the supine, prone, and postoperative periods. Blood samples were collected for biochemical analyses. **Results:** Baseline characteristics, surgical duration, and haemodynamic parameters showed no significant differences. The arterial blood gas levels and $ETCO_2$ were similar. Peak airway pressure was higher in VCV supine (27.13±4.05 vs. 23.87±1.33 cmH_2O; p<0.05) but higher in PCV prone (26.83±1.49 vs. 25.81±1.35; p=0.003). The plateau pressure was lower in the PCV group (p=0.01). The mean airway pressure was higher in the PCV prone group (p=0.01). Cortisol was lower in PCV prone (23.74±2.42 vs 24.9±2.16; p=0.03) and postoperative (25.63±3.35 vs 27.48±2.09; p=0.01). Glucose levels were lower in PCV group (p=0.01). Insulin and lactate levels were comparable. **Conclusion:** Pressure-controlled ventilation enhances respiratory mechanics and reduces stress response compared with volume-controlled ventilation during prone spine surgery, without affecting haemodynamic stability, suggesting its advantage as an intraoperative strategy.

INTRODUCTION

Mechanical ventilation is important during general anaesthesia within the operating room because it allows for gas exchange and haemodynamic stability to compensate for the absence of breathing.1 In complicated surgeries, the exact adjustment of mechanical ventilation contributes to maintaining homeostasis, decreasing the incidence of postoperative complications of the lungs, and enhancing results.1 Spine surgeries performed in a prone position, popularised due to advancements in surgery, create specific physiological issues related to cardiopulmonary function. The increase in pressure in the thorax and abdomen leads to decreased lung and chest wall compliance.2 Prone positioning can result in increased intrathoracic pressure, decreased venous return, and cardiovascular system functioning.2 It demands proper handling of breathing to ensure adequate ventilation and circulation balance. Although commonly employed, the best form of ventilation during this procedure remains controversial.

Pressure-controlled ventilation (PCV) and volume-controlled ventilation (VCV) are the main modes, with PCV characterised by breath delivery at a pre-set pressure and varying tidal volume with respect to compliance, whereas VCV involves breath delivery with pre-set tidal volumes and constant flow, but different airway pressures in view of changes in compliance and resistance. These differences result in various consequences for airway pressures, lung compliance, and ventilation.3-6 The use of the prone position implies compromised compliance; therefore, the avoidance of excessive airway pressure is important in this case. PCV appears to be related to a favourable pattern involving low airway pressure, higher lung compliance, and improved oxygenation compared with VCV.2 This advantage has been specifically demonstrated in the prone position during posterior lumbar spine surgery, where PCV was associated with lower peak airway pressures and better pulmonary compliance compared with VCV.4 PCV helps improve haemodynamics and limits stress responses in the prone position during spinal surgery. However, the superiority of PCV over VCV requires further investigation, as its advantages are significant. 2

Some studies have shown that the ventilation technique has no substantial effect on variables such as blood loss and the need for transfusion, which implies that with advances in the use of lung-protecting approaches, the differences might be minimal.7 Such findings highlight the challenge in managing mechanical ventilation, considering various factors such as the patients' physiological status, nature of surgery, and anaesthesia technique used. In addition to the effects on respiratory function, surgery induces stress responses through processes including sympathetic stimulation, cortisol secretion, and cytokine release, which help in sustaining homeostasis but in excess can result in poor outcomes.8,9 The administration of anaesthesia minimises the responses, but surgical stimulation is still a potent stimulus to different organs. Mechanical ventilation affects pulmonary physiology and stress responses. Any abnormality in gas exchange, such as hypoxia or hypercapnia, can trigger neuroendocrine and inflammatory responses.9,10 Unfavourable ventilatory parameters can induce ventilator-induced lung injury and exacerbate inflammation.10

The interaction between mechanical ventilation and stress response is of great importance. Different ventilation modalities impact the stress response during surgery; specifically, the use of PCV results in less stress and better haemodynamic performance in prone spine surgery.2 This research implies that there can be different outcomes regarding post-surgery performance related to the mode of ventilation used during surgery. Nevertheless, most researchers have focused on mechanical properties, while little attention has been paid to other physiological factors, such as the response to stress. Specifically, there are scarce data on the use of ventilation during prone-position spine surgery. While some researchers claim that PCV results in better mechanical and physiological performance, others provide conflicting evidence. 2,7 Therefore, a comprehensive assessment integrating respiratory and systemic parameters is required to determine the optimal ventilation strategy for this population.

