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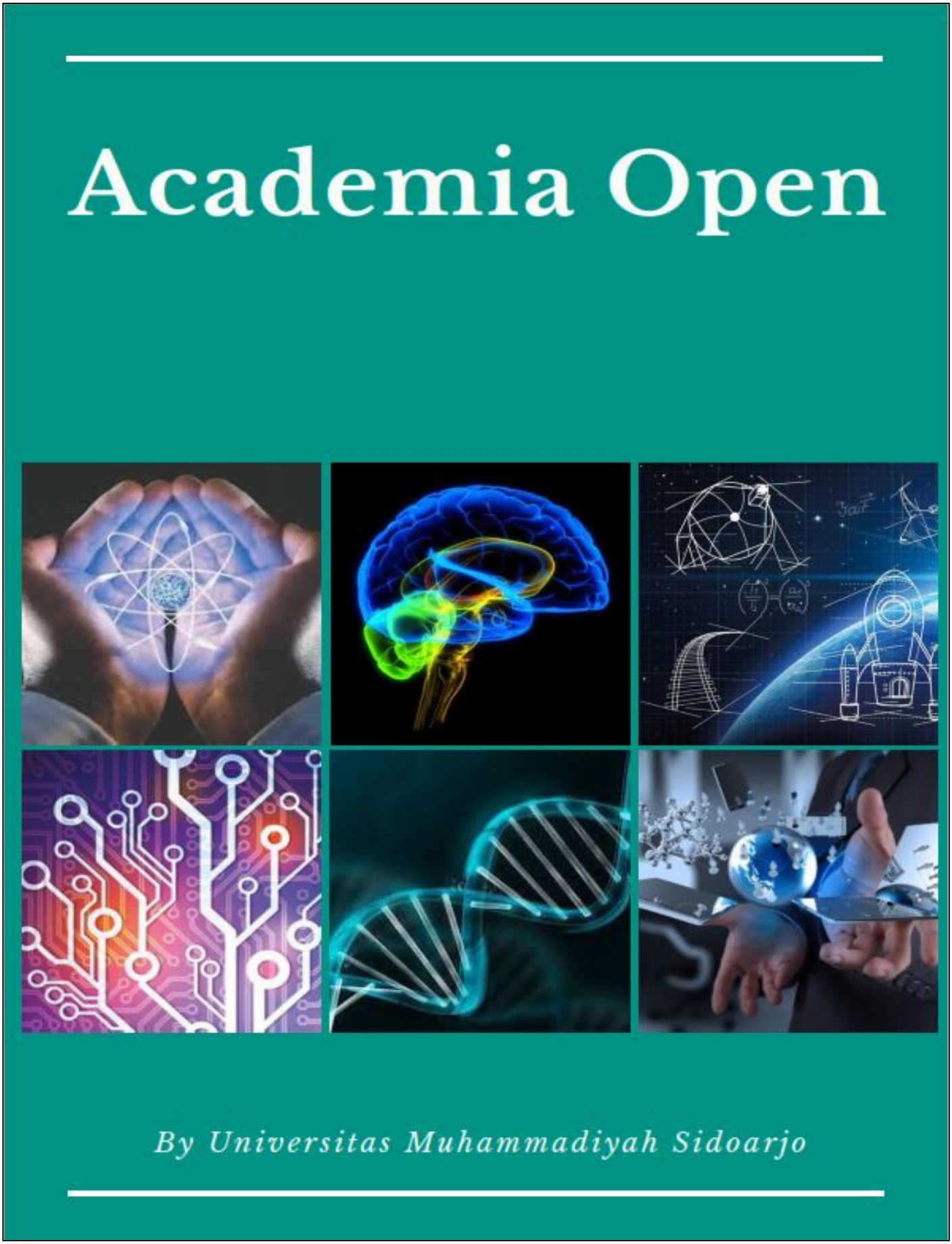

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Ephedrine Infusion Prevents Hypotension and Reduces Nausea in Cesarean Section Under Spinal Anesthesia

