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Comparative Evaluation of Bolus Phenylephrine, Ephedrine, and Mephentermine for Arterial Pressure Maintenance during Spinal Anesthesia in Cesarean Section Procedures

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Hypotension,anaesthesia,mephentermine.

Abstract: Background: One of the challenges frequently faced by an anaesthesiologist during a Caesarean section is the occurrence of low blood pressure following spinal anesthesia. This research aimed to compare the effectiveness of intravenous boluses of Phenylephrine, Ephedrine, and Mephentermine in maintaining arterial blood pressure during spinal anesthesia for Caesarean sections. Materials and methods: Sixty patients categorized as American Society of Anesthesiologists (ASA) types 1 and 2, scheduled for both elective and emergency Caesarean sections under spinal anesthesia, experienced episodesof hypotension. These patients were divided into three groups of 20 each. Group P received Phenylephrine at a dose of 100 micrograms, Group E received Ephedrine at 6 mg, and Group M received Mephentermine at 6 mg, all administered as a bolus intravenous injection in a 1 ml volume. Results: When comparing the three groups, it was found that the rise in diastolic blood pressure at 2, 4, and 6 minutes after administering the study drugs was notably lower in the Ephedrine and Mephentermine groups compared to the Phenylephrine group ($p < 0.05$). Likewise, the increase in systolic arterial pressure in the Phenylephrine group was significantly higher during the first 6 minutes, after which the differences diminished. There were no significant variations observed in the changes of systolic and diastolic blood pressure between the Ephedrine and Mephentermine groups at any given time. Additionally, in the Phenylephrine group, the post-study drug values of heart rate significantly decreased from the values at the onset of hypotension until the end of the surgery when compared to the other two groups ($p < 0.001$). Conclusion: The Phenylephrine group demonstrated faster control of blood pressure compared to the other two groups initially. However, over time, all three drugs achieved similar levels of blood pressure control. Notably, Phenylephrine showed an advantage over the other medications in terms of reducing heart rate.

INTRODUCTION

As the rate of Caesarean section procedures continues to rise [1], anesthesiologists find themselves in a challenging situation when making decisions regarding the choice of anesthetic technique. These decisions must prioritize the safety of both the mother and the fetus. In recent decades, there has been a global trend in obstetric anesthesia, favor- ing the use of regional anesthesia, with spinal anesthesia emerging as the most commonly preferred method [2]. The clinical introduction of spinal anesthesia can be attributed to German Surgeon Karl August Bier in 1898 [3]. Its popularity stems from several advantages it offers, including simplic- ity, rapid onset, reliability, extended duration, low failure rates, minimal side effects, and the ability for the mother to remain awake. Furthermore, it minimizes the exposure of both the mother and fetus to anesthetic drugs and helps avoid life-threatening complications such as aspiration, failed intubations, and neonatal depression. However, like any other anesthesia technique, spinal anesthesia is not without its share of complications, with hypotension being the most common, potentially affecting both the mother and the fetus adversely. In the typical clinical scenario, the administration of vasopressors in this context is often reactive rather than proactive. Maternal hypotension induced by spinal anesthesia is allowed to develop before being treated. The current studysought to evaluate and compare the effectiveness of intra- venous

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boluses of Phenylephrine, Ephedrine, and Mephentermine in maintaining arterial blood pressure following spinal anesthesia for both elective and emergency Caesarean sections.

Parameter	Study Groups	N	Mean	SD
Age (yrs)	Group P	20	23.16	2.51
	Group E	20	22.63	2.32
	Group M	20	22.43	1.59
Height (cms)	Group P	20	152.20	4.26
	Group E	20	151.63	4.66
	Group M	20	151.33	4.33
Weight (kg)	Group P	20	54.23	3.07
	Group E	20	54.93	4.62
	Group M	20	54.27	3.81
Pulse Rate	Group P	20	90.13	7.47
	Group E	20	86.33	7.93
	Group M	20	92.97	8.90