This study aimed to compare the perioperative haemodynamic values, respiratory parameters during mechanical ventilation, arterial blood gas status, and systemic stress response in adults undergoing spine surgical procedures in the prone position under pressure-controlled versus volume-controlled ventilation.

MATERIALS AND METHODS

This prospective randomised controlled study was conducted in 60 adult patients attending the Government Rajaji Hospital, Madurai Medical College, over a period of one year. Ethical approval was obtained from the Institutional Ethical Committee, and written informed consent was obtained from all participants prior to study initiation.

Inclusion and Exclusion criteria

This study included adult patients of either sex aged 18-70 years with ASA grades 1 and 2, who were undergoing elective spine surgical procedures under general anaesthesia. Patients with ASA grades 3 and 4, history of cardiac, pulmonary, hepato-renal, endocrine, cerebrovascular, or neuromuscular diseases, history of thoracic surgery, emergency cases, bleeding or coagulation disorders, obesity (BMI >30 kg/m²), age <18 or >70 years, and patient refusal were excluded from the study.

Materials

The study used standard monitoring equipment (ECG, pulse oximeter, temperature probe), intravenous and arterial cannulas for invasive blood pressure monitoring, drugs for general anaesthesia such as midazolam, propofol, fentanyl, atracurium, suxamethonium, sevoflurane, oxygen, nitrous oxide delivery system, reinforced endotracheal tubes, blood sampling syringes for arterial blood gas analysis, and laboratory assessment of cortisol, insulin, glucose levels, and all necessary emergency drugs.

Methods

Sixty patients were randomised into Group PC (n=30) for pressure-controlled and Group VC (n=30) for volume-controlled ventilation during anaesthesia. Standard monitoring (ECG, pulse oximetry, and temperature) was performed. Intravenous access was secured, and midazolam (0.03 mg/kg) was administered. After the Allen test and local anaesthesia, a radial arterial cannula was inserted for continuous arterial pressure monitoring. Baseline blood samples were collected for arterial blood gas, cortisol, insulin, and glucose analyses. Anaesthesia was induced with propofol (2 mg/kg) and fentanyl (2 µg/kg). Suxamethonium (2 mg/kg) facilitated tracheal intubation. Anaesthesia was maintained with sevoflurane 0.5-1.0 MAC in oxygen and nitrous oxide. Additional fentanyl (0.5–1 µg/kg) maintained the systolic arterial pressure within ±20% of the baseline. Atracurium 0.5 mg/kg loading and 0.1 mg/kg maintenance doses ensured neuromuscular

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blockade. Train-of-four (TOF) monitoring was used to confirm adequate neuromuscular blockade maintenance throughout the procedure. Ventilatory parameters such as respiratory rate 12 breaths/min, inspiratory to expiratory ratio 1:2, positive end-expiratory pressure 5 cmH_2 O, and FiO_2 50% were used for both groups.

Group PC had an adjusted pressure support for a tidal volume of 8 ml/kg, while Group VC maintained a tidal volume of 8 ml/kg based on the predicted body weight. Heart rate, arterial pressure, end-tidal carbon dioxide, peak, plateau, and mean airway pressures were recorded in the supine position after intubation. Patients were positioned prone with the head neutral, arms beside the head, chest supported, knees flexed, and pressure points padded. After 30 min of proning, haemodynamic and respiratory parameters were recorded, and blood samples were collected for arterial blood gas, cortisol, insulin, and glucose analysis. Anaesthesia was continued until the completion of the surgery. Postoperative analgesia included paracetamol (1 g), tramadol (100 mg), and surgical wound infiltration with 0.5% bupivacaine (10–15 ml). Neuromuscular blockade was reversed with neostigmine (0.04 mg/kg) and glycopyrrolate (0.01 mg/kg), and tracheal extubation was performed when the patient was awake. Haemodynamic parameters were recorded, and final blood sampling for arterial blood gas, cortisol, insulin, and glucose was performed 60 min post-extubation without supplemental oxygen.

Statistical analysis

A pilot study was conducted to determine the required sample size. A power analysis calculated 30 patients per group to achieve 80% power with $\alpha = 0.05$, delta = 3.5, and standard deviation (SD) = 4.8.

