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Perioperative Hemodynamic Changes in Patients is Undergoing Spine Surgery Under General Anaesthesia

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Abstract

Background: *Prone positioning during spine surgery under general anesthesia causes cardiovascular and respiratory alterations that may compromise the perioperative stability. Understanding these changes is essential for safe anesthetic management, particularly after patient positioning. This study evaluated perioperative hemodynamic and respiratory changes following transition from supine to prone position in patients undergoing elective spine surgery under general anesthesia.*

Methods: *This observational study was conducted at a tertiary care orthopedic institute from January to December 2025. Eighty adult patients undergoing spinal surgery under standardized general anesthesia were enrolled in the study. Hemodynamic and respiratory parameters were recorded in the supine position, immediately after prone positioning and at 5 and 10 min thereafter. Data were analyzed using SPSS version 25.0.*

Results: *Transition to the prone position resulted in a significant reduction in systolic blood pressure from 128.5 ± 14.2 mmHg to 115.3 ± 11.0 mmHg, diastolic blood pressure from 74.8 ± 7.2 mmHg to 71.0 ± 6.5 mmHg and mean arterial pressure from 92.7 ± 8.6 mmHg to 85.8 ± 7.2 mmHg ($p < 0.001$). Peak airway pressure increased from 14.0 ± 1.6 cmH_2O to 15.7 ± 1.5 cmH_2O ($p < 0.001$). Heart rate, oxygen saturation and end-tidal carbon dioxide levels showed no significant changes. Systolic blood pressure and mean arterial pressure recovered to 123.1 ± 10.2 mmHg and 89.2 ± 6.5 mmHg within 10 minutes.*

Conclusion: *Prone positioning during spine surgery under general anesthesia causes significant but transient hemodynamic changes with stable respiratory parameters, emphasizing the need for vigilant monitoring during early post-positioning.*

Keywords: *Prone position, spine surgery, general anesthesia, hemodynamic changes.*

1. Introduction

Prone positioning is a standard practice during spine surgery to enhance surgical exposure and improve operative precision.

However, this positioning incurs significant physiological changes, particularly affecting the cardiovascular and respiratory systems during general anesthesia. The prone position alters venous return and increases intrathoracic pressure, which modifies pulmonary mechanics and can destabilize perioperative hemodynamics [1]. These changes necessitate a thorough understanding of the associated physiological responses to ensure safe anesthetic management in spine surgery patients.

General anesthesia itself influences autonomic nervous system regulation and vascular tone, which may magnify hemodynamic fluctuations prompted by positional changes. Transitioning from supine to prone position has been shown to reduce cardiac output and arterial blood pressure. This reduction is primarily attributed to decreased preload coupled with increased systemic vascular resistance [2]. Furthermore, prone positioning elevates airway pressures due to diminished chest wall compliance and abdominal compression, thus affecting ventilation dynamics adversely [3]. These respiratory changes parallel findings in patients with compromised pulmonary function, including the imbalanced ventilation-perfusion matching observed during prone positioning.

Hemodynamic responses to prone positioning vary across studies, likely due to heterogeneity in patient demographics, surgical types, anesthesia protocols and positioning devices [4]. Some investigations report pronounced declines in systolic and mean arterial pressures immediately following prone positioning, whereas others note minimal or transient changes, often followed by rapid physiological compensation [5]. These inconsistencies underline the importance of context-specific assessment frameworks, especially in resource-limited healthcare environments where monitoring capabilities may differ.

In low- and middle-income countries, perioperative monitoring standards and patient characteristics often contrast with those in high-income settings. Spine surgery candidates in these regions frequently present with comorbidities that predispose them to enhanced hemodynamic instability following positional transitions, yet contemporary regional data remain scarce [6]. Moreover, most existing research concentrates on single-point hemodynamic measurements, limiting insight into the short-term compensatory mechanisms that unfold after prone positioning. Continuous or sequential monitoring during this early period may yield a more detailed understanding of physiological adaptation, thereby informing anesthetic strategies [7].

