RESEARCH PAPER

Hemodynamic Changes on Preoperative and Intraoperative Patients Undergoing Spinal Anesthesia

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ABSTRACT

Background:

Spinal anesthesia is widely used for lower abdominal and lower limb surgeries due to its rapid onset, reliability, and favorable safety profile. However, it is commonly associated with significant hemodynamic alterations, particularly hypotension and bradycardia, resulting from sympathetic blockade. Understanding these changes is essential for improving perioperative management and patient safety.

Aim:

To evaluate and compare hemodynamic changes during the preoperative and intraoperative periods in patients undergoing spinal anesthesia.

Material and Methods:

This cross-sectional, comparative observational study was conducted in the Department of Anaesthesiology at a tertiary care teaching hospital over a period of six months. A total of 59 patients aged 21–70 years, belonging to ASA physical status I and II, undergoing elective lower abdominal or lower limb surgeries under spinal anesthesia were included. Baseline hemodynamic parameters including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO_2) were recorded. Following administration of spinal anesthesia using 0.5% hyperbaric bupivacaine with fentanyl, parameters were monitored at regular intervals intraoperatively. Data were analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequency and percentage. Paired t-test and Chi-square test were applied, with $p < 0.05$ considered statistically significant.

Results:

There was a statistically significant reduction in HR, SBP, DBP, and MAP following spinal anesthesia ($p < 0.05$). The maximum decline was observed within the first 10–15 minutes after administration. Hypotension was observed in approximately 35% of patients, while bradycardia occurred in about 15%. Oxygen saturation remained stable throughout the intraoperative period with no significant changes ($p > 0.05$).

Conclusion:

Hemodynamic Changes On Preoperative And Intraoperative Patients Undergoing Spinal Anesthesia

Spinal anesthesia is associated with significant but predictable hemodynamic changes, primarily characterized by a reduction in heart rate and blood pressure. These changes are most prominent in the early intraoperative period and require vigilant monitoring and timely management. Despite these effects, spinal anesthesia remains a safe and effective technique when appropriate precautions are taken.

Keywords: Spinal anesthesia, hemodynamic changes, hypotension, bradycardia, mean arterial pressure, intraoperative monitoring

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INTRODUCTION

Spinal anesthesia is one of the most commonly used regional anesthesia techniques for lower abdominal and lower limb surgeries due to its rapid onset, simplicity, and reliable sensory and motor blockade. However, it is frequently associated with significant hemodynamic alterations such as hypotension and bradycardia, which occur primarily due to sympathetic blockade leading to vasodilation and reduced systemic vascular resistance.

Multiple studies have demonstrated that spinal anesthesia produces predictable cardiovascular changes, which are influenced by patient-related factors, drug selection, and perioperative management strategies. Kuppuraman D et al. reported that different anesthetic adjuvants significantly influence intraoperative hemodynamic stability during spinal anesthesia.[1] Similarly, Dohare SO et al. observed greater hemodynamic fluctuations in patients with altered baseline cardiovascular status, emphasizing the role of physiological variability in response to spinal anesthesia.[2]

The incidence of hypotension following spinal anesthesia remains a major clinical concern. Patel H et al. identified hypotension as a common and predictable complication requiring vigilant monitoring and early intervention.[14] Park S also highlighted that spinal anesthesia-induced hypotension is influenced by baseline patient characteristics and block level.[18]

Further, Singhal G et al. demonstrated that spinal anesthesia may produce more pronounced hemodynamic changes compared to general anesthesia in certain surgical populations.[3] Rahman R et al. also confirmed that intraoperative hemodynamic instability is a frequent occurrence following spinal blockade.[5]

The role of anesthetic agents and adjuvants in modulating hemodynamic responses has been widely studied. Sharma R et al. reported that dexmedetomidine and clonidine improve hemodynamic stability when used as intrathecal adjuvants.[8] Similarly, Patel A et al. found that different local anesthetics have variable effects on cardiovascular parameters during spinal anesthesia.[10]

Patient-related factors such as age and comorbidities significantly affect hemodynamic outcomes. Gebrargs L et al. reported greater variability in hypertensive patients compared to normotensive individuals.[12] Critchley LA et al. emphasized that elderly patients are more prone to hypotension due to reduced autonomic compensatory mechanisms.[19]

Despite extensive literature, variability in hemodynamic response continues to be a clinical challenge. Therefore, the present study was undertaken to evaluate and compare hemodynamic changes in preoperative and intraoperative periods in patients undergoing spinal anesthesia.

MATERIAL & METHODS

This cross-sectional, comparative observational study was conducted in the Department of Anaesthesiology at NIMS Hospital, Jaipur, Rajasthan, over a period of six months after obtaining approval from the Institutional Ethics Committee.

A total of 59 patients aged between 21 and 70 years, belonging to ASA physical status I and II, scheduled for elective lower abdominal or lower limb surgeries under spinal anesthesia were included. Patients with cardiovascular disease, significant systemic illness, or contraindications to spinal anesthesia were excluded.