Infus Efedrin Mencegah Hipotensi dan Mengurangi Mual pada Operasi Caesar dengan Anestesi Tulang Belakang

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Abstract

In this study, we aimed to evaluate the efficacy of ephedrine infusion in preventing hypotension and minimizing nausea in healthy pregnant women undergoing elective cesarean sections with spinal anesthesia. Forty-four participants were included, with 20 receiving ephedrine infusion and 24 serving as controls receiving bolus injections. Results revealed a significant reduction in the incidence of hypotension ($p > 0.1$) and nausea ($p < 0.001$) in the infusion group compared to the controls. No instances of reactive hypertension were observed in the infusion group. Other variables including Apgar scores, fetal blood gas tensions, and onset of respiration remained comparable between the groups. These findings suggest that ephedrine infusion is not only safe but also preferable in mitigating adverse events during cesarean sections under spinal anesthesia in normal pregnancies.

Highlights:

- Ephedrine infusion effectively prevents hypotension during cesarean sections under spinal anesthesia.
- Administration of ephedrine infusion significantly reduces the incidence of nausea compared to bolus injections.
- No instances of reactive hypertension were observed in patients receiving ephedrine infusion, highlighting its safety profile in this context.

Keywords: Ephedrine Infusion, Cesarean Section, Spinal Anesthesia, Hypotension Prevention, Nausea Reduction

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Introduction

It has been observed that a significant percentage of women—between half and eighty percent—experience hypotension when under spinal anesthesia, even in cases when left uterine displacement has been accomplished and patients have received prehydration [1]. This is concerning because it puts the fetus and the mother in danger. Fetal acidity, hypoxia, and therefore newborn depression can result from a decrease in uterine blood flow brought on by maternal hypotension [2], [3]. Many approaches have been suggested to prevent or cure maternal hypotension after spinal anesthesia in order to lessen this problem [4].

One recommendation [5] is the intravenous administration of ephedrine to reduce hypotension. Conversely, Gutsche [6] considers intramuscular use of ephedrine before starting spinal anesthesia. Another study carried out by Mathru and his colleagues [7] demonstrated that using 5% albumin with a dosage of 15 mg/kg can be an effective way of preventing hypotension in women who are undergoing spinal anesthesia. Al Imamain Al-Kadhimain Medical City and Abi Ghraib General Hospital

Another investigation was conducted by Clark and Brunner to find out whether the use of intravenous infusion of dopamine was an effective method of treatment for maternal hypotension after spinal anesthesia. However, it was revealed that dopamine had not shown any benefit over ephedrine in this situation [8].

Despite the apparent usefulness of these strategies to keep mothers' blood pressure within normal limits, they should be recognized as potentially negative as well. One approach that has been recommended by some authors and is based on continuous intravenous infusion of ephedrine with the dose controlled by maternal blood pressure merits future exploration, but more research is needed to ascertain its utility in obstetric cases. The purpose of this research was to evaluate the efficacy of prophylactic intravenous infusion of ephedrine in maintaining blood pressure during pregnancy with no adverse effects on either mother or baby.

In order to explore this approach, we sought to offer some important knowledge on hypotension management during cesarean sections performed under spinal anesthesia. Through an analysis of the possible advantages and disadvantages, we intended to deepen scientific knowledge on this subject and consequently improve patient outcomes.

Method

In Al Imamain Al-Kadhimain Medical City and Abi Ghraib General Hospital Over the time frame from December 2019 to June 2021 a sample of forty-four healthy women who were having their second scheduled cesarean section consented to take part in this study . In order to guarantee that each patient's autonomy is respected and that they voluntarily accept to participating in this scientific activity, appropriate consents were requested and received from each patient before they could be included in the study project. They were divided into two groups at random; the first group had ephedrine continually, while the second group got it as a bolus injection.