This study seeks to evaluate perioperative hemodynamic and respiratory changes associated with transitioning from supine to prone position in spine surgery patients under general anesthesia. By examining immediate and time-dependent physiological responses, the investigation aims to fill existing gaps in knowledge and contribute relevant evidence to optimize perioperative care and patient safety in diverse clinical contexts.

2. Materials & Methods

This hospital-based observational study was conducted in the Department of Anesthesiology at the National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, Bangladesh. The study period extended from January to December 2025. Adult patients undergoing elective spine surgery under general anesthesia were included. The study population consisted of patients requiring prone positioning during surgery and receiving standardized anesthetic management.

2.1. Sample Selection

Inclusion Criteria:

- Adult patients aged 18 years and above.
- Patients scheduled for elective spine surgery under general anesthesia.
- Patients classified as ASA physical status I–III.
- Patients requiring intraoperative prone positioning.

Exclusion criteria:

- Patients with significant cardiovascular instability.
- Patients with severe pulmonary disease or restrictive lung pathology.
- Patients with morbid obesity (BMI $\geq$ 35 kg/m²).

2.2. Data Collection Procedure

After obtaining informed consent, eligible patients were enrolled in this study. Preoperative assessment included demographic data, ASA classification and baseline vital parameters. Standard monitoring was applied in the operating room, including electrocardiography, noninvasive blood pressure, pulse oximetry, capnography and airway pressure monitoring. General anesthesia was induced using standardized agents, followed by endotracheal intubation and controlled mechanical ventilation. Hemodynamic and respiratory parameters were recorded in the supine position after induction and stabilization. Patients were then carefully transitioned to the prone position using standard positioning aids to avoid abdominal compression. Immediate post-positioning measurements were recorded once hemodynamic stability was achieved. Additional recordings were taken at 5 and 10 minutes following prone positioning. All measurements were documented by the attending anesthesiology team using calibrated monitors to ensure consistency and accuracy. Data confidentiality was maintained through anonymized coding and patient identifiers were excluded from analysis.

2.3. Statistical Analysis

Data were analyzed using SPSS version 25.0. Continuous variables were expressed as mean ± standard deviation. Comparisons between supine and prone positions were performed using paired t-tests. Repeated-measures analysis of variance was applied for time-dependent comparisons. A p-value < 0.05 was considered statistically significant.

3. Results

Table 1. *Baseline Characteristics of the Study Population (n = 80)*

Characteristic		Frequency (n)	Percentage (%)
Age Group	≤30 years	16	20.0
	31–50 years	40	50.0
	>50 years	24	30.0
	Mean ± SD	42.5 ± 12.3	
Sex	Male	56	70.0
	Female	24	30.0
BMI (kg/m²)	Mean ± SD	24.8 ± 3.2	
Duration of Surgery (minutes)	Mean ± SD	145 ± 35	
ASA Physical Status	ASA I–II	64	80.0
	ASA III	16	20.0

Table 1 shows baseline demographic and clinical characteristics of the study population. Half of the patients were aged 31–50 years, with a mean age of 42.5 ± 12.3 years. Male patients constituted 70% and the mean body mass index was 24.8 ± 3.2 kg/m². The average duration of surgery was 145 ± 35 minutes.

Most patients belonged to ASA physical status I–II (80%), while 20% were classified as ASA III.

Table 2. *Comparison of Hemodynamic and Respiratory Parameters Between Supine and Immediate Prone Position (n = 80)*

Parameter	Supine Mean ± SD	Immediate Prone Mean ± SD	Mean Difference	p-value
Heart Rate (beats/min)	79.2 ± 11.5	78.1 ± 10.8	1.1	0.312
Systolic BP (mmHg)	128.5 ± 14.2	115.3 ± 11.0	13.2	<0.001
Diastolic BP (mmHg)	74.8 ± 7.2	71.0 ± 6.5	3.8	<0.001
Mean Arterial Pressure (mmHg)	92.7 ± 8.6	85.8 ± 7.2	6.9	<0.001
Peak Airway Pressure (cmH_2O)	14.0 ± 1.6	15.7 ± 1.5	–1.7	<0.001
End-tidal CO_2 (mmHg)	34.6 ± 3.0	35.2 ± 2.8	–0.6	0.145
SpO_2 (%)	98.7 ± 1.0	99.0 ± 0.9	–0.3	0.089

