Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/61zj2040

COMPARISON OF THE EFFICACY OF CRYSTALLOID PRELOADING AND CO-LOADING FOR PREVENTION OF SPINAL-INDUCED HYPOTENSION IN PATIENTS UNDERGOING ELECTIVE LOWER LIMB SURGERIES AT TERTIARY CARE HOSPITAL, KARACHI

Sarah Nadia Jamal[1*], Rahma lodi[2], Sarah Ahmed[3], Roomi Ahmer[4], Baby Saba[5], Fatima Anees[6], Syed Wahaj Uddin[7]

[1]Senior Registrar, Department of Anaesthesia, SIUT Pakistan, FCPS
[2]Senior Registrar, Department of Anaesthesia, NICVD, SR, FCPS,
[3]Consultant Anaesthetist, Department Of Anaesthesia, Civil Hospital Karachi. MCPS,
[4]Anaesthesia consultant, Department of Anaesthesia, Civil hospital Karachi. FCPS,
[5]Senior Registrar Anesthesia, Anesthesia Department, Sindh institute of urology and transplant FCPS, dethosabadetho@gmail.com
[6]Senior lecturer, Anesthesia Department, Sindh institute of urology and transplant, Fcps anesthesia
[7*]Assistant Professor, Anesthesia Department, Sindh institute of urology and transplant, Fcps, anesthesia
[*]**Corresponding Author: Sarah Nadia Jamal**
splashinaday@yahoo.com

Abstract

Background/Objective: Spinal anesthesia **(**SA) is popular and well accepted technique for surgeries below umblicus, however, spinal anesthesia induced hypotension (SIH) is a common complication that occurs in 25-75% patients after SA. The timing of intravenous fluid administration plays a significant role in incidence of SIH. Therefore, this study aimed to assess the efficacy of preloading versus coloading in reducing SIH.

Methods: A quasi-experimental study was conducted at the Department of Anesthesia, Civil Hospital, Karachi from 26 March 2021 to 26 November 2021. A total of 148 patients in a 1:1 were divided into pre-load (P) and co-load (C) groups. The primary efficacy endpoint was the incidence of SIH in both groups while the secondary efficacy endpoints were the incidence of SIH in both groups based on gender, age, duration of surgery, diabetes status, and smoking status. SPSS software version 26.0 was used for data analysis. Chi-square test was used to check the association among groups. A p-value < 0.05 was considered statistically significant.

Results: In the P group, 47.30% patients experienced SIH, while only 27% patients in the C group were affected (p=0.010). 25% patients in the 20-40 years age in the P group developed SIH, whereas none of the patients in the same age range in the C group did. SIH occurred in 59.50% males in group P, compared with patients in group C. None of the 9 smokers in the P group developed SIH, while 17.60% smokers in the C group did. 53.80% in the P group had SIH, compared with 29.80% non-smokers in the C group. These differences were statistically significant (p=0.010)

Conclusion: Coloading fluids proved to be beneficial in reducing the incidence of SIH compared to preloading in our study. Future studies with more robust methodologies are needed to establish a more generalizable result.

Keywords: Spinal anesthesia; SA; Spinal anesthesia induced hypotension; SIH; Preload; Coload; Ringer lactate; RL

Introduction

Spinal anaesthesia (SA) is a popular and well-accepted technique for surgery below the umbilicus in adult patients. (1) Hypotension following SA is a common and troublesome physiological complication with an incidence ranging from 25% to 75% among the general population. (2) SA can cause severe hypotension due to pharmacological sympathectomy, resulting in potential deleterious consequences for the patient. The spectrum of morbidity associated with hypotension may include, but is not limited to, a higher incidence of nausea, vomiting, dizziness, aspiration, syncope and cardiac arrhythmias. (3)

Prevention of the spinal anaesthesia-induced hypotension (SIH) is of utmost importance, as the patient's life is at risk. The clinicians have used various methods and techniques, such as leg wrapping, elastic stockings, optimizing patients' position, intravenous fluids and vasopressors, from time to time to offset these hypotensive effects of spinal anaesthesia with varying degrees of success. (4, 5)