As a first step in preparation for anesthesia, all the patients were taken to a room assigned for pre-anesthetic preparation with an advance period of one hour to undergo vital assessments and ensure the necessary procedural arrangements. The interval at which the blood pressure and heart rate of the mother were taken throughout the entire course was 10 minutes, and through this, there was strict observation for any slight changes that would occur. The patient’s position is always on the left side, monitoring for signs of life in a fetal heart monitor. These rates were then compiled and analyzed to determine normal resting values for systolic arterial pressure (BSBP) as well as heart rate.

All patients received intravenous lactated Ringer's solution 20 minutes before to the onset of spinal anesthesia, at a standard dosage of 15 ml per kg. Carefully injecting a 0.5% bupivacaine dosage allowed for both achieving the intended level and guaranteeing that no safety precautions were broken. Following this phase, the patient was placed in a supine posture with a 15-degree wedge under the right hip to aid in the displacement of the left uterus.

To provide a constant supply of oxygen, the patient was given it via a disposable plastic mask at a flow rate of 6 L/min. This comprehensive method of administering anesthetic and providing for patients demonstrates the dedication and meticulousness of the medical experts participating in this investigation. The intravenous line was linked to the prepared ephedrine at a concentration of 50 mg in 500 ml of lactated Ringer's solution using a 16-gauge needle. The infusion of this solution was started right away in all 20 patients following the intrathecal injection of bupivacaine.

An ephedrine infusion was started during the first two minutes following induction at a rate of around 5 mg per minute (50 ml/min), based on the blood pressure response. Following then, the rate was manually changed to keep the systolic blood pressure (SBP) between 90% and 100% of the initial SBP. The ephedrine infusion was halted and an IV line was maintained open with lactated Ringer's solution after good SBP stabilization.

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When patients continued to have hypotension even after the maximal ephedrine infusion rate was reached, an intravenous bolus of 10 mg ephedrine was administered. If the SBP dropped to 80% of BSBP, another group of 24 patients, the control group, got an intravenous ephedrine bolus (20 mg). In order to maintain SBP over 80% of BSBP, these patients additionally received extra 10 mg ephedrine boluses as needed. Following these treatments, lactated Ringer's solution was administered to each patient group according on their specific needs..

Between the start of administering anesthesia and the delivery process, several essential signs such as SBP, DBP, MBP, and HR were closely monitored and duly noted every minute or even more frequently when required. The detailed surveillance was achieved with a sophisticated monitor coupled to an electrocardiogram that offered precise and immediate data gathering.

Arterial blood was extracted from the mother's clamped section of the umbilical cord and her radial artery as soon as the baby was delivered. Additionally, venous blood samples were taken from the umbilical cord. The Siggaard-Andersen nomogram was used to calculate parameters such as pH level, partial pressure of carbon dioxide (Paco2), partial pressure of oxygen (Pao2), and base deficit, which represents the acid-base balance.

Timing of the main points of the entire process, such as the administration of anesthesia, the beginning of surgery, making an incision in the uterus, and the delivery point, were recorded with precision in order to create a complete timeline for every individual’s journey. A very experienced pediatrician, who didn’t know whether the baby belonged to the control or study group, reliably assessed Apgar scores at both 1 and 5 minutes from birth to ensure unbiased estimation of the neonate’s welfare. Moreover, rhythmic respiration observed in the newborn at a particular time was also critically noted on paper.

For instance, for better patient care and safety, the parturients were advised to provide more information on early reporting of any unusual or discomfort symptoms in the process. Thus, it was possible to take into consideration those subjective complaints of patients that are commonly not documented in the literature but may significantly affect the results, such as nausea and vomiting, while analyzing statistical data. The chi-square analysis is a rigorous statistical technique used to compare proportions.

Similarly, the analysis of variance was used to test changes in blood pressure and heart rate, which were also followed by the Newman-Keuls multiple range test to show significant differences. This procedure, with a p-value of 0.05, corresponded to standard statistical norms, ensuring careful and trustworthy data analysis.

