Original Article: Determining the stability of hemodynamic status in the elderly under spinal anesthesia following ephedrine infusion during surgery

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ABSTRACT

Introduction: The high incidence of comorbid conditions in the elderly leads to a high risk for hypo perfusion caused by hypotension, with hypovolemia being the main risk factor. Therefore, ephedrine and phenylephrine are the preferred vasopressors for preventing SAIH in the elderly. Our study's goal was to assess how well prophylactic intravenous (IV) ephedrine or N/S infusions prevented hypotension and decreased CO after SA in patients older than 60 undergoing elective orthopedic surgery. **Material and Methods:** The patients were randomly assigned to one of the three groups using sealed envelope randomization for the administration of the prescribed medication. Thirty milliliters of 0.9% NaCl were infused into the C group (control group) 30 minutes after SA. Thirty minutes after SA, the E group (ephedrine group) received a continuous infusion of 30 ml of 0.9% NaCl and 20 mg of ephedrine. Following SA, a volumetric IV pump was used to begin the infusion of the prescribed treatment medication in all groups. Using the AESCULON, OSYPCA MEDICAL, 2011, monitor, we measured non-invasive blood pressure, non-invasive CO using the thoracic electrical bioimpedance (TEB) method, heart rate, and pulse oximetry (SpO2). **Results:** A brief statistically significant decrease in MAP was observed in the P group 10 and 20 minutes after the block, but by the time the measurements were complete, MAP had nearly reached baseline levels. In the E group, MAP was preserved following SA. At the conclusion of the measurements, there were no differences between the P and E group, but the decrease in MAP was noticeably greater in the C group than the E and P group. In the C and P groups, CI after SA decreased non-significantly, while in the E group, CI significantly increased after SA. **Conclusion:** In conclusion, our research demonstrates that we can maintain MAP following SA by combining the Ringers solution infusion with an infusion of ephedrine or phenylephrine. A phenylephrine infusion keeps CO constant but causes a drop in HR, whereas an ephedrine infusion also delays a drop in HR and boosts cardiac output.

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Introduction

Major regional techniques known as spinal blocks have a long history of being used successfully for a variety of surgical procedures and pain relief. After inserting a needle in the neuraxis [1]], it causes sympathetic block, sensory analgesia, and motor block depending on the dose, concentration, or volume of local anesthetics. However, the main drawbacks of spinal block include abrupt hypotension and difficulty in regulating the intensity of analgesia. Hypotension (33%) and bradycardia (13%) are the two most frequent serious side effects of spinal anesthesia [2-4]. The main mechanism for hypotension has been identified as systemic vasodilation caused by sympathetic blockade after spinal anesthesia (SA), which causes venous blood to pool and lowers systemic vascular resistance [5-7]. In addition, the development of hypotension is significantly influenced by the absence of significant reflex tachycardia following spinal anesthesia [8].

The "reverse" of the Bainbridge reflex and the blockade of sympathetic cardio accelerator fibers at T1 to T4 may be the causes of this phenomenon. "Caplan et al.". was proposed that after SA, there was sufficient bradycardia and hypotension to cause cardiac arrest. This was thought to be caused by decreased atrial filling and unopposed vagal tone [9-11]. In addition to the effects of venous and arterial dilation, the current study hypothesized that the absence of reflex tachycardia plays a significant role in the pathogenesis of hypotension caused by SA in elderly patients [12-14].

Elderly patients are more likely to experience these complications, which can be more dangerous because they may have a lower physiological reserve and compromised blood flow to several vital organs [15-17]. To address these issues, a variety of techniques are currently being used, including pre- or co-loading IV fluid, vasopressors, and physical methods like table tilting, leg binders, compression devices, and more [18-20].

None of these methods, however, is completely effective at averting such complications. As a result, efforts are constantly made to find methods or combinations of methods to stop the hypotension and bradycardia that spinal anesthesia can cause [21-23]. The elderly have a weakened Bainbridge reflex, which was the justification for choosing atropine in this study. In order to prevent blunted reflexes, atropine is used as a preventative measure [24-26]. This raises heart rate and cardiac output, which in turn raises blood pressure.