Data are presented as mean, SD, frequency, and percentage. Continuous variables were analysed using Student's t-test or the Mann-Whitney U test, and categorical variables were analysed using the chi-square test. Spearman's correlation assessed numerical variable correlations. Statistical significance was set at $p < 0.05$. Statistical analyses were performed using the SPSS software.

RESULTS

The age distribution was comparable between the groups. In the VCV group, most patients were 30-40 years (12 [40.0%]), followed by 40-50 years (8 [26.7%]), <30 years old (5 [16.7%]), 50-60 years (4 [13.3%]), and 60-70 years (1 [3.3%]). In the PCV group, most were 30-40 years (18 [60.0%]), with equal distribution in the <30, 40-50, 50-60, and 60-70 years (3 [10.0%] each). The mean ages were 39.27±9.45 and 36.63 ± 7.31 years in the VCV and PCV groups, respectively, with no significant difference (p=0.232).

The sex distribution was similar. The VCV group included 16 (53.3%) men and 14 (46.7%) women, while the PCV group included 19 (63.3%) men and 11 (36.7%) women. Regarding weight distribution in the VCV group, most weighed 50-60 kg (13 [43.3%]), followed by 60-70 kg (11 [36.7%]) and 70-80 kg (6 [20.0%]). In the PCV group, 50-60 kg (13 [43.3%]), 70-80 kg (8 [26.7%]), and 60-70 kg (9 [30.0%]). The mean weight was 60.27±5.3 kg in the VCV group and 60.8±5.5 kg in the PCV group, with no significant difference (p=0.141). [Table 1]

Table 1: Baseline Demographic Characteristics of Patients

		VCV Group	PCV Group	P value
Age (years)	<30	5 (16.7%)	3 (10.0%)	0.232
	30-40	12 (40.0%)	18 (60.0%)	
	40-50	8 (26.7%)	3 (10.0%)	
	50-60	4 (13.3%)	3 (10.0%)	
	60-70	1 (3.3%)	3 (10.0%)	
	Mean ± SD	39.27±9.45	36.63±7.31	-
Sex	Male	16 (53.3%)	19 (63.3%)	-
	Female	14 (46.7%)	11 (36.7%)	
Weight (kg)	50-60	13 (43.3%)	13 (43.3%)	0.141
	60-70	11 (36.7%)	9 (30.0%)	
	70-80	6 (20.0%)	8 (26.7%)	
	Mean ± SD	60.27±5.3	60.8±5.5	-

Surgery duration was similar between the groups. In VCV, most surgeries exceeded 100 min (17 [56.7%]), followed by 90–100 min (10 [33.3%]) and under 90 min (3 [10.0%]). In PCV, most lasted 90-100 minutes (10 [33.3%]), then over 100 min (11 [36.7%]), and under 90 min (9 [30.0%]). The mean duration was 102.9±9.95 min for VCV and 98.33±11.38 min for PCV, with no significant difference (p=0.103), indicating similar durations. [Table 2]

Table 2: Duration of Surgery Among Patients

		VCV Group	PCV Group	P value
Duration of surgery (minutes)	<90	3 (10.0%)	9 (30.0%)	0.103
	90-100	10 (33.3%)	10 (33.3%)	
	>100	17 (56.7%)	11 (36.7%)	
	Mean ± SD	102.9±9.95	98.33±11.38	-

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Heart rates were similar between the groups. Preoperatively, the heart rate was 79.07±7.91 beats/min in the VCV group and 79.83±7.47 beats/min in the PCV group (p=0.35). In the prone position, the heart rate was 86.4±6.83 beats/min in the VCV group and 84.47±6.94 beats/min in the PCV group (p=0.14). Postoperatively, the heart rate was 88.9±5.94 beats/min in the VCV group and 88.63±5.56 beats/min in the PCV group (p=0.43).

Systolic arterial pressure was similar between the groups. The preoperative pressure was 122.33±11.01 mmHg in the VCV group and 123.57±8.7 mmHg in the PCV group (p=0.32). In the prone position, it was 118.07±6.92 mmHg in the VCV group and 119.47±6.98 mmHg in the PCV group (p=0.22). Postoperatively, it was 132.1±6.62 mmHg in the VCV group and 130.87±5.3 mmHg in the PCV group (p=0.21).