Results and Discussions

A. Results

Table 1 presents a tabular assessment of several criteria that have been examined in detail. It is noteworthy that no statistically significant differences were found between the two groups with respect to the following: bupivacaine dosage, pre-hydration volume, total hydration volume until delivery time, ephedrine dose, induction-to-delivery interval, uterine incision-to-delivery time, mother's age, gravidity, mother's weight, baby's birth weight, duration of gestation, baseline blood pressure, sensory block level. Therefore, it is reasonable to presume that these criteria are not very important in differentiating between the two research groups.

Upon further examination of the control group, we discovered that a startling percentage—five patients, or 21 percent—maintained SBP over 80% of BSBP without using a vasopressor. The finding highlights the control group's capacity to keep their SBP relatively constant in the absence of outside assistance. However, ephedrine bolus injections were used to treat hypotension in these 19 extra members of the control group. For these individuals, this method assisted in controlling their SBP levels.

In the control group, it is worth noting that two patients needed extra support by administering a 10 mg bolus of ephedrine together with ongoing drip infusion in order to keep their systolic blood pressure above ninety percent of the baseline systolic blood pressure. This requirement in itself demonstrates how patients' responses vary individually; it shows how important individualized care and patient-centered interventions should be. These considerations are essential when formulating management plans to ensure an excellent outcome for each patient. To understand the results completely, it is crucial to analyze the changes in systolic blood pressure between these two groups.

The effectiveness of the interventions used can be better understood through this type of analysis. The figure enclosed in the paper shows how SBP in patients who received ephedrine infusion changed. Strangely enough, it was found that the SBP levels remained unchanged as a result of the administration of ephedrine. This outcome implies that ephedrine infusions tended to stabilize the SBP and keep it within normal limits. Therefore, conclusions drawn from this research could enlighten us about the various facets associated with the individuals studied.

Based on the absence of significant variations in any of the multiple parameters between the two groups, it

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suggests that these variables may not help in distinguishing the groups. Furthermore, the reported observation about managing hypotension with a systolic bolus of ephedrine that keeps SBP under control. More importantly, specific requirements seen in a few individuals among some patients act as another feather in the cap and underscore the demand for a personalized approach. Ultimately, understanding how SBP behaves when ephedrine is injected intravenously gives us valuable information about its stability in response to this intervention.

Five minutes after the start of spinal anesthesia, the systolic hypotension was most noticeable in the group that did not receive an infusion. Even with vigorous therapy, the SBP took around 6 minutes to return to pre-levels. Three patients (13% of the total) in the control group had SBPs that were greater than the baseline values of +1%, +15%, and +9%.

Compared to the infusion group, which had only one patient (3% of the group) experiencing a similar rise in SBP, the difference between the two groups was not significant (p=0.1). The highest increase in maternal heart rate showed no statistical significance between the two groups, with 113 beats per minute in the infusion group and 119 beats per minute in the control group, while the rates during ephedrine infusion were 93 beats per minute and 96 beats per minute for both groups, respectively. Among all patients given ephedrine infusion, all of them maintained their SBP above 70% of the baseline value, which was significantly lower than the SBP falling below 70% of the baseline value observed in three patients (13% of the group) who did not receive infusion (p=0.1).

It was shown that the infusion group had nausea and vomiting far less frequently than the control group. Of these, just one patient had nausea following an ephedrine infusion, whereas nine patients in the control group experienced nausea and/or vomiting. At $p < 0.005$, this variation in incidence was statistically significant. Moreover, when comparing the control group members who experienced nausea and/or vomiting with and without systolic blood pressure (SBP), no discernible change was seen (96.4 ± 10.8 torr versus 95.4 ± 10.5 torr, $p > 0.1$).

It was determined that every baby involved in this study had Apgar scores of more than 7 in the first and fifth minutes, indicating excellent health. Additionally, it seems that fewer than 90 seconds were needed to initiate continuous rhythmic breathing, indicating effective respiratory function. The results of this study's analysis of arterial blood samples from the mother and the umbilical cord venous and umbilical arterial segments, including pH, partial pressure of oxygen (PaO), partial pressure of carbon dioxide (PaCO2), and base deficit, are shown in Table 2.