MATERIAL AND METHODS

This comparative study was conducted over the course of one year and involved parturients undergoing both elective and emergency lower segment Caesarean sections under spinal anesthesia. After obtaining approval from the insti- tutional ethics committee, a total of ninety parturients with ASA I and II classifications who experienced hypotension following a subarachnoid block (SAB) were included in the study. All the parturients included in the study were at full term, had uncomplicated singleton pregnancies with cephalic presentation, and had a body weight of less than 60 kilograms. The study protocol was thoroughly explained to each patient in their native language, and informed written consent was obtained. The following criteria were used to select the parturients for inclusion in the study. The study was conducted on parturients who were scheduled for both elective and emergency lower segment Caesarean sections under spinal anesthesia over a period of one year. All the parturients included in the study were at term, had uncompli- cated singleton pregnancies with cephalic presentation, and had a body weight of less than 60 kilograms. The study protocol was thoroughly explained to each patient in their native language, and informed written consent was obtained. To be eligible for the study, patients had to meet specific inclusion criteria, which included being aged between 20 and 30 years, having an ASA Class I or II classification,and having baseline systolic blood pressure between 100 and 140 mmHg and diastolic blood pressure between 70 and 90 mmHg. Furthermore, patients had to develop hypotension during the operation, which was defined as a decrease in sys-tolic pressure by more than 20% from the baseline value or a reading below 90 mmHg [4]. Patients with certain medical complications, including diabetes mellitus, cardiovascular diseases, severe anemia, and cerebrovascular diseases, were excluded from the study. Additionally, individuals with a body weight exceeding 60 kilograms were not considered eligible. Obstetrical complications, such as antepartum hemor- rhage, pregnancy-induced hypertension, cord complications (such as nuchal cord or cord prolapse), fetal malformations, or malpresentations, led to exclusion. Patients with condi- tions such as autonomic neuropathy, spinal deformities, other neurological diseases, infections in the lumbar area, coagu- lation abnormalities, or hypovolemia due to any cause were also excluded from the study. These exclusion criteria were put in place to ensure a specific and homogeneous patient population for the research study. As a routine pre-surgical practice, patients were administered intravenous doses of Ranitidine (50 mg) and Metoclopramide (10 mg). The pa- tients included in the study were divided into three groups, each consisting of 20 individuals. The assignment of patients to these groups was based on the order of cases that satisfiedthe predefined inclusion criteria. The first 20 cases that met these criteria were allocated to the Phenylephrine group, the subsequent 20 to the Ephedrine group, and the remaining 20 to the Mephentermine group. It's important to note that this study was conducted in an open-label fashion, meaning that both the healthcare providers and the patients were awareof the treatment group assignments. Hyperbaric bupivacaine at a concentration of 0.5% was utilized to establish spinal anesthesia. Prior to commencing the procedure, the patients were preloaded with fluids, and their pulse rate, systolic blood pressure, and diastolic blood pressure were recorded three times, with the middle value considered as the baseline measurement. Subsequently, these parameters were recorded again after the subarachnoid block was administered, and then at two-minute intervals for the initial 20 minutes. After- ward, measurements were taken every six minutes until the conclusion of the surgical procedure. Whenever hypotension occurred, the appropriate study drug was administered intra- venously. The study meticulously documented the number ofboluses required and the time taken for patients to recover from the hypotensive

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episode. In the event of bradycardia, defined as a pulse rate of 60 beats per minute or lower, Atropine at a dose of 0.3 mg was administered intravenously for treatment. RESULTS: The baseline demographics of the study participants were comparable, and these details are provided in Table1

Table 1: Patients Pre-operative data (Mean + SD) There were no statistically significant differences observed among the three groups in terms of the level of thoracic sensory block at the beginning of the surgery ($p>0.05$). However, when comparing the rise in systolic and diastolic blood pressure at 2, 4, and 6 minutes following the administra- tion of study drugs, it was found that both the Ephedrine and Mephentermine groups had significantly lower increases compared to the Phenylephrine group ($p<0.05$). Fig 1: Com- parison of changes in Mean Diastolic Blood Pressure When comparing the three groups, it was observed that the in- crease in diastolic blood pressure at 2, 4, and 6 minutes following the administration of study drugs was significantly lower in both the Ephedrine group and the Mephentermine group in comparison to the Phenylephrine group ($p<0.05$). Furthermore, no significant differences were noted in the changes in systolic and diastolic blood pressure between the Ephedrine and Mephentermine groups. During episodes of hypotension, heart rate increased in all three groups under study. However, a notable difference emerged in Group P,