No published clinical study had compared the effectiveness of prophylactic use of atropine or ephedrine preventing hypotension and bradycardia in elderly patients after spinal anesthesia [27-29]. Various studies also showed that ephedrine improves hemodynamic parameters when used preoperatively in spinal anesthesia [30].

The national arthroplasty registers of many European nations, England, Australia, and Canada have shown an increase in the prevalence of hip and knee arthroplasty over the past few decades [31-33]. The number of such procedures in the future appears to be even higher. There are many elderly patients among them. Spinal anesthesia (SA) is a method that is frequently employed for elderly patients undergoing orthopedic surgery [34-36].

SA frequently has a negative side effect called hypotension. The decline in systemic vascular resistance (SVR) and cardiac output (CO) is what causes the elderly to experience SA-induced hypotension (SAIH) at a rate that has been estimated to be as high as 80%. The administration of crystalloids can quickly result in volume overload and signs of congestive heart failure in the elderly and is frequently ineffective at maintaining blood pressure [37-39].

The high incidence of comorbid conditions in the elderly leads to a high risk for hypo perfusion caused by hypotension, with hypovolemia being the main risk factor [40-42]. Therefore, ephedrine and phenylephrine are the preferred vasopressors for preventing SAIH in the elderly. Our study's goal was to assess how well prophylactic intravenous (IV) ephedrine or N/S infusions prevented hypotension and decreased CO after SA in patients older than 60 undergoing elective orthopedic surgery [43].

Material and Methods

Study design

90 patients over the age of 60 who were scheduled for orthopedic hip or knee replacement surgery under SA were the subject of our study. Every patient gave their written, informed consent.

Inclusion and Exclusion criteria

Exclusion criteria for participants included any contraindications to SA (absolute: patients' refusal, infection at the injection site, untreated hypovolemia, allergy, increased intracranial pressure, or relative: coagulopathy, sepsis, fixed CO states, indeterminate neurological disease) or administration of vasoconstrictors (allergy or hypersensitivity to vasoconstrictors, unstable angina, recent coronary artery bypass surgery, recent myocardial infarction refractory ar.

Protocol

The night before the procedure, the patients fasted. With the exception of -blockers, antihypertensive medications were stopped the day before surgery. One hour prior to surgery, midazolam 7 point 5 mg was administered as premedication. A short time after the patient entered the operating room, an IV line was put in place, and the lateral decubitus position was applied to the patient. The L2-L3 interspace was punctured using the paramedian approach and a 25-gauge Sprotte needle. Within 15 seconds, 3 mL of 0 point 5 percent levobupivacaine were injected with the needle aperture pointed in the cephalad direction.

By releasing the IV roller clamp and "eyeballing" the infusion rate, each patient received a 1000 mL infusion of lactated Ringer solution within 45 minutes of the measurement's start (500 mL before and 500 mL after SA). The patients were randomly assigned to one of the three groups using sealed envelope randomization for the administration of the prescribed medication. Thirty milliliters of 0 point nine percent NaCl were infused into the C group (control group) 30 minutes after SA. After 30 minutes of SA, the P group (phenylephrine group) received a continuous infusion of 30 ml of 0 point 9 percent NaCl and 250 mcg of phenylephrine. Thirty minutes after SA, the E group (ephedrine group) received a continuous infusion of 30 ml of 0 point nine percent NaCl and 20 mg of ephedrine. Following SA, a volumetric IV pump was used to begin the infusion of the prescribed treatment medication in all groups. Using the AESCULON, OSYPCA MEDICAL, 2011, monitor, we measured non-invasive blood pressure, non-invasive CO using the thoracic electrical bioimpedance (TEB) method, heart rate, and pulse oximetry (SpO2).