Notably, there were no statistically significant differences between the two groups in the Apgar ratings, blood gas tensions, time before rhythmic breathing began, or acid-base status. This suggests that the ephedrine infusion did not significantly alter any of these characteristics.

However, it is worth mentioning that the original text does not report pH values of umbilical venous blood; thus, no further deductions or comparisons may be made based on this one-sided information. As such, the role of these pH levels remains uncertain and should be considered for future research. In conclusion, ephedrine infusion was significantly associated with lower rates of nausea and vomiting compared to the control group.

Despite this discrepancy, no discernible differences were discovered in the two groups' Apgar scores, blood gas tensions, or the amount of time until rhythmic breathing began. These findings generally show that ephedrine infusion has no negative effects on the babies' wellbeing or quality of life. To ascertain the impact on various factors and outcomes within this age range, further research must be done.

In the course of the research, the values of blood pH were estimated to be under 7.30, specifically 7.26, 7.26, 7.28, and 7.28 for individual patients. The correlations between the mother’s blood pressure and umbilical venous pH level, arterial pH level, Po2, or Pco2 levels could not be found to be significantly correlated..

Blood pH levels were predicted to be below 7.30 for the length of the study, namely 7.26, 7.26, 7.28, and 7.28 for individual individuals. It was not possible to find a significant association between the mother's blood pressure and the arterial pH level, Po2, Pco2, or umbilical venous pH level.

Maternal	infusion group (n = 20)	Bolus injection group(n = 24)
Age (yrs)	29.8± 4	29.9 ± 3.1
Gravidity	2.50 ±0.9	2.25 ±0.7
Weight (kg)	78.0 ±12.6	73.3 ±10.0
Base line SBP (torr)	124.8±7.9	122.0 ±6.8
Level of anesthesia (T)	4.1 ±1.0	4.2 ±0.9
Prehydration (ml/kg)	14.3 ±1.9	7.9 ± 0.6
Bupivacaine dosage(mg)	7.8 ±0.7	15.4 ±2.1
Hydration prior to delivery (ml/kg)	22.6 ± 2 2.4	24.4 ±2.2
Ephedrine dosage (mg)	31.6 ±8.8	26.8 ±9.8
Induction-to-delivery	16.0 ±4.9	15.5 ±3.8

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Uterine incision-to time delivery time (sec)	70.5 ±23.7	70.3 ±30.6
Fetal Weight (gr)	3428 ±324	3419 ±421
Gestational age (wk.)	39.0 ± 0.7	39.3 ± 0.8
Values are means f SD. There were no statistically significant differences between the two groups		

Table 1. *Characteristics of Two Groups of Patients*

	infusion group	Bolus Injection group
Maternal arterial blood		
Po2(torr)	173 ±45	155 ±52
PCO(torr)	26.6 f 3.0	27.1 ±3.5
Base deficit	4.3 f 2.2	3 ±2.3
PH	7.43 ±0.03	7.44 ±0.03
Umbilical venous blood		
PH	7.34 ±0.04	7.36 ±0.05
Po2 (torr)	28 ±6	30 ±6
Pco2 (torr)	37.4 ±t 4.2	38.3 ±5.4
Base deficit	4.8 ±2.1	3.4 ±2.8
Umbilical arterial blood		
PH	7.26 ±0.03	7.28 ±0.06
Po2 (torr)	15.0 ±5.7	15.5 ±3.1
PCO(torr)	50.2 ±5.4	50.1 ±5.1
Base deficit	5.2 ±2.2	4.0 ±3.1
Values are means f SD. There were no statistically significant differences between the two groups.		