where post-administration of the study drug resulted in a significant decrease in heart rate. These lowered heart rates were observed from the onset of hypotension and contin- ued until the conclusion of the surgery when compared to the other two groups ($p<0.001$). Conversely, no significant distinctions were noted in heart rate changes between the Ephedrine and Mephentermine groups. This indicates that the administration of Phenylephrine led to a distinct reduction in heart rate, a finding not replicated in the other two groups.

I. DISCUSSION

The Caesarean section is a surgical procedure with a long history, dating back centuries. However, the use of anesthesia for Caesarean sections is a relatively recent development, spanning just about a century, and it has not been without its share of controversies. Over time, regional anesthesia, particularly spinal anesthesia, has emerged as the preferred technique for Caesarean sections [5], [6]. This preference is driven by the unique capability of spinal anesthesia to offer a combination of minimal physiological interference along with profound sensory numbing and muscle relaxation. Con- sequently, the safety of spinal anesthesia encompasses both pharmacological and physiological aspects. Nevertheless, a significant challenge associated with this technique is the frequent occurrence of hypotension, particularly in pregnant parturients. Hypotension represents one of the most prevalent and concerning issues that poses risks to both the mother and the child during medical procedures like Caesarean sections [5], [7]. A study by Dinesh Sahu et al. [8] highlighted that maternal hypotension during spinal anesthesia for Caesarean deliveries was a persistent challenge in approximately 85% of cases [8]. This high incidence and severity of maternal hypotension following spinal anesthesia can be attributed to various factors, including the quantity of local anesthetic administered, sympathetic blockade, and the uterus impeding venous return from the extremities while the patient is in a supine position [6]. Hypotension represents one of the most prevalent and concerning issues that poses risks to both the mother and the child during medical procedures like Caesarean sections [5], [7]. A study by Dinesh Sahu et al. [8] highlighted that maternal hypotension during spinal anesthesia for Caesarean deliveries was a persistent challenge in approximately 85% of cases [8]. This high incidence and severity of maternal hypotension following spinal anesthesia can be attributed to various factors, including the quantity of local anesthetic administered, sympathetic blockade, and the uterus impeding venous return from the extremities while the patient is in a supine position [6]. In our study, we observed that cardiovascular stability was notably improved with the use of Phenylephrine [8], [9]. Notably, Phenyle- phrine resulted in a significant reduction in heart rate follow- ing the administration of the bolus dose, a consistent effect that has been observed in studies involving women treated with Phenylephrine as well [10]–[15]. Conversely, in both the Ephedrine and Mephentermine groups, we observed an increase in heart rate compared to the pre-operative values. This trend is in line with the findings of an earlier Indian study conducted by Dinesh Sahu [8].Thomas D.G. et al. [12] previously reported a relatively high incidence of bradycardia (heart rate less than 60 beats per minute) when Phenyle- phrine was

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administered as an intravenous bolus following the induction of spinal anesthesia. However, in our study, we did not observe any instances of such severe hypotension. The differences in patient selection and criteria for manag- ing hypotension between the studies may account for this variation. In our current research, the only side effects noted were nausea and vomiting, with no instances of extreme hypertension or headache as reported in a study by Taylor JC et al. [16].

II. CONCLUSION

Our study has revealed that Phenylephrine, Ephedrine, and Mephentermine, when administered in intravenous bolus form, are effective in maintaining arterial pressure within a 20% limit of the baseline values. It's worth noting that Phenylephrine exhibits a faster peak effect compared to Ephedrine and Mephentermine. Additionally, Phenylephrine is associated with a reduction in heart rate, which could be advantageous in cases involving cardiac patients and situa- tions where tachycardia is undesirable.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORS' CONTRIBUTIONS

All authors equally contributed to preparing this article.

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