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Original Article

Hemodynamic Responses to Spinal Anesthesia in Hypertensive Patients Receiving Angiotensin Receptor Blockers: A Comparative Analysis

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ABSTRACT

Background: Hypotension is a frequent complication of spinal anesthesia. Hypertensive patients receiving renin–angiotensin–aldosterone system (RAAS) inhibitors, particularly angiotensin receptor blockers (ARBs), may be more susceptible to hemodynamic instability. However, evidence regarding continuation versus withdrawal of ARBs before spinal anesthesia remains inconclusive.
Objective: To evaluate and compare hemodynamic responses to spinal anesthesia in normotensive patients, hypertensive patients who continued ARBs on the day of surgery, and hypertensive patients who withheld ARBs preoperatively.
Methods: This prospective comparative observational study was conducted at a tertiary care center. The primary outcome was the incidence of spinal-anesthesia-induced hypotension, defined as a ≥20% reduction in mean arterial pressure (MAP) from baseline. Secondary outcomes included changes in MAP, vasopressor (ephedrine) requirement, and heart rate variations. Statistical analysis involved chi-square or Fisher's exact test for categorical variables and ANOVA or Kruskal–Wallis test for continuous variables. Multivariable logistic regression was used to identify predictors of hypotension.
Results: A total of 120 patients were enrolled, with 40 patients in each group. Hypotension occurred most frequently in patients who continued ARBs (45%), followed by those who withheld ARBs (22.5%), and was least common in normotensive patients (10%). Greater reductions in MAP and higher vasopressor requirements were observed in the ARB-continued group. Hemodynamic trends were illustrated using tables and figures.
Conclusion: Continuation of ARBs on the day of spinal anesthesia is associated with increased hypotension and higher vasopressor requirements compared to withholding ARBs. These findings support individualized perioperative management of ARBs and highlight the need for further randomized controlled trials.

Keywords: *spinal anesthesia, hypotension, angiotensin receptor blocker, ARB, hypertension, perioperative management, mean arterial pressure.*

INTRODUCTION

Spinal anesthesia is widely used for lower abdominal, pelvic, and lower limb procedures owing to its rapid onset, effective neural blockade, and reduced airway-related complications. Despite these benefits, hypotension remains a common adverse effect of spinal anesthesia, primarily resulting from sympathetic blockade leading to vasodilation and reduced systemic vascular resistance [1,2]. The reported incidence of hypotension following spinal anesthesia ranges from 15% to 50%, depending on patient- and technique-related factors [3]. Hypertension is one of the most common

comorbid conditions encountered in surgical patients, and angiotensin receptor blockers are frequently prescribed for long-term blood pressure control. ARBs block the vasoconstrictive effects of angiotensin II, thereby reducing vascular tone and aldosterone secretion [4]. While beneficial for hypertension management, this mechanism may impair compensatory responses during anesthesia-induced vasodilation, increasing the risk of perioperative hypotension [5]. Several studies have reported a higher incidence of intraoperative hypotension in patients who continue RAAS inhibitors, including ARBs, during the perioperative period [6,7]. Conversely, withholding ARBs prior to surgery has been shown to reduce hypotensive episodes in some studies, although results remain inconsistent across different anesthetic techniques [8]. Evidence specifically focusing on spinal anesthesia is limited, leading to variability in clinical practice regarding perioperative ARB management [9]. Therefore, this study aimed to compare the hemodynamic effects of spinal anesthesia among normotensive patients and hypertensive patients receiving ARBs, with emphasis on continuation versus withdrawal of ARBs.

MATERIALS AND METHODS

This was a prospective comparative observational study conducted at a tertiary care hospital after approval from the institutional ethics committee. Adult patients aged 18–65 years scheduled for elective lower abdominal or lower limb surgery under spinal anesthesia were enrolled.

Inclusion Criteria

- ASA physical status I–III
- Patients receiving spinal anesthesia
- Hypertensive patients on stable ARB therapy for ≥4 weeks
- Normotensive patients not receiving antihypertensive drugs

Exclusion Criteria

- Emergency surgery
- Combined spinal–epidural or general anesthesia
- Patients on ACE inhibitors or multiple antihypertensive agents
- Cardiac valvular disease, heart failure, autonomic neuropathy
- Incomplete hemodynamic data

Group Allocation

- Patients were divided into three groups:
- Group N: Normotensive patients
- Group AC: Hypertensive patients who continued ARBs on the day of surgery
- Group AS: Hypertensive patients who withheld ARBs 24 hours before surgery

Anesthetic Technique

Spinal anesthesia was administered using 0.5% hyperbaric bupivacaine under standard monitoring. Baseline heart rate and blood pressure were recorded before spinal injection.

Outcome Measures

Hypotension was defined as a ≥20% decrease in mean arterial pressure (MAP) from baseline. Vasopressor requirement and MAP changes at predefined intervals were recorded.

Statistical Analysis

Data were analyzed using standard statistical software. Continuous variables were expressed as mean ± SD and compared using one-way ANOVA or Kruskal–Wallis test, as appropriate. Categorical variables were compared using the chi-square or Fisher's exact test. Changes in mean arterial pressure over time were analyzed using repeated measures ANOVA. A p-value < 0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Characteristics of Patients

Variable	Normotensive (n=40)	ARB Continued (n=40)	ARB Withheld (n=40)	P-value
Age (years)	45.2 ± 8.1	47.6 ± 7.9	46.9 ± 8.3	0.42
Baseline SBP (mmHg)	124 ± 9	138 ± 11	136 ± 10	<0.001
Baseline MAP (mmHg)	82 ± 6	91 ± 7	89 ± 6	<0.001
Baseline HR (bpm)	72 ± 8	74 ± 9	73 ± 8	0.61

Baseline demographic characteristics were comparable among the three groups, except for higher baseline blood pressure values in hypertensive patients (Table 1).