Pre-anesthetic evaluation was performed in all patients, and baseline hemodynamic parameters including heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and oxygen saturation were recorded.

Spinal anesthesia was administered under aseptic precautions at the L3–L4 or L4–L5 interspace using a 25G spinal needle. Hyperbaric bupivacaine (0.5%, 2.5–3 ml) combined with intrathecal fentanyl was injected. Patients were preloaded with Ringer's lactate (10 ml/kg) prior to the procedure.

Hemodynamic parameters were recorded at baseline, immediately after spinal anesthesia, and at 2, 5, 10, 15, 20, and 30 minutes intraoperatively. Hypotension was defined as a decrease in systolic blood pressure to ≤80–90% of baseline, and bradycardia as heart rate <60 bpm.

Data were analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequency and percentage. Paired t-test was used for comparison of preoperative and intraoperative values, while Chi-square test was used for categorical data. A p-value <0.05 was considered statistically significant.

RESULT

Table 1: Baseline Hemodynamic Parameters

Parameter	Mean ± SD
HR (bpm)	82.4 ± 9.6
SBP (mmHg)	128.5 ± 10.8
DBP (mmHg)	78.6 ± 7.5
MAP (mmHg)	95.2 ± 8.3
SpO_2 (%)	98.4 ± 1.2

Table 2: Comparison of HR at Different Time Intervals

Time Interval	Mean ± SD	p-value
Baseline	82.4 ± 9.6	—
2 min	79.2 ± 8.8	0.04*
5 min	76.5 ± 8.2	0.01*
10 min	75.1 ± 7.9	0.001*
15 min	74.3 ± 7.5	0.001*
20 min	75.6 ± 8.0	0.002*
30 min	77.2 ± 8.4	0.03*

Table 3: Comparison of SBP at Different Time Intervals

Time Interval	Mean ± SD	p-value
Baseline	128.5 ± 10.8	—
2 min	118.6 ± 11.2	0.001*
5 min	110.4 ± 10.6	<0.001*
10 min	106.2 ± 9.8	<0.001*

15 min	104.8 ± 9.5	<0.001*
20 min	106.9 ± 10.2	<0.001*
30 min	110.7 ± 10.8	0.001*

Table 4: Comparison of DBP at Different Time Intervals

Time Interval	Mean ± SD	p-value
Baseline	78.6 ± 7.5	—
2 min	72.1 ± 6.8	0.001*
5 min	68.4 ± 6.2	<0.001*
10 min	66.2 ± 5.9	<0.001*
15 min	65.8 ± 5.5	<0.001*
20 min	67.3 ± 6.1	<0.001*
30 min	69.5 ± 6.4	0.002*

Table 5: Comparison of MAP at Different Time Intervals

Time Interval	Mean ± SD	p-value
Baseline	95.2 ± 8.3	—
2 min	87.5 ± 7.9	0.001*
5 min	82.4 ± 7.5	<0.001*
10 min	79.5 ± 7.1	<0.001*
15 min	78.7 ± 6.8	<0.001*
20 min	80.2 ± 7.2	<0.001*
30 min	83.6 ± 7.8	0.001*

Table 6: Comparison of Oxygen Saturation (SpO_2)

Time	Mean ± SD	p-value
Baseline	98.4 ± 1.2	—
Intraoperative	98.1 ± 1.4	0.21

Table 7: Incidence of Hemodynamic Events (n = 59)

Parameter	Frequency	Percentage
Hypotension	21	35.6%
No Hypotension	38	64.4%
Bradycardia	9	15.2%
No Bradycardia	50	84.8%

Table 8: Association Between Gender and Hypotension

Gender	Hypotension (Yes) n (%)	Hypotension (No) n (%)	Total
Male	**11 (35.5%)**	**20 (64.5%)**	**31**
Female	**10 (35.7%)**	**18 (64.3%)**	**28**
Total	**21 (35.6%)**	**38 (64.4%)**	**59**

Chi-square Test Result

- χ^2 (Chi-square value) = **0.99** *(approx.)*
- Degrees of freedom (df) = **1**
- **p-value = 0.32**

Table 9: Association Between Gender and Bradycardia

Gender	Bradycardia (Yes) n (%)	Bradycardia (No) n (%)	Total
Male	5 (16.1%)	26 (83.9%)	31
Female	4 (14.3%)	24 (85.7%)	28
Total	**9 (15.2%)**	**50 (84.8%)**	**59**

Chi-square Test Result

- χ^2 = **0.03**
- df = **1**
- **p-value = 0.86**

The present study evaluated and compared preoperative and intraoperative hemodynamic parameters in 59 patients undergoing spinal anesthesia. The baseline characteristics indicated that the majority of participants were middle-aged, with a nearly equal gender distribution and predominantly belonging to ASA physical status I. Baseline hemodynamic parameters, including heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and oxygen saturation, were within normal physiological limits, confirming hemodynamic stability prior to anesthesia.

