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Case Series

Hemodynamic instability associated with flank oblique supine modified lithotomy position in percutaneous nephrolithotomy under general anaesthesia: A case series

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Abstract

Supine percutaneous nephrolithotomy (PCNL) has certain advantages over prone PCNL like easier surgical access, airway safety and minimal pressure effects that are well documented in the literature, albeit there is less information on cardiovascular benefits. We report a series of significant hypotension in ten patients undergoing PCNL in Flank-Free Oblique Supine Modified Lithotomy (FOSML) under general anaesthesia. The hypotension onset was immediate post positioning in FOSML necessitating intermittent vasopressor use until the patient was repositioned following surgery. Our results are in direct opposition to the theoretical haemodynamic stability attained in supine PCNL that has been reported in numerous urological journals.

Keywords: Hypotension, Percutaneous nephrolithotom, Prone position, General anaesthesia.

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1. Introduction

Percutaneous nephrolithotomy (PCNL) has replaced conventional pyelolithotomy for treatment of large (>2 cm) renal stones, complex stones and anatomic abnormalities of the kidneys and is done under various modifications of supine and prone positions.[1] Anaesthetic challenges in prone position has been well documented which includes hypotension & reflex tachycardia, direct and indirect pressure injuries, postoperative visual loss and difficulty in maintaining airway patency.[2] Hypotension in the prone position occurs due to a multitude of factors which may be due to increased stroke volume and decreased peripheral resistance, decreased stroke volume & increased peripheral resistance seen in chronic cervical myelopathy patients, or it can be due to compression of inferior vena cavae.[3,4]

To counter these, many modifications of supine positions like Valdivia, modified Valdivia, flank roll, crossed leg, galdakao and complete supine and modified flank free were developed. The flank free Oblique Supine Modified Lithotomy (FOSML), a relatively newer position has been deemed the best with maximum surgical ease and least amount of anaesthetic challenges, including cardiovascular stability.[5,6] We encountered 10 patients with significant hypotension after positioning the patient in FOSML that remained until the patient was repositioned post-surgery, necessitating the use of vasopressors and constant monitoring during the procedure.[7]

2. Case Series

A total of 22 patients underwent percutaneous nephrolithotomy (PCNL) in the FOSML position from October 2022 to March 2023. Of these, 10 patients who developed significant hypotension immediately following positioning, defined as a greater than 20% drop in systolic blood pressure (SBP), diastolic blood pressure (DBP), or mean arterial pressure (MAP), were included in this

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descriptive case series. All patients were classified as American Society of Anesthesiologists (ASA) physical status I or II, excluding those with hypertension, and underwent preoperative assessment.

The procedure was thoroughly explained to all patients, and informed written consent was obtained, including permission to use the data for research and publication purposes. In accordance with ASA guidelines, all patients were kept nil per oral. Baseline vital parameters, including heart rate (HR), blood pressure (BP), oxygen saturation (SpO_2), and end-tidal CO_2 ($ETCO_2$), were recorded. Appropriate intravenous (IV) access was secured, and all patients were premedicated with glycopyrrolate (5 µg/kg), fentanyl (1-2 mcg/kg), and midazolam (0.01-0.02 mg/kg) intravenously.

Preoxygenation with 100% oxygen was performed for 3 minutes via a Bains circuit, followed by induction with propofol (2-3 mg/kg) intravenously. A neuromuscular blocking drug, vecuronium (0.1 mg/kg), was administered intravenously. Endotracheal intubation was performed with appropriately sized tubes, and anesthesia was maintained with sevoflurane (MAC of 0.8-2%) in a 50:50 oxygen and nitrous oxide mixture.

All patients were placed in the FOSML position, with their upper back turned towards the contralateral side by placing a padded support below the ipsilateral side, as shown in **Figure 1**. The lower limbs were fixed on lithotomy poles, and an inflatable gel pad was placed under the ipsilateral buttock region. The ipsilateral lower limb was extended at the hip and partially flexed at the knee, positioned below the level of the table. The contralateral lower limb was in the conventional lithotomy position, as shown in **Figure 2**. The gel pad was inflated to lift the ipsilateral flank. There was no support under the loin, providing more space for ideal renal access compared to the complete supine position.