Table 2: Incidence of Hypotension

Group	Patients with Hypotension n (%)
Normotensive	4 (10%)
ARB Continued	18 (45%)
ARB Withheld	9 (22.5%)

The incidence of spinal-anesthesia-induced hypotension was significantly higher in patients who continued ARBs compared with those who withheld ARBs and normotensive patients (Table 2, $p < 0.01$).

Table 3: Mean Arterial Pressure Changes (mmHg)

Time (min)	Normotensive	ARB Continued	ARB Withheld
Baseline	82 ± 6	91 ± 7	89 ± 6
5 min	72 ± 5	68 ± 6	76 ± 5
10 min	73 ± 6	70 ± 6	78 ± 6
15 min	75 ± 5	74 ± 6	80 ± 5
20 min	76 ± 5	79 ± 6	83 ± 5

Mean arterial pressure decreased in all groups following spinal anesthesia; however, the decline was more pronounced in the ARB-continued group, particularly during the early post-spinal period (Table 3, Figure 1).

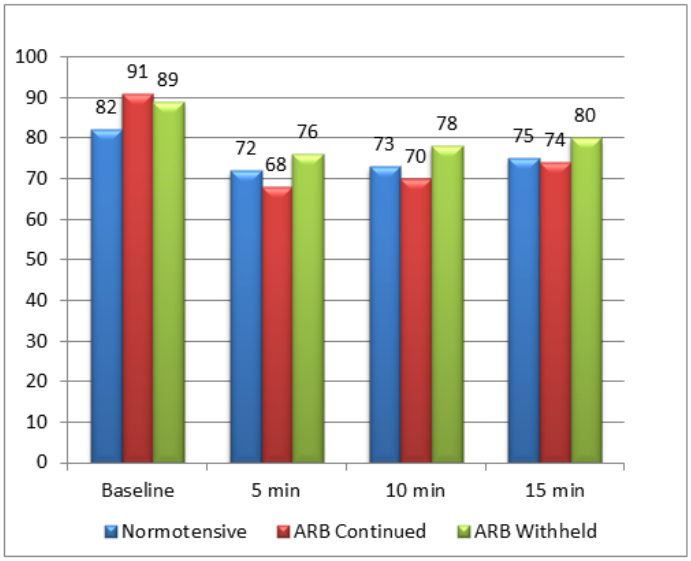

Figure 1: Changes in mean arterial pressure following spinal anesthesia

Table 4: Maximum Percentage Drop in MAP

MAP Drop (%)	Normotensive	ARB Continued	ARB Withheld
<10%	18	6	12
10–20%	18	16	19
≥20%	4	18	9

A greater proportion of patients in the ARB-continued group experienced a ≥20% reduction in MAP (Table 4).

Table 5: Vasopressor (Ephedrine) Requirement

Group	Mean Ephedrine Dose (mg)
Normotensive	4.5 ± 3.2
ARB Continued	18.2 ± 6.4
ARB Withheld	9.6 ± 4.1

Vasopressor requirements were significantly higher among patients who continued ARBs compared to the other groups (Table 5).

DISCUSSION

The findings of this study indicate that continuation of angiotensin receptor blockers on the day of surgery is associated with a higher incidence of hypotension following spinal anesthesia. This observation supports existing literature suggesting that RAAS inhibition interferes with compensatory vasoconstrictive mechanisms necessary to maintain blood pressure during sympathetic blockade [10]. The increased vasopressor requirement observed in patients who continued ARBs further highlights the clinical significance of these hemodynamic effects. Similar findings have been reported in previous studies demonstrating increased vasopressor use and refractory hypotension in patients receiving ACE inhibitors or ARBs perioperatively [11,12]. This effect is likely due to reduced angiotensin II–mediated vascular tone and diminished responsiveness to endogenous catecholamines [13]. Withholding ARBs 24 hours before surgery resulted in improved hemodynamic stability, although hypotension was not completely prevented. This suggests that factors such as intravascular volume status and anesthetic dose also contribute to hypotension following spinal anesthesia [14,15]. Evidence from randomized trials and systematic reviews, including the POISE-2 trial, emphasizes the need to balance intraoperative hemodynamic stability with long-term cardiovascular outcomes [16]. Overall, available evidence supports individualized perioperative management of ARBs, particularly in patients undergoing neuraxial anesthesia where hypotension may have adverse consequences [17]. Further randomized controlled trials focusing on spinal anesthesia are needed to establish definitive guidelines [18].

CONCLUSION

Continuation of angiotensin receptor blockers on the day of spinal anesthesia is associated with an increased incidence of hypotension, greater reductions in mean arterial pressure, and higher vasopressor requirements. Temporary withdrawal of ARBs before surgery appears to improve hemodynamic stability. Careful perioperative planning and vigilant monitoring are essential in hypertensive patients receiving ARBs. Additional randomized studies are required to formulate standardized recommendations.

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