The mean arterial pressure did not differ significantly. Preoperatively, it was 88.63±3.93 mmHg in both groups (p=0.5). In the prone position, it was 92.07±4.73 mmHg in the VCV group and 92.07±4.7 mmHg in the PCV group (p=0.5). Postoperatively, it was 86.93±4.6 mmHg in the VCV group and 86.77±4.66 mmHg in the PCV group (p=0.44). [Table 3]

Table 3: Comparison of Hemodynamic Parameters Between Groups

		VCV Group	PCV Group	P value
Heart Rate (beats/min)	Preop	79.07±7.91	79.83±7.47	0.35
	Prone	86.4±6.83	84.47±6.94	0.14
	Postop	88.9±5.94	88.63±5.56	0.43
Systolic Arterial Pressure (mmHg)	Preop	122.33±11.01	123.57±8.7	0.32
	Prone	118.07±6.92	119.47±6.98	0.22
	Postop	132.1±6.62	130.87±5.3	0.21
Mean Arterial Pressure (mmHg)	Preop	88.63±3.93	88.63±3.93	0.5
	Prone	92.07±4.73	92.07±4.7	0.5
	Postop	86.93±4.6	86.77±4.66	0.44

Arterial oxygen tension (PaO_2) was similar between the groups. Preoperatively, the mean PaO_2 was 90.57±3.31 mmHg in the VCV group and 90.43±3.16 mmHg in the PCV group (p=0.44). In the prone position, PaO_2 rose to 168.37±18.26 mmHg in the VCV group and 166.7±16.17 mmHg in the PCV group (p=0.35). Postoperatively, values returned to 90.83±2.73 mmHg in the VCV group and 90.6±2.63 mmHg in the PCV group (p=0.37). The arterial carbon dioxide tension ($PaCO_2$) did not differ significantly. Preoperative $PaCO_2$ was 39.9±2.92 mmHg in the VCV group and 40.13±1.91 mmHg in the PCV group (p=0.36). In the prone position, the $PaCO_2$ was 37.13±4.66 mmHg in the VCV group and 37.73±3.84 mmHg in the PCV group (p=0.29). Postoperatively, $PaCO_2$ increased to 42.57±3.87 mmHg in the VCV group and 42.9±3.51 mmHg in the PCV group (p=0.36).

The arterial pH remained comparable. The preoperative pH was 7.37±0.03 in both groups (p=0.48). In the prone position, it was 7.4±0.04 in the VCV group and 7.39±0.05 in the PCV group (p=0.2). Postoperatively, the pH values were 7.39±0.03 in the VCV group and 7.39±0.04 in the PCV group (p=0.38). The end-tidal carbon dioxide ($ETCO_2$) values were also similar. In the supine position, the $ETCO_2$ was 33.87±1.66 mmHg in the VCV group and 33.77±1.76 mmHg in the PCV group (p=0.41). In the prone position, $ETCO_2$ increased slightly to 35±2.21 mmHg in the VCV group and 34.73±2.16 mmHg in the PCV group (p=0.32). [Table 4]

Table 4: Comparison of Arterial Blood Gas and Respiratory Parameters Between Groups

		VCV Group	PCV Group	P value
PaO_2 (mmHg)	Preop	90.57±3.31	90.43±3.16	0.44
	Prone	168.37±18.26	166.7±16.17	0.35
	Postop	90.83±2.73	90.6±2.63	0.37
$PaCO_2$ (mmHg)	Preop	39.9±2.92	40.13±1.91	0.36
	Prone	37.13±4.66	37.73±3.84	0.29
	Postop	42.57±3.87	42.9±3.51	0.36
pH	Preop	7.37±0.03	7.37±0.03	0.48
	Prone	7.4±0.04	7.39±0.05	0.2
	Postop	7.39±0.03	7.39±0.04	0.38
$ETCO_2$ (mmHg)	Supine	33.87±1.66	33.77±1.76	0.41
	Prone	35±2.21	34.73±2.16	0.32

The peak airway pressure varied significantly. In the supine position, it was higher in VCV (27.13±4.05 cmH_2O) than in PCV (23.87±1.33 cmH_2O) ($p<0.05$). Prone, it was higher in PCV (26.83±1.49 cmH_2O) than in VCV (25.81±1.35 cmH_2O) (p=0.003). The plateau pressure was lower in the PCV group. The supine values were 22.53±1.36 cmH_2O (VCV) and 21.8±0.89 cmH_2O (PCV) (p=0.01). The prone values were 23.23±1.1 cmH_2O (VCV) and 22.67±0.8 cmH_2O (PCV) (p=0.01).