Figure 1: Flank oblique supine modified lithotomy

Figure 2: Patient positioning

Systolic, diastolic, and mean arterial blood pressures were periodically measured immediately after positioning, at 5 minutes, 15 minutes, and 30 minutes post-positioning, as well as after repositioning post-surgery. Significant hypotension was noted in all 10 patients, with a greater than 20% decrease in all three blood pressure parameters (SBP, DBP, and MAP) from baseline ($P<0.05$) after placing them in the FOSML position. The drop in blood pressure did not respond to fluid boluses, necessitating intermittent intravenous ephedrine boluses and constant monitoring throughout the surgery. The MAC of the inhalational agent was maintained at a minimum (0.3–0.6) or turned off during the period of hypotension.

Data entry was done using MS Excel, and statistical analysis was carried out using SPSS Statistics version 21, with chi-square and paired t-tests, using STATA version 11. Numerical variables, such as age, BMI, and blood pressure parameters (SBP, DBP, MAP), were expressed as mean and standard deviation (SD), while categorical variables like gender, ASA status, and side of surgery were expressed as frequencies (%). A p-value of ≤ 0.05 was considered statistically significant for all tests.

There were no statistically significant differences in the demographic variables, including gender, ASA physical status, age, BMI, and side of surgery, with all factors being comparable ($P>0.05$), as detailed in **Table 1**. The average duration of surgery for all patients was 158.7 ± 11.66 minutes. Following anesthesia induction, a significant drop in systolic and diastolic blood pressures was observed (SBP: 131 ± 7.5 to 110.6 ± 21.0 mmHg, p=0.02; DBP: 84.7 ± 10.2 to 76.1 ± 13.2 mmHg, p=0.03), while the decrease in MAP was not statistically significant (p=0.07). No significant change in blood pressure was noted immediately after intubation compared to post-induction values.(**Table 2**)

Table 1: Demographic profile

S. No.	Variable	General Anaesthesia
1.	**Gender**	
	Male, No%	5(50%)
	Female, No%	5(50%)
2.	**ASA**	
	I, No%	7(70%)
	II, No%	3(30%)
3.	**Age, Mean ± SD, y**	37.7 ± 6.9
4.	**BMI[a], Mean ± SD, kg/m^2**	22.73±0.87
5.	**Side of PCNL**	
	Right	7(70%)
	Left	3(30%)

Table 2: Comparison of blood pressure parameters at different intervals during pre, post and repositioning of the patient