Table 2. *Maternal and Fetal Acid-Base Status and Blood Gas Tensions* *

B. Discussion

Maternal hypotension under anesthesia should be quickly and aggressively treated in accordance with the guidelines. When systolic blood pressure (SBP) hits 70% to 80% of the baseline level, the therapy usually starts [9]. We thought it would be interesting to compare two patient groups based on this idea: one group was treated as usual, while the other group had a prophylactic ephedrine infusion to avoid their SBP from dropping. We decided to use SBP percentage fluctuation analysis to define hypotension therapy [10].

Indeed, it has been found that the decrease in uterine blood flow is directly related to a proportional decline in maternal blood pressure [11], rather than simply looking at the level of blood pressure. This enabled us to appreciate more vividly all hypotension and subsequent treatment outcomes. In the case of ephedrine administration, it is often given as a bolus dose to address hypotension. However, in this way, it is unavoidable that there will be quite pronounced hypotension for some period until blood pressure normalizes.

If an unnecessary vasopressor is given in the form of a bolus before hypotension onset, it can stimulate reactive hypertension in some patients. Strategies to prevent and manage post-spinal hypotension are characterized by significant variation over the years. Gutsche (6) found that 50mg of ephedrine injection intramuscularly did not reduce SBP by more than 10% from the baseline level. Thus, this underscores the importance of developing new ways and techniques to manage hypotension effectively in patients undergoing conduction anesthesia.

The study's findings indicated that there was no relationship between mother blood pressure and umbilical venous pH, arterial pH, umbilical venous polypoison, or umbilical venous PCO2. The creation of prompt and intensive therapy for the mother's hypotension during conduction anesthesia is the work's contribution. Some guidance on how to proceed has been offered by a comparison trial comparing prophylactic ephedrine infusion with standard medication in the management of hypotension. Furthermore, the examination of the variations in SBP indicated that knowing the right sort of medication would be crucial.

This research is another source of information and insights on post-spinal hypotension that can be useful in finding ways of preventing or treating it. It also discloses that reperfusion hypertension did occur, albeit with an average increment of 16% higher than the baseline value of systolic blood pressure (SBP). Another important point to consider when using intramuscular ephedrine is its unreliability due to erratic absorption rates and difficulty accurately estimating peak effects of the vasopressor.

In one investigation, decided against correcting hypotensive shock brought on by spinal anesthesia in favor of intravenous dopamine infusion. Regretfully, compared to a group of patients whose mothers had bolus injections of

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ephedrine, reactive hypertension was noted in 25% of their patients, and umbilical oxygen tension decreased. Looked into the impact of 5% albumin prehydration on spinal hypotension in another investigation [12]. It was noted that this method might effectively control blood pressure.

However, there are significant disadvantages associated with this strategy, including the expense of albumin solution and the potential to overload individuals whose minimal cardiovascular capacity is unknown. On the other hand, ephedrine use as a continuous infusion with doses modified based on mother blood pressure may have some advantages. The overall amount of ephedrine appears to be equivalent to that utilized for bolus injections of ephedrine during case management, as does the total volume of fluid. Regulation may be changed depending on the circumstances with the use of infusion method monitoring, allowing the dosage to change correspondingly [13].

Additional bolus doses of ephedrine can be administered if the therapy has to be sustained, although if the infusion method is mastered, this should not happen very often. One benefit of injecting ephedrine is that a rate controller device may be used to deliver the drug precisely and securely. When maintaining blood pressure is the major objective of ephedrine infusion, this kind of administration is possible, effective, and safe even if it isn't as exact as manual control. It does, however, require constant monitoring in order to make timely adjustments to the infusion pace..

Our study's approach involved maintaining patients receiving ephedrine infusions at dosages that increased to 90%–100% of baseline systolic blood pressure, which served to lessen any abrupt changes in blood pressure. As a result, we saw a decline in the occurrence of illness and emesis, demonstrating that the ladies benefited from our approach. However, mean SBP was closest to baseline with ephedrine infusion compared to bolus injection, umbilical arterial pO2 tensions, and acid-base states seemed similar, even though maternal blood pressure was well conserved with a dose-response relationship [14].