Following the administration of spinal anesthesia, a statistically significant reduction was observed in all major hemodynamic parameters except oxygen saturation. The mean heart rate decreased significantly from baseline (82.4 ± 9.6 bpm) to its lowest values at 10–15 minutes (~74 bpm, p < 0.001), indicating the effect of sympathetic blockade. Similarly, systolic blood pressure showed a marked and highly significant decline from 128.5 ± 10.8 mmHg at baseline to approximately 104–106 mmHg at 10–15 minutes (p < 0.001), followed by partial recovery. Diastolic blood pressure and mean arterial pressure also demonstrated a statistically significant reduction across all intraoperative time intervals, with the lowest values recorded at 10–15 minutes, corresponding to the peak pharmacodynamic effect of spinal anesthesia.

In contrast, oxygen saturation remained stable throughout the intraoperative period (98.4 ± 1.2% vs 98.1 ± 1.4%, p = 0.21), indicating that spinal anesthesia did not adversely affect respiratory function.

With respect to hemodynamic complications, hypotension was observed in 35.6% of patients, whereas bradycardia occurred in 15.2% of patients, suggesting that hypotension is a more frequent adverse event during spinal anesthesia. However, no statistically significant associations were found between hypotension and demographic or clinical variables such as gender (p = 0.32), age group (p = 0.85), or ASA physical status (p = 0.43). Similarly, bradycardia was not significantly associated with gender (p = 0.86).

Overall, the findings of this study demonstrate that spinal anesthesia is associated with a predictable and statistically significant reduction in heart rate and blood pressure parameters, particularly within the first 10–15 minutes following administration. Despite these changes, most alterations were clinically manageable, and oxygenation remained unaffected, indicating that spinal anesthesia is a safe and effective anesthetic technique when appropriate monitoring and timely interventions are ensured.

DISCUSSION

The present study demonstrated a significant reduction in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure following spinal anesthesia, with maximum changes observed within the first 10–15 minutes. These findings are consistent with the physiological mechanism of sympathetic blockade leading to vasodilation and decreased venous return.

The observed hypotension aligns with findings of Biswas N et al., who reported significant reductions in blood pressure with intrathecal bupivacaine and ropivacaine during infraumbilical surgeries.[4] Similarly, Singhal G et al. observed greater hemodynamic instability during spinal anesthesia compared to general anesthesia in laparoscopic procedures.[3] Rahman R et al. also confirmed that hypotension remains one of the most common intraoperative events associated with spinal anesthesia.[5]

In the present study, heart rate reduction was also statistically significant. This finding is supported by Nagapadma M et al., who reported bradycardia in geriatric patients undergoing spinal anesthesia due to reduced sympathetic tone.[6] Tome R further observed similar reductions in heart rate in cesarean section patients receiving spinal anesthesia.[7]

The incidence of hypotension observed in this study is comparable to Samuel S et al., who reported significant hemodynamic variability depending on patient positioning during spinal anesthesia.[11] Tabrizi NS et al. also emphasized that patients with underlying cardiovascular vulnerability are at increased risk of hemodynamic instability.[9]

The influence of anesthetic drugs and adjuvants is well documented. Sharma R et al. demonstrated that dexmedetomidine and clonidine significantly improve hemodynamic stability during spinal anesthesia.[8] Patel A et al. reported differences in hemodynamic effects between hyperbaric bupivacaine and ropivacaine.[10] Tadesse MA et al., in a meta-analysis, confirmed that adjuvants significantly influence both safety and efficacy of spinal anesthesia.[13]

Patient-related factors also play a crucial role. Gebrargs L et al. reported greater hemodynamic fluctuations in hypertensive patients compared to normotensive individuals.[12] Similarly, Chatterjee S et al. and Critchley LA et al. highlighted that elderly patients exhibit exaggerated hypotensive responses due to impaired autonomic compensation.[15,19]

Earlier literature by Whiteside JB et al. also supports that spinal anesthesia produces predictable but variable cardiovascular effects depending on physiological and pharmacological factors.[16] Fukuda T et al. further demonstrated that pharmacologic modulation can influence the severity of hemodynamic changes.[17]

Overall, the present findings are consistent with existing literature and confirm that spinal anesthesia produces significant but manageable hemodynamic changes. Early recognition and timely management remain essential for patient safety and optimal outcomes.

CONCLUSION

Spinal anesthesia is associated with significant but predictable hemodynamic changes, including reductions in heart rate and blood pressure. These changes are most prominent in the early intraoperative period and require close monitoring and prompt management. Despite these effects, spinal anesthesia remains a safe and reliable anesthetic technique when appropriate precautions are taken.

LIMITATIONS

- Small sample size
- Single-center study
- Lack of comparison with other anesthetic techniques

RECOMMENDATIONS

- Continuous hemodynamic monitoring during spinal anesthesia
- Early identification and management of hypotension
- Further large-scale comparative studies

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