The patient was placed in the lateral decubitus position, and we began taking hemodynamic measurements five minutes later. We kept track of the data for 45 minutes (for 15 minutes before and 30 minutes after the local anesthetic solution was injected into the subarachnoid space). At 5-min intervals, blood pressure data were taken and saved on the hard drive, while other hemodynamic data were taken at 1-min intervals. In the event of hemodynamic instability, the following was the protocol for rescue therapy:

1. Severe hypotension (a systolic blood pressure drop of more than 30% from baseline or a systolic blood pressure less than 80 mmHg): additional ephedrine boluses of 5 mg repeated in 3 min with an additional infusion of Ringer

solution, or additional phenylephrine boluses of 50 mcg repeated in 3 min with an additional infusion of Ringer solution.

2. Bradycardia (less than 50 beats per minute): bolus of atropine 0 mg, repeated every 1 minute until heart rate frequency reaches more than 50 beats per minute or until a total of 2 mg atropine is reached.

3. The ongoing infusion should be stopped if there is hypertension (an increase in systolic blood pressure of more than 30% from baseline).

Patients who experienced at least one episode of hypertension, hypotension, or bradycardia throughout the case and who received the recommended treatment were considered to be hypotensive, hypertensive, or bradycardic patients.

Data Analysis

The SPSS 25.0 program was used to analyze the data. Where applicable, one-way analysis of variance and 2 were used to compare demographic data and baseline values. The hemodynamic data before, 10, 20, and 30 min after SA were compared using an ANOVA with Bonferroni correction for post hoc comparisons and, when necessary, the Student's t-test for paired samples. Additionally, repeated measurement analysis of variance with Bonferroni correction was used to compare the change in hemodynamic measurements between the three treatment groups as well as the change over time.

Results

90 patients were randomized. Patients with side effects necessitating a rescue protocol were excluded from the final analysis and underwent separate analysis. Two patients were excluded for not meeting the inclusion criteria, and four patients were excluded because they declined to participate. Hemodynamic instability led to the exclusion of seven patients from the C group (5 of whom had severe hypotension, 1 bradycardia, and 1 hypotension with bradycardia). Due to bradycardia and hypotension in two patients, and a single hypotension episode in the other two, both patients were removed from the P group(Fig 1).

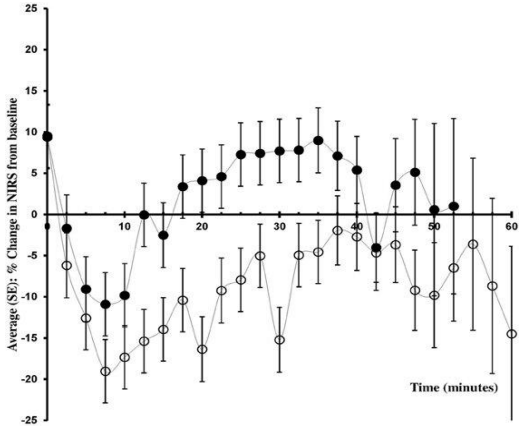

Figure 1. Hemodynamic instability between tow groups

Due to hypotension, two patients were removed from the E group, and one patient was also removed due to bradycardia. 70 patients total were therefore included in the analysis: 25 patients in the E group, 24 patients in the P group, and 21 patients in the C group. Regarding the demographic information and baseline hemodynamics, there were no noticeable differences between the groups. Ten, twenty, and thirty minutes after the spinal block, the C group experienced the greatest decrease in MAP, which was statistically significant(Fig 2).

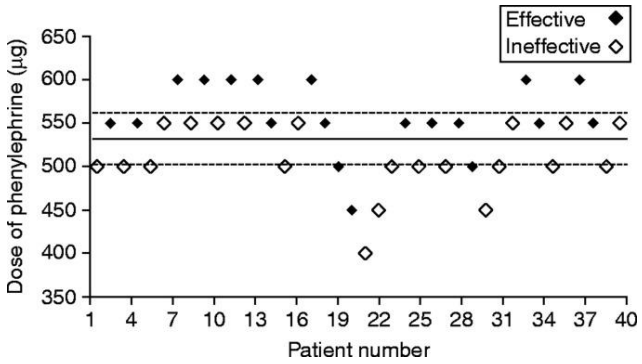

Figure 2. Intervention effective in MAP

A brief statistically significant decrease in MAP was observed in the P group 10 and 20 minutes after the block, but by the time the measurements were complete, MAP had nearly reached baseline levels. In the E group, MAP was preserved following SA. At the conclusion of the measurements, there were no differences between the P and E group, but the decrease in MAP was noticeably greater in the C group than the E and P group. In the C and P groups, CI after SA decreased non-significantly, while in the E group, CI significantly increased after SA.

