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HEMODYNAMIC RESPONSE AND VASOPRESSOR REQUIREMENT DURING SPINAL ANESTHESIA IN HYPERTENSIVE VERSUS NORMOTENSIVE PATIENTS UNDERGOING LOWER LIMB SURGERY

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Abstract

Spinal anesthesia is widely used for lower limb surgery because of its rapid onset, cost-effectiveness, and excellent postoperative analgesia. However, sympathetic blockade can lead to hemodynamic instability, particularly in patients with hypertension due to chronic cardiovascular adaptations such as vascular remodeling, impaired baroreceptor sensitivity, and altered autonomic regulation. To compare hemodynamic response and vasopressor requirement during spinal anesthesia in hypertensive versus normotensive patients undergoing lower limb surgery. A prospective observational comparative study was conducted at Heavy Industry Taxila (HIT) Hospital over a period of approximately four months. A total of 110 patients were enrolled using convenience sampling, including 55 controlled hypertensive patients (Group B) and 55 normotensive patients (Group A). inclusion was age 18-70 years, either gender, ASA class I, II, III. The incidence of bradycardia, hypotension, and vasopressor requirement was compared between the two groups. Hypertensive patients exhibited significantly higher rates of bradycardia ($p = 0.004$), hypotension ($p = 0.007$), and vasopressor requirement ($p = 0.004$) compared with normotensive patients undergoing lower limb surgery under spinal anesthesia. The study revealed that the All-observed differences were statistically significant ($p < 0.05$). Hypertensive patients undergoing lower limb surgery under spinal anesthesia experience significantly greater hemodynamic instability, characterized by higher rates of bradycardia, hypotension, and vasopressor requirement, compared with normotensive patients. Enhanced perioperative monitoring and timely management are therefore essential in this population.

INTRODUCTION

The advantage of spinal anesthesia are to provide an excellent sensory and motor blockade, adequate muscle relaxation, effective postoperative analgesia[1], preservation of spontaneous respiration, avoidance of airway manipulation, reduced postoperative nausea and vomiting, attenuation of the surgical stress response, decreased intraoperative blood loss, and shorter recovery and hospital stay[2] and have led to the widespread use of this type of anesthesia in the surgical procedures of the lower limbs, particularly in orthopedic, vascular, urological, and lower abdominal

surgery[3].Although it has many benefits, spinal anesthesia is often accompanied by important cardiovascular changes which can have a significant impact on operations. These changes are primarily due to sympathetic blockade causing arterial and venous vasodilation, systemic decreasing vascular resistance, and in turn, a decrease in cardiac output, which in turn causes a varying degree of hypotension after spinal anesthesia[4]. Maintenance of a stable blood pressure is an important goal of anesthesia during spinal anesthesia, and significant hypotension and bradycardia can lead to decreased tissue perfusion and oxygen delivery to vital organs, increasing the perioperative morbidity and adverse clinical outcomes[5].Hypertension ranks among the most common chronic cardiovascular diseases in the world and is a significant cause of cardiovascular morbidity and mortality, especially in developing nations, by global estimates. Hypertension is a frequent problem in patients attending for elective and emergency surgery. Thus, the management of patients with hypertension before, during and after surgery is an integral part of the modern anesthetic care of the patient[6]. Long-term high blood pressure brings about a number of structural and functional changes in the cardiovascular system. These changes cause vascular remodeling, increased arterial stiffness, endothelial dysfunction and left ventricular hypertrophy which further decreases the vascular compliance and leads to impaired cardiovascular reserves. Moreover, chronic hypertension has been found to be associated with both impaired autonomic nervous system control and decreased baroreceptor sensitivity, which are important in regulating blood pressure during acute physiological stress[7]. Therefore, blood pressure may be less well controlled in hypertensive patients during acute decreases in systemic vascular resistance resulting from spinal anesthesia. These types of physiological changes could have a profound impact on the cardiovascular response to spinal anesthesia. In patients with controlled hypertension, the compensatory mechanisms or vascular compliance may be less intact and thus may lead to greater fluctuations in blood pressure following sympathetic blockade than in normotensive patients, and these patients may require more intense monitoring and therapeutic interventions than normotensive patients. These changes are influenced not just by the underlying condition but also by anesthetic medicines, surgical stimulation, and the outcomes of long-term hypertension therapy[8]. Thus, preventing and managing hypotension and bradycardia promptly would be crucial to maintain optimum organ perfusion, and thereby maximise perioperative safety, with several studies pointing to hypertension as an important risk factor for development of hypotension during spinal anaesthesia[9]. Special attention should be paid to patient population who may be especially susceptible to hemodynamic instability, to better implement strategies to prevent it and optimize perioperative care. Vasopressor drugs are sometimes given to maintain adequate blood pressure during spinal anesthesia. The use of vasopressors (phenylephrine and ephedrine) for counteracting decreases in systemic vascular resistance and restoring hemodynamic stability may be an indirect indicator of intraoperative cardiovascular instability. These differences are significant in the perioperative care of patients with hypertension and may warrant a different approach to their care with regard to preventing hypotensive events and the amount of vasopressors needed during surgery. Although there are several studies evaluating the hemodynamic changes with spinal anesthesia, limited data exist which compare the vasopressor requirement and the hemodynamic response of controlled hypertensive and normotensive patients undergoing lower limb surgery[10]. Moreover, results of published studies vary in their conclusions about the impact of controlled BP on perioperative cardiac stability and vasopressor use. Previous studies have examined only single hemodynamic parameters, and only a few have examined both hemodynamic stability and vasopressor requirement as markers of cardiovascular performance in the setting of spinal anesthesia. Thus, the present study was designed to compare the hemodynamic response