The administration of intravenous fluids to optimize the blood volume during sympathectomy has been the most popular and widely used as the first line of therapy among these techniques. (6) The intravenous fluids can be used both before and during the administration of spinal anaesthesia, the techniques appropriately named as pre-loading and co-loading, respectively. (5, 7) Numerous research studies and available literature evidence suggest that both of these techniques can be equally effective in preventing hypotension. (8) Preloading for the prevention of SIH is a common and traditional practice in anaesthesia. However, the preloading of crystalloid is rapidly redistributed. It induces the secretion of atrial natriuretic peptide (ANP), resulting in peripheral vasodilation and an increased rate of excretion of the preloaded fluid. (9) Due to inconsistent results of the benefits of pre-loading, the concept of co-loading has also gained widespread acceptance among clinicians. (10)

Results of several studies have shown a sustained increase in cardiac output with the rapid administration of crystalloids after the initiation of SA. (11) Studies about the kinetics of intravenous infusion of crystalloids as co-load have shown that it reduces the incidence of SIH. Khan et al. compared crystalloid preloading versus crystalloid co-loading to prevent hypotension. SIH occurred in 70% of patients in the preload group and 50% of the patients in the co-load group, respectively. (12)

The study aims to compare the efficacy of crystalloid preloading and co-loading for the prevention of SIH in patients in order to establish the local perspective, as there is a paucity of local data in patients undergoing elective lower limb surgeries.

Methods

A quasi-experimental study was conducted after approval from the Institutional Review Board (IRB) and College of Physicians and Surgeons (CPSP) at the Department of Anaesthesia, Dow University of Health Sciences (DUHS), Civil Hospital, Karachi. The study was conducted from 26 March 2021 to 26 November 2021. The sample size was calculated by using the WHO software, where the power of the test was kept at 1-beta=80 and the confidence interval at 95%, and taking efficacy to be 30% and 50% in the preload and co-load groups. (12) The sample size came out to be 148, with 74 participants in each group. A non-probability consecutive sampling technique was employed to select patients.

Those patients were included in the study who underwent elective lower limb procedure surgery under SA, had a weight of < 90 kg and a height of > 150 cm, were of either gender, with ASA ≤ 2 and aged 20-60 years. Those patients were excluded who did not consent to participate, had a history of anatomically abnormal spine, like kyphosis and scoliosis, had a hemoglobin level less than 8 gm/dl, had bradycardia at the time of admission, or had a history of hypertension, hypo- or hyperthyroidism,

congestive heart failure (CHF), chronic liver disease (CLD), chronic obstructive pulmonary disease (COPD), or stroke.

Data was collected from the consenting patients visiting the Department of Anesthesia, DUHS, Civil Hospital, Karachi. A brief history was taken from each patient. Each participant's height in metres was measured using a wall-mounted scale, and weight to the nearest kilogram was measured using a weighing machine, and BMI was calculated at the time of admission to the hospital prior to the surgery. Patients were randomly allocated using sealed opaque envelopes bearing P (preload group) and C (co-load group). All patients were fasting for 6 hours before surgery. On arrival to the operation theatre, standard monitoring was instituted, including ECG, non-invasive blood pressure, and pulse oximetry. After noting the baseline values, all parameters were recorded and checked every 1, 3, 6, 9, 12, 15, 20 and then every 5 minutes till the end of surgery. An 18-gauge intravenous cannula was inserted in the forearm. In group P, 20 ml/kg Ringer lactate (RL) fluid was preloaded 20 minutes before commencement of surgery. In group C, 20 ml/kg RL fluid was co-loaded in 20 minutes just after lumbar puncture (LP). Thereafter, all patients were infused with 2 ml/kg of RL intraoperatively. All patients receive 3 ml of 0.5% hyperbaric bupivacaine intrathecally, in the L3-L4 intervertebral space with a 23-gauge spinal needle. After spinal injection, the patients were put in the supine position. A sensory level of T8 was achieved using a pinprick with a 25-gauge needle. Urinary catheterization was done. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP) and oxygen saturation (SPO2) were recorded every 3 minutes. Patients were handed over for the procedure after 10 minutes of SA. SIH was labelled by a fall in SBP $\geq$ 20% or SBP $\leq$ 90 mm of Hg of the baseline value at the time of surgery. One dose of phenylephrine 50 mcg was injected intravenously to treat hypotension. Efficacy was taken as positive if patients in either group did not develop SIH. The findings of quantitative variables (age, SBP, DBP, HR, height, weight, BMI and duration of surgery) and qualitative variables (gender, diabetes mellitus type II, smoking status and SIH) were entered in the proforma.