Table 2 presents a comparison of hemodynamic and respiratory parameters between the supine position and immediate prone positioning. Mean systolic blood pressure decreased from 128.5 ± 14.2 mmHg to 115.3 ± 11.0 mmHg, while diastolic blood pressure decreased from 74.8 ± 7.2 mmHg to 71.0 ± 6.5 mmHg. Mean arterial pressure declined from 92.7 ± 8.6 mmHg to 85.8 ± 7.2 mmHg. Peak airway pressure increased from 14.0 ± 1.6 cmH_2O to 15.7 ± 1.5 cmH_2O. Heart rate, end-tidal carbon dioxide and oxygen saturation showed minimal variation.

Table 3. *Hemodynamic and Airway Pressure Changes Over Time Following Prone Positioning (n = 80)*

Parameter	Immediate Mean ± SD	5 Minutes Mean ± SD	10 Minutes Mean ± SD	P-value
Heart Rate (beats/min)	78.1 ± 10.8	77.0 ± 9.8	77.4 ± 9.9	0.421
Systolic BP (mmHg)	115.3 ± 11.0	119.2 ± 10.5	123.1 ± 10.2	<0.001
Diastolic BP (mmHg)	71.0 ± 6.5	71.6 ± 6.0	72.3 ± 5.9	0.156
Mean Arterial Pressure (mmHg)	85.8 ± 7.2	87.5 ± 6.7	89.2 ± 6.5	<0.001
Peak Airway Pressure (cmH_2O)	15.7 ± 1.5	16.0 ± 1.4	15.9 ± 1.3	0.023

Table 3 describes changes in hemodynamic and airway parameters over time following prone positioning. Systolic blood pressure increased progressively from 115.3 ± 11.0 mmHg immediately after positioning to 123.1 ± 10.2 mmHg at 10 minutes. Mean arterial pressure increased from 85.8 ± 7.2 mmHg to 89.2 ± 6.5 mmHg during the same interval. Heart rate and diastolic blood pressure remained stable. Peak airway pressure showed a mild but consistent elevation over time.

4. Discussion

This study evaluated perioperative hemodynamic and respiratory responses to prone positioning in patients undergoing spine surgery under general anesthesia and demonstrated distinct, predictable physiological changes. The most notable findings were a significant immediate reduction in arterial blood pressure parameters and a concomitant rise in peak airway pressure following transition from supine to prone position, with gradual hemodynamic recovery within 10 minutes. These findings reinforce the clinical relevance of close monitoring during early post-positioning and align with existing evidence on positional physiology under anesthesia [8,9]. The observed drop in systolic blood pressure by approximately 13 mmHg and mean arterial pressure reduction aligns mechanistically with diminished venous return due to inferior vena cava compression and blood volume redistribution, phenomena exacerbated by anesthesia-induced vasodilation [10]. Comparable immediate blood pressure decreases following prone positioning have been documented in spine surgery contexts, reinforcing the commonality and clinical relevance of these changes [11].

Despite these reductions, heart rate remained relatively stable, changing minimally from 79.2 ± 11.5 beats/min in the supine position to 78.1 ± 10.8 beats/min after prone positioning. The absence of compensatory tachycardia suggests blunted autonomic reflexes under general anesthesia and adequate intravascular volume status in the study population. Similar heart rate stability has been reported by Chui and Craen, who observed preserved chronotropic control despite significant preload alterations during prone positioning [12]. This finding underscores the importance of arterial pressure monitoring rather than reliance on heart rate alone as an indicator of hemodynamic compromise.