and vasopressor requirement in controlled hypertensive and normotensive patients during spinal anesthesia for the surgery of lower limb during which anesthesia was used. The results of this study could help in better perioperative risk stratification, early detection of patients who could be at risk for hemodynamic instability and improving a pre-emptive approach to management with the anaesthesiologist to optimize surgical outcomes.

METHODLOGY

This prospective observational comparative study was conducted at Heavy Industry Taxila (HIT) Hospital over a period of approximately four months following approval from the institutional ethics review committee and the University of Haripur. Sample size was 110 and subsequent divides in two groups Group A (n=55) Normotensive patients, Group B (n=55) Hypertensive Patient, and convienence sampling technique was used for this study.

Patients aged 18–70 years of either gender with ASA physical status I, II, or III undergoing lower limb surgery under spinal anesthesia were included, while were allocated to patients with coagulation disorders, contraindications to spinal anesthesia including coagulopathy, infection at the injection site or raised intracranial pressure, those undergoing emergency surgeries, and pregnant patients were excluded.

Patients undergoing spinal anesthesia for lower limb surgery were monitored perioperatively. Baseline heart rate, systolic blood pressure, and diastolic blood pressure were recorded prior to the procedure, followed by intraoperative hemodynamic monitoring. The incidence of hypotension, defined as a reduction of >20% from baseline systolic blood pressure, and bradycardia, defined as heart rate <50 beats per minute, were recorded. Vasopressor type and requirement were also documented. Data were analyzed using SPSS version 25 and descriptive statistic, Chi-square test and crosstabs was applied for statistical analysis.

RESULTS

Demographic Characteristic

Group B (Hypertensive) had a male predominance with 33 males (60.0%) and 22 females (40.0%), Group A (Normotensive) had a nearly equal gender distribution with 27 males (49.1%) and 28 females (50.9%). However, there was no statistically significant difference between the two groups ($p = 0.241$), indicating gender comparability. In terms of age, Group B had a significantly older distribution with 41.82% of patients aged 51–60 years, 34.55% of patients aged 41–50 years, and 23.64% of patients aged 61–70 years. This difference was highly significant ($p < 0.001$), in line with the established epidemiological association between growing older and hypertension. With respect to ASA physical status, the majority of normotensive patients in Group A were classified as ASA I (63.6%) and the remaining as ASA II (36.4%), with no ASA III patients, whereas all patients in Group B (Hypertensive) were classified as either ASA II (56.4%) or ASA III (43.6%), reflecting a significantly greater systemic comorbidity burden ($p < 0.001$).