This finding shouldn't be shocking, though, considering the control group's condition was transient hypotension rather than peripheral [15]. It is important to note that before to the administration of spinal anesthetic, a preload of one liter of lactated Ringer's solution was given to each of our patients. It follows that there is very little chance of fetal acidity in these situations. We put the fetus's protection and well-being first and did all within our power to ensure that the mother and child would be happy with the results [16].The findings of this research were in line with the outcomes from other studies [17] that utilized general anesthesia or epidural anesthesia in cesarean section.

Conclusion

In conclusion, ephedrine administration as a prophylactic measure via intravenous infusion was found to be both safe and effective in parturient patients who underwent spinal anesthesia for cesarean section. It maintained maternal blood pressure near baseline without any significant maternal tachycardia, hypertension, nausea, or vomiting. Similarly, no fetal compromise was observed.

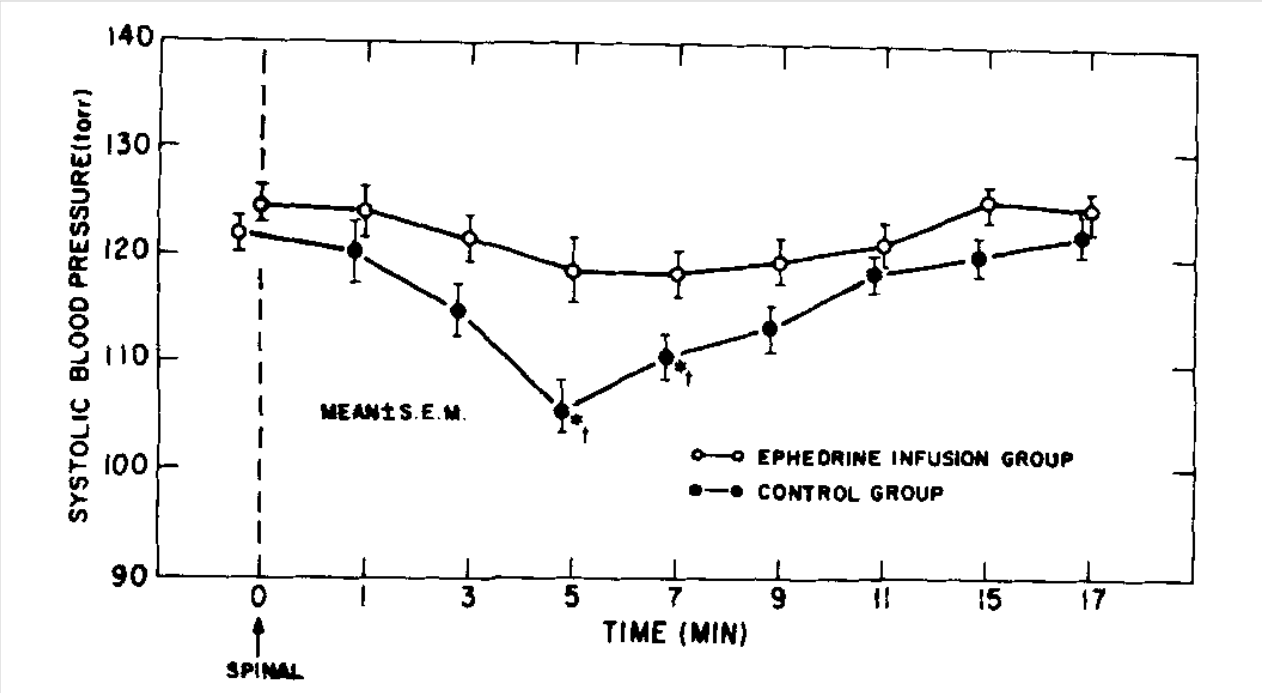

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Figure 1. *Systolic blood pressures considerably (p >0.001) different from the baseline value after receiving a preventive ephedrine infusion (G-0) and a therapeutic bolus ephedrine injection (M*). significantly (p < 0.025) different from a comparable result when ephedrine was infused.*

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