This study's key strength lies in its assessment of short-term hemodynamic changes following prone positioning, with observed increases in systolic blood pressure (from 115.3 ± 11.0 mmHg to 123.1 ± 10.2 mmHg) and mean arterial pressure (from 85.8 ± 7.2 mmHg to 89.2 ± 6.5 mmHg) within 10 minutes, indicating partial hemodynamic recovery. These changes likely reflect underlying compensatory mechanisms, such as venous blood redistribution and stabilization of preload, which promote transient recovery after initial hypotension. Previous research similarly demonstrated time-dependent recovery of arterial pressure within minutes of prone positioning in physiologically stable patients, supporting the notion that early hypotension is often transient after positioning changes [13].

The relative stability of diastolic blood pressure (maintaining approximately 71-72 mmHg) aligns with maintained systemic vascular resistance, which prior studies have suggested increases during prone positioning as a compensatory response to reduced cardiac output. This mechanism helps stabilize diastolic pressure despite reductions in preload and cardiac output, supporting the physiologic explanation noted in this cohort [14]. The predominance of ASA I–II patients in this study cohort likely contributed to the observed hemodynamic resilience, facilitating rapid compensatory responses and limiting hypotension duration. In contrast, patients with higher ASA classifications or pre-existing cardiovascular disease have been reported to experience more sustained and pronounced hypotension during prone positioning, emphasizing the influence of preoperative physiological reserve on hemodynamic outcomes during positioning changes [15].

Clinically, these findings underscore the importance of anticipating immediate blood pressure reductions and increased airway pressures after prone positioning, necessitating adequate volume optimization, avoidance of abdominal compression and continuous monitoring—either invasive or noninvasive—to prevent adverse events. The observed stability in oxygenation and ventilation parameters also supports the safety of prone positioning when standardized anesthetic and positioning protocols are applied, consistent with reports showing improved ventilation-perfusion matching and oxygenation without compromising hemodynamics in patients with acute respiratory distress syndrome (ARDS) [16].

Importantly, this study provides valuable region-specific evidence from a South Asian tertiary care setting, addressing the scarcity of localized anesthetic data in low- and middle-income countries. This aligns with expert calls emphasizing the need for locally generated perioperative research to guide anesthesia practice in these regions [17]. By integrating immediate and short-term physiological responses, this research provides actionable insights applicable to routine spine surgeries under general anesthesia in similar healthcare contexts.

5. Limitations and Recommendations

The study was conducted at a single center with a relatively small sample size which limits the generalizability of the findings. Future multicenter studies with larger cohorts, including patients with significant comorbidities, are recommended to enhance generalizability and guide individualized anesthetic-management strategies.

6. Conclusion

This study demonstrated that the transition from the supine to the prone position during spine surgery under general anesthesia results in predictable transient reductions in arterial blood pressure and a concomitant increase in peak airway pressure. The hemodynamic parameters showed a gradual recovery within 10 min, whereas the respiratory gas exchange remained stable. These findings highlight the importance of vigilant perioperative monitoring during positional changes to ensure hemodynamic stability and patient safety in the prone position.

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Conflicts of Interest: There are no conflicts of interest.

References

[1] Shu Q, Dong Y, Chen W, Shen J. Profound hypoxemia and hypotension during posterior spinal fusion in a spinal muscular atrophy child with severe scoliosis: a case report. BMC anesthesiology. 2024 Apr 18;24(1):148.

[2] Yu L, Liu X, Zhao X, Shan X, Bischof E, Lu HH. Ciprofol versus propofol for anesthesia induction in cardiac surgery: a randomized double-blind controlled clinical trial. BMC anesthesiology. 2024 Nov 12;24(1):412.

[3] Wang YX, Zhong M, Dong MH, Song JQ, Zheng YJ, Wu W, Tao JL, Zhu L, Zheng X. Prone positioning improves ventilation–perfusion matching assessed by electrical impedance tomography in patients with ARDS: a prospective physiological study. Critical Care. 2022 May 27;26(1):154.

[4] Wilson JP, Bonin B, Quinones C, Kumbhare D, Guthikonda B, Hoang S. Spinal anesthesia for awake spine surgery: a paradigm shift for enhanced recovery after surgery. Journal of Clinical Medicine. 2024 Sep 9;13(17):5326.