Baseline Hemodynamic Parameters (Heart Rate, SBP and DBP)

The two groups baseline heart rate distributions differed statistically significantly ($p = 0.041$). Patients in Group B (Hypertensive) had a comparatively higher resting heart rate, with the predominant range being 81–90 bpm (36.36%), which is typical of sympathetic overactivity frequently linked to chronic hypertension, while patients in Group A (Normotensive) had a resting heart rate that was primarily in the normal range of 71–80 bpm. There was also a significantly significant difference ($p < 0.001$) between the two groups in terms of baseline systolic blood pressure. Only 9 patients (16.4%) reached 121–130 mmHg in Group A (Normotensive), with 22 patients (40%) falling in the 100–110 mmHg range and 24 patients (43.6%) in the 111–120 mmHg range. With 9 patients (16.4%) in the 121–130 mmHg range, 22 patients (40%) in the 131–140 mmHg range, 20 patients (36.4%) in the 141–150 mmHg

range, and 4 patients (7.3%) in the 151–160 mmHg range, Group B (Hypertensive) showed that SBP values had shifted to higher ranges. Similarly, there was a significant difference ($p < 0.001$) in the baseline diastolic blood pressure between the two groups; most patients in Group A (Normotensive) were concentrated in the 71–80 mmHg range (n = 32, 58.2%), whereas patients in Group B (Hypertensive) had higher DBP values distributed throughout the 81–90 mmHg range (n = 27, 49.1%) and the 91–100 mmHg range (n = 18, 32.7%).

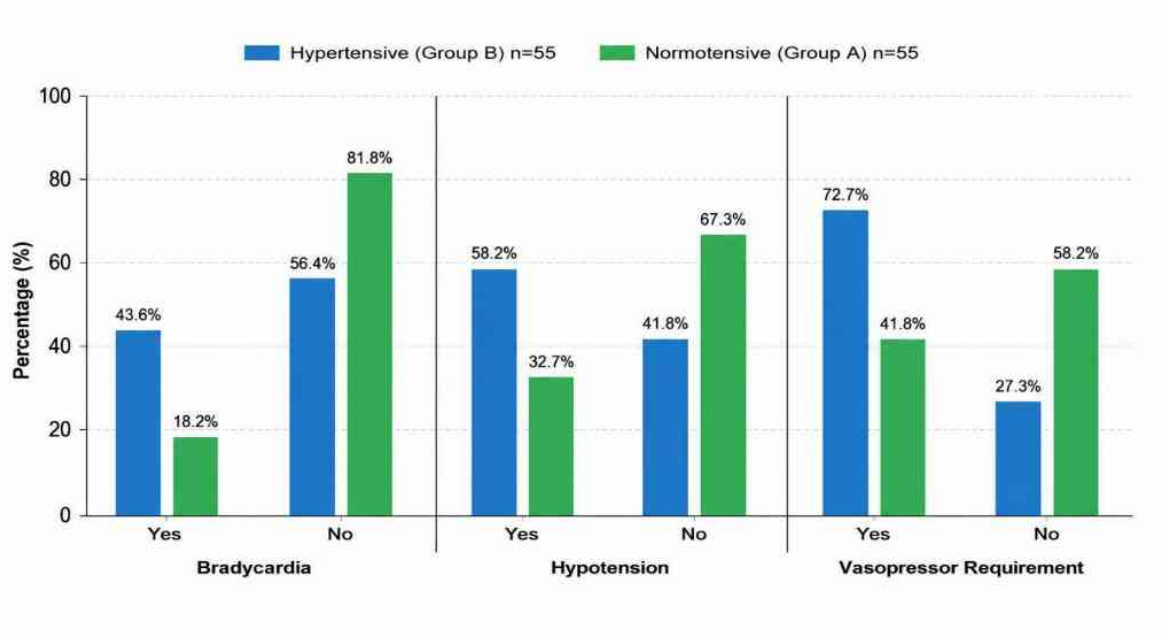
Table 1: Comprehensive Summary of Statistical Results