The mean airway pressure was similar in the supine position: 11.77±0.68 cmH_2O (VCV) and 12±0.74 cmH_2O (PCV) (p=0.11). Prone, it was higher in PCV (12.4±0.67 cmH_2O) than in VCV (12±0.69

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cmH_2O) (p=0.01). Preoperative cortisol levels were similar (12.04±1.03 µg/dl, p=0.5). Prone, they had lower PCV (23.74±2.42 µg/dl) than VCV (24.9±2.16 µg/dl) (p=0.03). Postoperatively, PCV (25.63 ± 3.35 µg/dl) was lower than VCV (27.48±2.09 µg/dl) (p=0.01). Insulin levels were also similar. Preoperatively, they were 7.43±1.12 µIU/ml (p=0.5). Prone, they were 8.53±0.9 µIU/ml (VCV) and 8.16±1.29 µIU/ml (PCV) (p=0.1). Postoperatively, they were 13.25±1.92 µIU/ml (VCV) and 12.98±1.5 µIU/ml (PCV) (p=0.27).

Blood glucose levels were comparable preoperatively (91.77±6.01 mg/dl, p=0.5). Prone, they were higher in VCV (114.9±8.06 mg/dl) than in PCV (109.8±9.2 mg/dl) (p=0.01). Postoperatively, they were higher in VCV (128.2±6.51 mg/dl) than in PCV (125.23±8.22 mg/dl), but not significantly (p=0.06). Lactate levels were comparable between the groups. Preoperatively, the lactate was 2.58±0.39 mmol/l (p=0.5). Prone, they were 2.86±0.33 mmol/l (VCV) and 2.82±0.32 mmol/l (PCV) (p=0.32). Postoperatively, the values were 2.84±0.41 mmol/l (VCV) and 2.81±0.34 mmol/l (PCV) (p=0.37). [Table 5]

Table 5: Comparison of Airway Pressure and Systemic Stress Response Parameters Between Groups

		VCV Group	PCV Group	P value
Peak Airway Pressure (cmH_2O)	Supine	27.13±4.05	23.87±1.33	<0.05
	Prone	25.81±1.35	26.83±1.49	0.003
Plateau Pressure (cmH_2O)	Supine	22.53±1.36	21.8±0.89	0.01
	Prone	23.23±1.1	22.67±0.8	0.01
Mean Airway Pressure (cmH_2O)	Supine	11.77±0.68	12±0.74	0.11
	Prone	12±0.69	12.4±0.67	0.01
Cortisol (µg/dl)	Preop	12.04±1.03	12.04±1.03	0.5
	Prone	24.9±2.16	23.74±2.42	0.03
	Postop	27.48±2.09	25.63±3.35	0.01
Insulin (µIU/ml)	Preop	7.43±1.12	7.43±1.12	0.5
	Prone	8.53±0.9	8.16±1.29	0.1
	Postop	13.25±1.92	12.98±1.5	0.27
Glucose (mg/dl)	Preop	91.77±6.01	91.77±6.01	0.5
	Prone	114.9±8.06	109.8±9.2	0.01
	Postop	128.2±6.51	125.23±8.22	0.06
Lactate (mmol/l)	Preop	2.58±0.39	2.58±0.39	0.5
	Prone	2.86±0.33	2.82±0.32	0.32
	Postop	2.84±0.41	2.81±0.34	0.37

DISCUSSION

Our study compared pressure-controlled (PCV) and volume-controlled (VCV) ventilation on respiratory mechanics and systemic stress in patients undergoing prone spine surgery. Baseline characteristics, such as age (39.27±9.45 vs. 36.63±7.31 years; p=0.232), weight (60.27±5.3 vs. 60.8±5.5 kg; p=0.141), and surgery duration (102.9±9.95 vs. 98.33±11.38 min; p=0.103) were similar, ensuring valid outcome comparison. The haemodynamic parameters were similar between the two groups. Heart rate, systolic, and mean arterial pressure showed no significant differences, with prone heart rates of 86.4±6.83 beats/min in VCV and 84.47±6.94 beats/min in PCV (p=0.14). These results are consistent with those of Lee et al., who found no significant intergroup haemodynamic differences during prone spine surgery.10 Han et al.'s meta-analysis of 454 patients also showed no heart rate (MD: -0.55; 95% CI: -1.51 to 0.42; p=0.27) or mean arterial pressure (MD: 2.28; 95% CI: -0.60 to 5.17; p=0.12) differences between PCV and VCV groups.[12] However, Ragheb et al. reported lower heart rate and blood pressure in PCV, suggesting that haemodynamic effects may vary with patient and intraoperative factors.[13]