At the conclusion of the measurements, the E group's CI was significantly higher than that of the C and P groups, while there were no differences between the C and P groups. At the conclusion of the measurements, the decrease of HR after SA was significantly higher in the C and P group compared to the E group, with no significant differences between the C and P group(Fig 3).

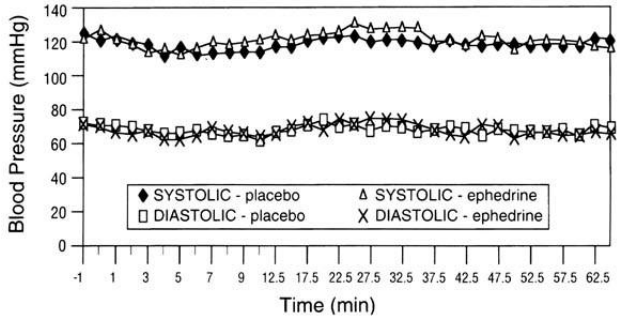

Figure 3. Blood Pressure Change between study groups

HR decreased significantly after SA in the C and P group but not in the E group. After SA in the C group, SVI increased briefly (10, but did not change. minutes after the block) in the P group and significantly increased in the E group after 20 minutes of SA, with the increase in SVI being noticeably higher in the E group compared to the C and P group.

There were 14 patients who experienced side effects, but there were no notable variations between the groups. Although there were more bradycardic (n = 3) and hypotensive (n = 6) patients in group C, there were no statistically significant differences between the groups in terms of the incidence of these events (n = 14). Neither the incidence of patients receiving ephedrine or phenylephrine as the rescue medication nor the number of patients receiving these drugs were statistically different between the groups.

Discussion

We investigated the effects of preemptive administration of two different vasopressors

(ephedrine and phenylephrine) on the reduction of post-SA hypotension and changes in hemodynamics in elderly patients [44-46]. The subject is unquestionably crucial, and to our knowledge, our study is the first to have established the effectiveness of a prophylactic ephedrine infusion following SA in elderly patients [47-49].

Numerous studies have demonstrated the significance of preventing even brief episodes of hypotension in elderly patients in order to reduce complications and mortality [50-52]. Throughout the time of the measurements, Ringer's solution was continuously infused into each participant in our study [53]. The research demonstrated that the MAP after SA (E group) was maintained by an additional ephedrine infusion. The P group's MAP was also kept at a constant level, but the additional phenylephrine infusion did not work as well as the ephedrine infusion did [54-56].

After SA, MAP decreased by about 14% in patients (C group) who were not taking vasopressors. Following SA, CI was maintained in the C and P group and increased by roughly 14% in the E group. Following SA, HR dropped in the C and P groups while remaining stable in the E group [57-59]. Nakasuji and other people. Marhofer and coworkers also demonstrated that SAIH in elderly ASA 3 patients was caused by a decrease in systemic vascular resistance index, without change in cardiac index, as the primary mechanism of hypotension seen during SA in elderly patients, rather than a decrease in CO.

While CO increases in the group of patients receiving lactated Ringer's solution at the time of spinal block, Kamenik and Eren's research on middle-aged patients who did not receive crystalloids prior to SA as well as those who did showed that CO decreases after SA in both of these groups of patients [60-62]. Later, Zorko and Kamenik demonstrated that the infusion of 1000 mL of lactated Ringer following spinal block prevented the decrease in CO following SA, with CO actually rising while the infusion was underway.