Outcome		Hypertensive (Group B) n=55	Normotensive (Group A) n=55	Total n=110	χ^2	p-value
Bradycardia	Yes n (%)	24 (43.6%)	10 (18.2%)	34 (30.9%)	8.47	0.004
	No n (%)	31 (56.4%)	45 (81.8%)	76 (69.1%)		
Hypotension	Yes n (%)	32 (58.2%)	18 (32.7%)	50 (45.5%)	7.187	0.007
	No n (%)	23 (41.8%)	37 (67.3%)	60 (54.5%)		
Vasopressor Requirement	Yes n (%)	40 (72.7%)	23 (41.8%)	63 (57.3%)	13.36	0.004
	No n (%)	15 (27.3%)	32 (58.2%)	47 (42.7%)		

The overall comparison of hemodynamic outcomes and vasopressor requirement in the 2 groups (hypertensive patients, Group B and normotensive patients, Group A) of patients under spinal anesthesia for lower limb surgery is presented in Table 4.1. The study included a total of 110 patients, divided into two groups of 55 patients. Hypertensive patients had a significantly higher rate of bradycardia. Of the 55 in Group B, 24 (43.6%) had bradycardia, while 10 (18.2%) had bradycardia in Group A. On the other hand, most normotensive patients (45, 81.8%) had normal heart rate while 31 (56.4%) hypertensive patients did. In total, bradycardia was seen in 34 (30.9%) patients. On the other hand, the chi-square analysis showed statistical significance between the presence of hypertension and the occurrence of bradycardia ($p = 0.004$), pointing out that patients under spinal anesthesia with hypertension had a significantly higher risk of developing bradycardia. The pattern was the same for hypotension. More than half of the hypertensive patients, 32 (58.2%), developed hypotension compared with only 18 (32.7%) normotensive patients. Of the normotensive patients, 37 (67.3%) did not develop hypotension compared with 23 (41.8%) hypertensive patients. Hypotension was found in 50 (45.5%) of the study subjects overall. The p value ($p = 0.007$) indicated that the controlled

hypertensive patients had significantly greater risk of lowering their blood pressure after spinal anesthesia compared with normotensive patients.

Figure 1: Comprehensive Comparison of hemodynamic response and vasopressor requirement in normotensive and hypertensive groups



The difference between the groups was even more pronounced with regard to vasopressor requirement. During surgery, 40 (72.7%) of the hypertensive patients needed vasopressor treatment to keep their blood pressure at an adequate level, while only 23 (41.8%) normotensive patients needed vasopressor treatment. In addition, 15 (27.3%) hypertensive patients did not require vasopressor support to maintain hemodynamic stability, whereas 32 (58.2%) normotensive patients were not supported by vasopressors to maintain hemodynamic stability. In all, 63 (57.3%) patients were requiring vasopressors. There was a high level of association between hypertension status and requirement of vasopressors ($p = 0.004$), indicating that hypertensive patients required a significantly greater level of vasopressor support to maintain cardiovascular stability.

DISCUSSION

A prospective observational comparative study was conducted at Heavy Industry Taxila (HIT) Hospital over approximately four months. Data analysis was done through SPSS 25th version and Microsoft EXCEL 2024. Descriptive statistics and chi square test were used for statistical analysis. The analysis revealed that all variables were statistically significant.110 patients were studied 55 were hypertensive and 55 were normotensive. Data on demographics, baseline or intra-operative hemodynamic variables were compared. Age, gender distribution, and ASA physical status were similar in the two groups. The patients had the following characteristics. Baseline hemodynamic assessment changed to complete before spinal anesthesia was administered. Controlled hypertensive patients usually showed better baseline blood flow values compared to normotensive patients, it is expected due to the underlying disturbance mode. However, all patients were clinically stable until the spinal block, allowing for proper assessment of cardiovascular changes occurring after spinal anesthesia. Following management of

spinal anesthesia, each company experienced discounting in blood flow and coronary artery recharge secondary to sympathetic blockade. However, the hemodynamic adaptations had been additionally reported in hypertensive patients, suggesting a low ability to recover surprising decreases in systemic vascular resistance and venous flow [4].

