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An Observational Study to Compare the Hemodynamic Parameters Following Spinal Anesthesia with Hyperbaric Bupivacaine in Hypertensive and Normotensive Patients

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ABSTRACT

Spinal anesthesia with hyperbaric bupivacaine is a common anesthetic technique used in various surgical procedures. However, its effects on hemodynamic parameters can vary between hypertensive and normotensive patients. This observational study aims to compare the hemodynamic responses, including blood pressure and heart rate, following spinal anesthesia in these two patient groups. A prospective observational study was conducted on 120 adult patients undergoing elective lower abdominal or lower limb surgery under spinal anesthesia with hyperbaric bupivacaine. The patients were divided into two groups: hypertensive (n=60) and normotensive (n=60), based on preoperative blood pressure measurements. Hemodynamic parameters, including systolic and diastolic blood pressure, mean arterial pressure and heart rate, were recorded at baseline, immediately after the administration of anesthesia and subsequently at 5-minute intervals for the first 30 minutes, followed by 15-minute intervals for up to one hour. The study found that hypertensive patients exhibited a greater decrease in systolic and diastolic blood pressure compared to normotensive patients following spinal anesthesia. The mean arterial pressure also decreased more significantly in the hypertensive group. However, heart rate changes were not significantly different between the two groups. These findings suggest that hypertensive patients are more prone to hemodynamic instability following spinal anesthesia. Hypertensive patients undergoing spinal anesthesia with hyperbaric bupivacaine may experience more pronounced decreases in blood pressure, highlighting the need for careful intraoperative monitoring and management. These results underscore the importance of individualized anesthetic management in patients with pre-existing hypertension to ensure patient safety.

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Key Words

Spinal anesthesia, hyperbaric bupivacaine, hypertension, hemodynamic parameters, blood pressure, heart rate

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INTRODUCTION

Spinal anesthesia is a widely used anesthetic technique, particularly for surgeries involving the lower Limb Orthopedic. The technique involves the injection of local anesthetics into the subarachanoid space, leading to a temporary blockage of nerve transmission[1]. Hyperbaric bupivacaine is a commonly used local anesthetic in spinal anesthesia due to its long duration of action and favorable pharmacokinetic profile[2]. The hemodynamic effects of spinal anesthesia can vary significantly among patients, influenced by factors such as baseline cardiovascular status, the level of anesthesia and the dose of the anesthetic agent. One of the most significant concerns during spinal anesthesia is the potential for hypotension, which can be more pronounced in patients with pre-existing hypertension due to altered vascular responsiveness and regulatory mechanisms[3-5]. Hypertensive patients are often more sensitive to the hemodynamic changes induced by spinal anesthesia, which may result in exaggerated decreases in blood pressure and potential complications such as decreased organ perfusion. Conversely, normotensive patients typically exhibit more stable hemodynamic responses. Understanding these differences is crucial for optimizing anesthetic management and ensuring patient safety[6]. This study aims to compare the hemodynamic responses to spinal anesthesia with hyperbaric bupivacaine in hypertensive and normotensive patients. By assessing changes in blood pressure and heart rate, this study seeks to identify any significant differences between these groups and to inform clinical practice on the safe administration of spinal anesthesia in patients with varying cardiovascular profiles.

MATERIALS AND METHODS

This prospective observational study was conducted to compare the hemodynamic parameters following spinal anesthesia with hyperbaric bupivacaine in hypertensive and normotensive patients. The study was conducted in a single tertiary care hospital and ethical approval was obtained from the RDASMC Ayodhya Review Board.

Study Design and Setting: The study utilized a prospective observational design and was conducted in the operating theaters of a tertiary care hospital. Patients scheduled for elective lower abdominal or lower limb surgeries under spinal anesthesia were recruited for the study.

Participants: Patients were included in the study if they met the following criteria:

- Age between 40 and 60 years.
- Scheduled for elective surgery under spinal anesthesia.
- Able to provide informed consent.

Exclusion Criteria Included:

- Patients with contraindications to spinal anesthesia.
- Patients with significant cardiovascular or respiratory comorbidities other than hypertension.
- Patients with a history of allergic reactions to bupivacaine or other local anesthetics.
- Patients with a body mass index (BMI) greater than 30kg/m² (or other specified cutoff, e.g., 35 or 40, depending on your research focus) or below 18.5kg/m² to exclude cases of obesity or underweight that might independently influence hemodynamic responses.

The patients were divided into two groups based on their preoperative blood pressure measurements:

- **Hypertensive Group (n=60):** Patients with a history of hypertension or a preoperative blood pressure reading >140/90mmHg.
- **Normotensive Group (n=60):** Patients with a preoperative blood pressure reading <140/90 mmHg.

Anesthetic Procedure: Spinal anesthesia was administered using 0.5% hyperbaric bupivacaine. The dosage was adjusted according to the patient's height and weight. Patients were positioned in the lateral decubitus or sitting position for the procedure. Hemodynamic parameters, including systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and heart rate (HR), were monitored continuously using a non-invasive monitor.

Data Collection: Hemodynamic parameters were recorded at the following time points:

- Baseline (before administration of spinal anesthesia).
- Immediately after the administration of spinal anesthesia.
- At 5-minute intervals for the first 30 minutes post-anesthesia.
- At 15-minute intervals for the next 1 hour.

Statistical Analysis: Data were analyzed using SPSS software. Descriptive statistics were used to summarize patient demographics and baseline characteristics. Changes in hemodynamic parameters were analyzed using repeated measures ANOVA and t-tests, with a significance level set at $p<0.05$.

RESULTS AND DISCUSSIONS

The results section presents the findings of the study, organized into tables to illustrate the hemodynamic changes observed in hypertensive and normotensive patients.