The hydration plan we employed in our study was slightly altered. Throughout the measurement period (15 minutes before and 30 minutes after SA) [63], 1000 ml of Ringers solution was continuously infused. According to our findings, the C group's CI after SA was kept at roughly baseline levels with this regimen. However, we were unable to maintain the MAP in this group of patients, which is thought to have decreased as a result of the lower systemic vascular resistance. In the C group, HR additionally decreased following SA. Most of the decrease in MAP was mitigated by adding more of the pure (alpha) vasoconstrictor phenylephrine [64].

The decrease in HR after SA was not stopped by the phenylephrine infusion, though. In their research, Stewart et al., the authors discovered that when comparing three different phenylephrine infusion regimens, there was a dose-dependent decrease in both maternal HR and CO, as assessed with suprasternal Doppler. In our study, the P group, HR also decreased, but due to a slight rise in SVI, CI was maintained.

The highest infusion rate reduced both CO and HR by more than 20%. Given that both groups received the same amount of infusion, the slight increase in SVI in the P group when compared to the C group was likely brought on by the vasopressor's effects on venous tone [64]. We were able to maintain the MAP in the ephedrine group while the HR and SVI rose, increasing the CI. The inotropic effects of ephedrine are likely to blame for an additional rise in HR and SVI in the E group. Comparing the C group (n = 7) to the P group (n = 4) and the E group (n = 3), there were more patients who experienced side effects.

Despite the fact that the differences were not statistically significant (due to the small sample size), the C group had a nearly twofold incidence of side effects. We made the decision to exclude

the patients with side effects requiring rescue medications from the final data presentation because the hemodynamics of vasopressors was the primary focus of our study. In order to reduce side effects, we could also take a lower dose local anesthetic approach for intrathecal anesthesia in the elderly.

Depending on the patient population, the ideal vasopressor might actually differ. Because it has a positive impact on fetal acid-base balance and umbilical pH, phenylephrine is currently preferred over ephedrine as the preferred alpha agonist for treating SA-related hypotension. According to research by Mon and colleagues, ephedrine infusion was associated with better systolic blood pressure control and no decrease in the maternal CO or HR when compared to the phenylephrine group.

In contrast, Larson et al. a number of studies have suggested that phenylephrine may negatively impact cerebral oxygen saturation and perfusion. Despite the fact that phenylephrine has never been proven to improve outcomes, the authors claimed that using it to treat SAIH is a common practice among anesthesia professionals. However, according to Das et al., another strategy might involve combining the use of vasopressors with various timings.

Half the usual doses of ephedrine and phenylephrine were combined in obstetric patients, but this did not have a particularly successful result. Our study demonstrates the significance of prophylactic infusion treatment with vasopressors in this group of patients, but a certain and widely used method of predicting pre-operative hypotension is not ideal. In normovolemic elderly patients undergoing elective procedures, a high incidence of hypotension (the overall incidence of SAIH was 49 percent, ranging from 39 percent in the colloid group to 62 percent in the crystalloid group) follows SA.

NIRS may offer an early indicator of hypotension, according to Berlac and Rasmunssen. As opposed to this, Hanss et al. a greater change in heart rate variability was observed in women who experienced more severe hypotension after SA. In our study, CO was noninvasively measured using TEB. However, there is debate over the absolute value of CO as measured by TEB, despite the fact that most researchers now accept the TEB method for tracking CO trend changes. It has an advantage over invasive methods, which are rarely ethically justified, in patients who are breathing on their own during SA because it is non-invasive. In our study, the TEB method was also used as a trend monitor to track changes in hemodynamic parameters following SA.

Conclusion

In conclusion, our research demonstrates that we can maintain MAP following SA by combining the Ringers solution infusion with an infusion of ephedrine or phenylephrine. A phenylephrine infusion keeps CO constant but causes a drop in HR, whereas an ephedrine infusion also delays a drop in HR and boosts cardiac output. We advise the infusion of ephedrine in elderly patients receiving SA because flow is better maintained. Additional research is required to determine the best dose to improve elderly patients' hemodynamic stability following SA as well as the length of time that the effects of ephedrine infusion last.

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