The arterial blood gas parameters and $ETCO_2$ values were comparable. PaO_2 in the prone position was 168.37±18.26 mmHg in VCV and 166.7±16.17 mmHg in PCV (p=0.35), with no significant $PaCO_2$ and pH differences. These findings match Lee et al.'s report of no significant arterial blood gas differences.[11] However, Han et al.'s meta-analysis showed improved oxygenation with PCV, as indicated by higher PaO_2/FiO_2 ratios, suggesting potential advantages of PCV under certain conditions.[12] Similarly, Gupta et al. (2021) reported higher postoperative PaO_2 levels in the PCV group (p=0.045), indicating improved oxygenation.[14] The lack of significant oxygenation differences in our study might be due to the adequate baseline pulmonary function and standardised ventilatory settings in both groups.

Respiratory mechanics favoured PCV, with significantly lower peak airway pressure in the PCV group (23.87±1.33 cmH_2O) than in the VCV group (27.13±4.05 cmH_2O; p<0.05) in the supine position. Plateau pressure was also lower in the PCV group in both supine (21.8±0.89 vs. 22.53±1.36 cmH_2O; p=0.01) and prone positions (22.67±0.8 vs. 23.23±1.1 cmH_2O; p=0.01). Lee et al. found lower peak airway pressures and higher dynamic compliance in the PCV-VG group than in the VCV group (p=0.045 and p=0.040, respectively).11 Han et al.'s meta-analysis supports these results, showing lower peak airway pressure (MD: −2.79; 95% CI: -3.50 to -2.07; p<0.00001) and higher dynamic compliance (MD: 6.34; 95% CI: 5.37 to 7.31; $p<0.00001$) with PCV than with VC.[12]

Gupta et al. reported lower peak airway pressures and better dynamic compliance with PCV. Sen et al. noted higher P-peak and P-plateau in the VCV group. Although in the prone position, peak airway pressure was slightly higher in the PCV group (26.83±1.49 vs 25.81±1.35 cmH_2O; p=0.003) this increases chest wall stiffness, and the peak pressure simply reflects this added resistance at airway level, the lower plateau pressure suggests improved alveolar mechanics with PCV.[14,15]

The mean airway pressure was higher in the PCV group in the prone position (12.4±0.67 vs. 12±0.69 cmH_2O; p=0.01), indicating improved alveolar recruitment, whereas Lee et al. found no significant difference.[11] Systemic stress markers favoured PCV, with lower cortisol levels in the prone position (23.74±2.42 vs. 24.9±2.16 µg/dl; p=0.03) and postoperatively (25.63±3.35 vs. 27.48±2.09 µg/dl; p=0.01). Blood glucose levels were also lower in the PCV group (109.8±9.2 vs. 114.9±8.06 mg/dl; p=0.01). Ragheb et al. reported lower serum cortisol and glucose levels with PCV, consistent with Gupta et al.'s findings of a smaller increase in these markers ($p<0.05$).[13,14] Sen et al. observed cortisol levels remained elevated in the VCV group but returned to baseline in the PCV group postoperatively. 15 Insulin and lactate levels were similar between the groups, which is consistent with the findings of Sen et al,[15]

Limitations

This study is limited by a small sample size, single-centre design, and short follow-up period. Exclusion of high-risk patients may limit generalisability, and lack of long-term outcomes restricts assessment of sustained clinical benefits.

CONCLUSION

This study demonstrates that pressure-controlled ventilation is associated with lower airway pressures and improved respiratory mechanics compared to volume-controlled ventilation during prone spine surgery, without compromising haemodynamic stability or arterial blood gas parameters. Although peak airway pressures were slightly higher in the prone position with PCV, plateau pressures remained lower, suggesting reduced alveolar stress. In addition, lower perioperative cortisol and blood glucose levels in the PCV group indicate an attenuated systemic stress response. Overall, PCV provided favourable respiratory and stress response profiles compared to VCV in this setting.

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