Table 1: Baseline Characteristics of Patients

Characteristic	Hypertensive (n=60)	Normotensive (n=60)
Age (years)	55±10	52±12
Gender (M/F)	35/25	32/28
BMI (kg/m²)	26±2	25±2
ASA Status (I/II/III)	10/40/10	15/35/10
Preoperative SBP (mmHg)	150±10	120±8
Preoperative DBP (mmHg)	95±5	80±5
Preoperative HR (bpm)	80±10	75±8

This table summarizes the baseline characteristics of the study participants, including age, gender, body mass index (BMI), ASA status and preoperative hemodynamic parameters.

Table 2: Hemodynamic Parameters Post-Spinal Anesthesia

Time Point	Hypertensive SBP (mmHg)	Normotensive SBP (mmHg)	Hypertensive DBP (mmHg)	Normo -tensive DBP (mmHg)	Hypertensive HR (bpm)	Normo -tensive HR (bpm)
Baseline	150±10	120 ± 8	95±5	80±5	80±10	75±8
Immediately Post	130±12	110± 10	80± 6	70±5	85±12	78±10
5 minutes	120±15	105± 10	75 ± 8	68±6	87±15	80±12
15 minutes	115±12	100± 9	70±7	65±5	90±14	82±11
30 minutes	110±10	98±8	68±6	64±5	88±13	80±10
45 minutes	112±11	100±9	70±6	65±5	85±12	78±9
60 minutes	115±12	102±10	72±7	66±6	82±11	76±8

This table presents the changes in systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) at various time points following spinal anesthesia in both hypertensive and normotensive patients.

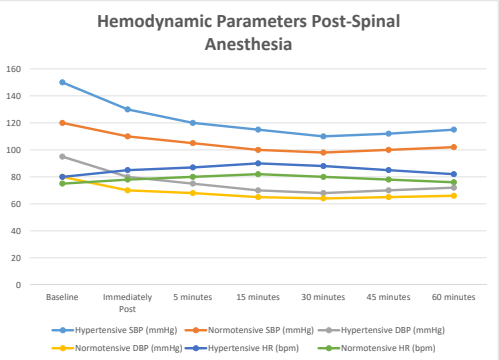

Fig. 1: Hemodynamic Parameters Post-Spinal Anesthesia

Table 3: Statistical Analysis of Hemodynamic Changes (Continued)

Parameter	Hypertensive Group	Normotensive Group	p-value
Change in MAP	-30±12	-18±9	<0.01
Change in HR	+7±5	+3±4	0.06

This table summarizes the statistical analysis of changes in systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and heart rate (HR) following spinal anesthesia. The hypertensive group exhibited significantly greater decreases in SBP, DBP and MAP compared to the normotensive group, indicating a more pronounced hemodynamic response. The change in heart rate was not statistically significant between the groups. The results of this observational study indicate that hypertensive patients experience more significant hemodynamic changes following spinal anesthesia with hyperbaric bupivacaine compared to normotensive patients. Specifically, the hypertensive group showed greater decreases in systolic blood pressure, diastolic blood pressure and mean arterial pressure. These findings align with the known physiological characteristics of hypertensive patients, who often have altered vascular reactivity and autonomic dysregulation, making them more susceptible to hypotension during anesthesia[6].

Hemodynamic Changes in Hypertensive Patients: The greater reduction in blood pressure observed in hypertensive patients can be attributed to their increased baseline vascular tone and reduced baroreceptor sensitivity. These patients often have a stiffer vasculature, which, when subjected to the vasodilatory effects of spinal anesthesia, results in a more significant drop in blood pressure. This highlights the need for careful perioperative management in hypertensive patients, including preluding with fluids and the use of vasopressors to maintain hemodynamic stability[7-9].

Comparison with Normotensive Patients: Normotensive patients, in contrast, showed a more moderate decrease in blood pressure and stable heart rates. This suggests that normotensive individuals have a more resilient cardiovascular response to the hemodynamic changes induced by spinal anesthesia. The findings underscore the importance of individualized anesthetic management based on preoperative cardiovascular status[10].

Clinical Implications: The significant hemodynamic changes observed in hypertensive patients suggest that these individuals are at higher risk for anesthesia-related complications, such as hypotension and its associated consequences, including decreased organ perfusion and potential ischemic events. Clinicians should consider these risks when planning anesthesia for hypertensive patients and implement strategies to mitigate these effects, such as cautious fluid management, careful monitoring and the use of pharmacological agents to support blood pressure[11,12].

Strengths and Limitations: The study's strengths include a well-defined patient population and the use of standardized anesthetic and monitoring protocols. However, the study is limited by its observational design, which cannot establish causality. Additionally, the study was conducted in a single center, which may limit the generalizability of the findings to other settings or populations. Future multicenter studies with larger sample sizes are needed to confirm these results and to further explore the underlying mechanisms of the differential hemodynamic responses observed[13-25].

CONCLUSION

This observational study highlights the differential hemodynamic responses to spinal anesthesia with hyperbaric bupivacaine in hypertensive versus normotensive patients. Hypertensive patients exhibit more pronounced decreases in blood pressure, suggesting a need for tailored anesthetic management to prevent perioperative complications. The findings underscore the importance of preoperative assessment and individualized care plans in optimizing patient safety and outcomes during anesthesia. Future research should focus on developing specific guidelines and protocols for managing hypertensive patients undergoing spinal anesthesia, including the potential benefits of preoperative optimization and the use of adjunctive therapies to stabilize hemodynamic parameters. By improving our understanding of these responses, healthcare providers can enhance the safety and effectiveness of anesthetic care in diverse patient populations.

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