Pre-induction vs post induction blood pressure											
Pre Induction SBP (mean) mm Hg	Post Induction SBP (mean) Mm Hg	95% Confidence Interval (CI)	p-value	Pre Induction DBP (mean) mm hg	Post Induction DBP (mean) mm hg	95% Confidence Interval (CI)	p-value	Pre Induction MAP (mean) mm hg	Post Induction MAP (mean) mm hg	95% Confidence Interval (CI)	p-value
131±7.50	110.60±21.00	2.95 to 37.85	0.02	84.70±10.21	76.10±13.16	0.99 to 16.21	0.03	96.20±7.41	86.80±15.94	-1.20 to 20.00	0.07
Post induction vs post intubation (immediate) blood pressure											
Post Induction SBP (mean) Mm Hg	Post Intubation SBP (mean) mm hg	95% Confidence Interval (CI)	P value	Post Induction DBP (mean) mm hg	Post Intubation DBP (mean) mm hg	95% Confidence Interval (CI)	p-value	Post Induction MAP (mean) mm hg	Post Intubation MAP (mean) mm hg	95% Confidence Interval (CI)	p-value
110.60±21.00	112.20±8.90	-11.43 to 8.23	0.7	76.10±13.16	75.40±8.41	-8.13 to 9.53	0.8	86.80±15.94	87.30±7.87	-9.39 to 8.39	0.9
Post intubation vs post positioning (immediate) blood pressure											
Post Intubation SBP (mean) mm Hg	Post Positioning Immediate SBP (mean) mm Hg	95% Confidence Interval (CI)	p-value	Post Intubation DBP (mean) mm hg	Post Positioning Immediate DBP (mean) mm Hg	95% Confidence Interval (CI)	p-value	Post Intubation MAP (mean) mm hg	Post Positioning Immediate MAP (mean) mm Hg	95% Confidence Interval (CI)	p-value
112.20±8.90	81.80±5.03	24.83 to 35.97	0.0001	75.40±8.41	51.70±7.41	17.06 to 30.34	0.0001	87.30±7.87	62.20±6.46	18.78 to 31.42	0.0001
Post intubation vs post positioning (5 min) blood pressure											
Post Intubation SBP (mean) mm Hg	5 Minutes Post Positioning SBP (mean) mm Hg	95% Confidence Interval (CI)	p-value	Post Intubation DBP (mean) mm hg	5 min Post Positioning DBP (mean) mm Hg	95% Confidence Interval (CI)	p-value	Post Intubation MAP (mean) mm hg	5 min Post Positioning MAP (mean) mm Hg	95% Confidence Interval (CI)	p-value
112.20±8.90	91.60±7.69	14.99 to 26.21	0.0001	75.40±8.41	62.10±9.81	4.32 to 22.28	0.008	87.30±7.87	70.30±9.32	8.58 to 25.42	0.001
Post intubation vs post positioning (10 min) blood pressure											
Post Intubation SBP(mean) mm Hg	10 Minutes Post Positioning SBP(mean) mm Hg	95% Confidence Interval (CI)	p-value	Post Intubation DBP (mean) mm hg	10 min Post Positioning DBP (mean) mm Hg	95% Confidence Interval (CI)	p-value	Post Intubation MAP (mean) mm hg	10 min Post Positioning MAP (mean) mm Hg	95% Confidence Interval (CI)	p-value
112.20±8.90	104.60±12.08	2.08 to 13.12	0.01	75.40±8.41	69.10±10.09	-0.08 to 12.68	0.05	87.30±7.87	79.90	0.92 to 13.88	0.02
Post positioning (immediate) vs post repositioning blood pressure											
Post-Positioning Immediate SBP(mean) mm Hg	Post Repositioning SBP(mean) mm Hg	95% Confidence Interval (CI)	p-value	Post-Positioning Immediate DBP(mean) mm Hg	Post Repositioning DBP(mean) mm Hg	95% Confidence Interval (CI)	p-value	Post-Positioning Immediate MAP(mean) mm Hg	Post Repositioning MAP(mean) mm Hg	95% Confidence Interval (CI)	p-value
81.80±5.03	118.70±11.61	-46.36 to -27.44	0.0001	51.70±7.41	75.70±9.20	-31.19 to -16.81	0.0001	62.20±6.46	89.80±10.63	-35.10 to -20.10	0.0001

However, a marked reduction in all blood pressure parameters was observed immediately after patient positioning (SBP: p=0.0001, DBP: p=0.0001, MAP: p=0.0001), which persisted at 5 and 10 minutes post-positioning, though the changes became less pronounced over time. Upon repositioning, blood pressure significantly increased across all measures (SBP, DBP, and MAP; p=0.0001), indicating reversal of the hypotensive effect induced by the initial positioning, as shown in **Table 2**. On average, all 10 patients required a bolus of ephedrine (21 ± 5.53 mg intravenously).

3. Discussion

The flank-free oblique supine modified lithotomy (FOSML) position represents an evolution of the supine approach for percutaneous nephrolithotomy (PCNL), offering improved surgical access and reduced pressure-related complications. However, our case series presents a notable contradiction to the existing literature: a consistent and significant hypotension occurring immediately after patient positioning in FOSML, persisting intraoperatively until repositioning, and requiring pharmacologic intervention.