One of the predominant findings of the present study was the drastically higher prevalence of hypotension in controlled hypertensive patients. Hypotension occurred in 58.2% of hypertensive patients compared to 32.7% of normotensive patients, and the difference became statistically significant ($p = 0.007$). These results indicate that hypertensive patients are more susceptible to blood flow discounting after spinal anesthesia. The findings regarding hypotension are consistent with previous studies. An observation conducted at Gandhi Medical College and Hamidia Hospital mentioned a much additional incidence of hypotension in hypertensive patients receiving antihypertensive medications compared to normotensive people[11]. Similarly, a prospective cohort study conducted at Black Lion Hospital in Ethiopia showed that controlled hypertensive patients managed low blood pressure much extra frequently than normotensive patients after spinal anesthesia[12].

Another important finding of this study was that bradycardia was significantly more prevalent in patients with hypertension. Bradycardia occurred in 43.6% of hypertensive patients compared to 18.2% of normotensive patients, and the difference became statistically huge ($p = 0.004$). The higher incidence of bradycardia in hypertensive patients may be explained using persistent autonomic dysfunction, altered cardiovascular reflexes, and impaired baroreceptor sensitivity associated with prolonged hypertension. After the sympathetic block, these physiological changes may additionally limit the ability of the cardiovascular device to maintain the proper cardiac recharge response. A main location of the dominant study changed to the drastically multiplied vasopressor requirement phenylephrine in hypertensive patients. During surgery, 72.7% of hypertensive patients required vasopressor guidance compared to best 41.8% of normotensive patients. This difference became statistically massive ($\chi 2 = 13.36$, $p = 0.004$). The more the requirement of vasopressors in hypertensive patients is likely associated with higher prevalence of hypotension and impaired cardiovascular compensatory responses found on this regimen. The results of the present observation are supported via the previous literature. The study conducted at Gandhi Medical College confirmed notably higher mephentermine distress among hypertensive patients receiving antihypertensive medication. Similarly, the Ethiopian observation suggested multiple vasopressors use in controlled hypertensive patients compared to normotensive subjects. The study comparing continuation of angiotensin receptor blockers additionally observed multiple vasopressors use in patients with hypertension, although the difference does not become statistically significant.[11]

The findings of dominant gaze have important medical implications. Controlled hypertensive patients showed significantly higher incidence of hypotension and bradycardia and required significantly higher vasopressor assistance compared to normotensive patients. Therefore, careful preoperative evaluation, optimization of antihypertensive therapy, sufficient fluid control, continuous hemodynamic monitoring, and early availability of vasopressor stores are important in this group of patients. Special care should be taken during the primary 30 minutes after spinal anesthesia, when cardiovascular instability is most likely. The strengths of this look at are potential setup, equal description of hypertensive and normotensive patients, and assessment of clinically relevant effects involving hypotension, bradycardia, and vasopressor requirement. However, certain obstacles must be stated again. The have a look to be conducted at a single center and used convenience sampling, which may also limit the generalizability of the findings. In addition, the consequences of individual practice of antihypertensive medications have not now been evaluated one after another, and postoperative hemodynamic consequences had not been evaluated.

CONCLUSION

The present study was comparative hemodynamic reaction and vasopressor requirement during spinal anesthesia in controlled hypertension and normotensive patients present process reduce limb surgery. The findings showed that controlled hypertensive patients experienced significantly higher hemodynamic instability after spinal anesthesia. The incidence of hypotension and bradycardia has been significantly higher in hypertensive patients compared to normotensive patients. In addition, hypertensive patients required vasopressor guidance more frequently to maintain blood flow and cardiovascular balance. These findings suggest that persistent hypertension, despite adequate manage, may additionally impair physiological compensatory mechanisms all through sympathetic blockade. The study highlights the increased vulnerability of hypertensive patients to spinal anesthesia-induced cardiovascular adaptations. Therefore, careful preoperative assessment, close intraoperative tracking, and well-timed vasopressor administration are critical for this population. Increased vigilance in the perioperative period may help prevent headaches and improve patient safety. Overall, controlled hypertensive patients require a greater extent of hemodynamic management than normotensive patients undergoing lower limb surgery under spinal anesthesia.

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