[5] Hahn RG. Fluid distribution during surgery in the flat recumbent, Trendelenburg and the reverse Trendelenburg body positions. Acta Anaesthesiologica Scandinavica. 2024 Sep;68(8):1059-67.

[6] Eltaher E, Nasr N, Abuelnaga ME, Elgawish Y. Effect of ultrasound-guided thoracolumbar interfascial plane block on the analgesic requirements in patients undergoing lumbar spine surgery under general anesthesia: a randomized controlled trial. Journal of pain research. 2021 Nov 3:3465-74.

[7] Yan S, Li Q, He K. The effect of esketamine combined with propofol-induced general anesthesia on cerebral blood flow velocity: a randomized clinical trial. BMC anesthesiology. 2024 Feb 20;24(1):66.

[8] Edgcombe H, Carter K, Yarrow S. Anaesthesia in the prone position. Br J Anaesth. 2008;100(2):165-183.

[9] Zeuzem-Lampert C, Groene P, Brummer V, Hofmann-Kiefer K. Cardiorespiratory effects of perioperative positioning techniques. Der Anaesthesist. 2019 Dec 1;68(12):805-13.

[10] Szrama J, Gradys A, Bartkowiak T, Woźniak A, Nowak Z, Zwoliński K, Lohani A, Jawień N, Smuszkiewicz P, Kusza K. The incidence of Perioperative Hypotension in patients undergoing major abdominal surgery with the use of arterial waveform analysis and the hypotension prediction index hemodynamic Monitoring—A retrospective analysis. Journal of Personalized Medicine. 2024 Feb 2;14(2):174.

[11] Gilbertson LE, Muhly WT, Montana MC, Chidambaran V, DiCindio S, Sadacharam K, Wilder RT, Whyte SD, Hifko A, Sponseller PD, Frankville DD. A survey of practice in the anesthetic management of adolescent idiopathic scoliosis spine fusion by the North American Pediatric Spine Anesthesiologists Collaborative. Pediatric Anesthesia. 2024 Jul;34(7):645-53.

[12] Chui J, Craen RA. La position ventrale: une mise à jour. Canadian Journal of Anesthesia/Journal canadien d'anesthésie. 2016 Jun; 63:737-67.

[13] Olmos M, Esperatti M, Fuentes N, Miranda Tirado A, Gonzalez ME, Kakisu H, Suarez J, Tisminetzky M, Barbaresi V, Santomil I, Bruhn Cruz A. Early physiologic changes after awake prone positioning predict clinical outcomes in patients with acute hypoxemic respiratory failure. Intensive Care Medicine. 2024 Dec;50(12):2105-13.

[14] Boesing C, Graf PT, Schmitt F, Thiel M, Pelosi P, Rocco PR, Luecke T, Krebs J. Effects of different positive end-expiratory pressure titration strategies during prone positioning in patients with acute respiratory distress syndrome: a prospective interventional study. Critical Care. 2022 Mar 26;26(1):82.

[15] Schmidt M, Hajage D, Lebreton G, Dres M, Guervilly C, Richard JC, Sonneville R, Winiszewski H, Muller G, Beduneau G, Mercier E. Prone positioning during extracorporeal membrane oxygenation in patients with severe ARDS: the PRONECMO randomized clinical trial. Jama. 2023 Dec 26;330(24):2343-53.

[16] Wang YX, Zhong M, Dong MH, Song JQ, Zheng YJ, Wu W, Tao JL, Zhu L, Zheng X. Prone positioning improves ventilation–perfusion matching assessed by electrical impedance tomography in patients with ARDS: a prospective physiological study. Critical Care. 2022 May 27;26(1):154.

[17] Zaaqoq AM, Barnett AG, Griffee MJ, MacLaren G, Jacobs JP, Heinsar S, Suen JY, Bassi GL, Fraser JF, Dalton HJ, Peek GJ. Beneficial effect of prone positioning during venovenous extracorporeal membrane oxygenation for coronavirus disease 2019. Critical Care Medicine. 2022 Feb 1;50(2):275-85

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