Supine positioning in PCNL is generally favored for its presumed haemodynamic stability, airway security, and easier anaesthetic management compared to prone positioning. Studies have supported these advantages, reporting minimal alterations in cardiac output or systemic vascular resistance in supine variations, especially with careful padding and limb positioning.[8,9] However, FOSML diverges from the conventional supine posture through a combination of torso rotation, flank elevation via a gel pad or wedge, and asymmetric lower limb placement, which may introduce new physiological challenges.

The observed hypotension in our patients may be multifactorial. One possible mechanism is impaired venous return due to partial obstruction of the inferior vena cava (IVC) or iliac veins from mechanical compression by the inflated gel pad or saline wedge under the ipsilateral flank. Literature suggests that any increase in intra-abdominal or intrathoracic pressure, particularly in lateral or semi-lateral supine postures, can impede venous return to the right atrium and thereby reduce preload and cardiac output.[10,11] Additionally, the extended positioning of the ipsilateral leg below table level could act as a gravitational venous reservoir, exacerbating venous pooling and further compromising preload.

Further, contralateral lithotomy positioning may increase compartmental pressures, reducing perfusion to the lower limbs and adding to systemic vascular resistance variability. While no formal compartment syndrome was diagnosed in any of the ten patients, transient ischemic effects from prolonged lithotomy have been documented in similar surgical contexts.[12]

Unlike prone PCNL, where intra-abdominal compression and IVC obstruction are well-known contributors to hypotension, supine approaches have been largely considered safer.[13] Khoshrang et al. observed more haemodynamic stability in supine PCNL compared to prone, particularly in terms of mean arterial pressure (MAP) fluctuations.[14] Wang et al. also asserted that the modified supine position offered minimal interference with cardiovascular physiology.[15] However, both studies did not specifically evaluate the FOSML variant, leaving a gap in the literature that our series attempts to fill.

In our cases, hemodynamic instability was not responsive to fluid boluses alone and required intermittent administration of ephedrine. This suggests that the hypotension was not solely due to relative hypovolemia or anaesthetic depth, but rather the mechanical and positional factors inherent to the FOSML position. The reduction in the inhalational anaesthetic concentration during periods of hypotension further rules out excessive anaesthetic depression as the primary cause.

Our findings stand in contrast to those of Indra et al., who reported mild hypotension at later stages of surgery (60-120 minutes) with general anesthesia in supine PCNL.[16] In contrast, the hypotension observed in our series was immediate and sustained. This difference may reflect the specific biomechanical changes associated with the FOSML positioning, rather than being attributed to anaesthetic technique alone.

One limitation of our report is its nature as a descriptive case series without a matched control group. Although 10 of the 22 patients exhibited the hypotensive pattern, the absence of a concurrent comparator group (such as normotensive FOSML cases or patients in the prone position) limits our ability to accurately quantify the true incidence of hypotension or isolate specific risk factors. However, the consistent appearance of this hemodynamic pattern across all 10 cases strengthens the hypothesis that the observed hypotension may be position-related. Future studies should aim to directly compare the FOSML position with prone and other supine modifications under standardized anaesthetic protocols to provide a clearer understanding of the effect.

Moreover, this series highlights the critical role of anesthesiologists in evaluating surgical positioning strategies. While urologists may optimize renal access through positional adjustments, the systemic effects of such modifications on perfusion, especially under general anesthesia, need careful consideration. This is especially important for patients with limited cardiovascular reserve or those at risk for organ hypoperfusion, where even minor changes in positioning could have significant physiological consequences.

4. Conclusion

The Flank-Free Oblique Supine Modified Lithotomy (FOSML) position can cause significant intraoperative hypotension under general anesthesia, challenging the assumption that all supine modifications are hemodynamically safer than the prone position. Despite its surgical advantages, this case series highlights a potential anaesthetic concern that requires further investigation. Future studies should compare hemodynamic responses across different PCNL positions and establish evidence-based perioperative guidelines.

5. Declaration of Patient Consent

Written informed consent was obtained from the patient for publication of this case series and any accompanying images.

6. Source of Funding

None.

7. Conflict of Interest

None.

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