Data was analyzed on the Statistical Package of Social Sciences (SPSS) Version 20. Means and standard deviations were calculated for the quantitative variables (age, SBP, DBP, HR, height, weight, BMI and duration of surgery) based on normality. Frequencies and percentages were calculated for the qualitative variables like gender, diabetes mellitus type II, smoking status and SIH incidence (Yes/No). Chi-square was used to check the association of SIH occurrence with age groups, gender, diabetes mellitus type II, and smoking status. Effect modifiers were controlled through stratification of age, gender, diabetes mellitus type II, smoking status and duration of surgery to see the effect of these on the outcome variables. A p-value of $\leq$ 0.05 was considered statistically significant.

Results

A total of 148 patients were included in the final analysis. The mean age of participants in groups P and C was 48.21 ± 6.24 and 49.48 ± 8.41. Most of the patients in the P (54, 73%) and C groups (50, 67.60%) belonged to the 41-60 years of age group. The two groups were also comparable in terms of surgical duration and baseline measurements. On average, surgeries lasted 2.54 ± 1.78 hours in group P and 2.97 ± 1.56 hours in group C. Mean systolic pressures were 131 ± 10.54 mmHg and 128 ± 12.89 mmHg, while diastolic pressures averaged 92 ± 7.54 mmHg and 82 ± 8.89 mmHg in groups P and C, respectively. Participants in group P had an average height of 147 ± 4.21 cm and weighed 71.7 ± 7.25 kg, compared with 158 ± 5.28 cm and 78.7 ± 9.87 kg in group C. The corresponding mean BMI values were 28.9 ± 5.14 kg/m² and 29.6 ± 4.91 kg/m². ***(Table 1)***

Table 1. Demographics and Baseline Characteristics of the Participants (N = 148)

Variable	**Group P**	**Group C**
	n (%)	
Age, Mean ± SD	48.21 ± 6.24	49.48 ±8.41

Min-Max	20-60	20-60
20-40 years	20 (27%)	24 (32.40%)
41-60 years	54 (73%)	50 (67.60%)
Gender		
Male	37 (50%)	35 (47.30%)
Female	37 (50%)	39 (52.70%)
Diabetes Mellitus Type II		
Yes	20 (27%)	33 (44.60%)
No	54 (73%)	41 (55.40%)
Smoking Status		
Yes	9 (12.20%)	17 (23%)
No	65 (87.80%)	57 (77%)
Duration of Surgery, Mean ± SD	2.54 ±1.78	2.97 ± 1.56
Min-Max	1-3	1-3
< 2 hours	56 (75.70%)	29 (39.20%)
≥2 hours	18 (24.30%)	45 (60.80%)
SBP, Mean ± SD	131 ±10.54	128 ± 12.89
Min-Max	120-148	120-148
DBP, Mean ± SD	92 ± 7.54	82 ± 8.89
Min-Max	70-95	70-95
Height, Mean ± SD	147 ± 4.21	158 ±5.28
Min-Max	138-172	138-172
Weight, Mean ± SD	71.7 ±7.25	78.7 ±9.87
Min-Max	68-115	68-115
BMI, Mean ± SD	28.9 ±5.14	29.6 ±4.91
Min-Max	23-33	23-33

In the P group, 35 (47.30%) patients experienced SIH, while only 20 (27%) patients in the C group were affected. This difference was statistically significant (p = 0.01). Likewise, the difference remained significant across subgroups such as age, gender, and smoking status (p = 0.01). In the 20–40-year age group, 5 (25%) out of 20 patients in the P group developed SIH, whereas none of the 33 patients in the same age range in the C group did. Among male participants, SIH occurred in 22 (59.50%) of 37 men in group P, compared with 10 (20%) of 35 men in group C. Smoking status also

showed variation. None of the 9 smokers in the P group developed SIH, while 3 (17.60%) out of 17 smokers in the C group did. A similar difference was seen among non-smokers. 35 (53.80%) of 65 patients in the P group had SIH, compared with 17 (29.80%) of 57 non-smokers in the co-load group. ***(Table 2)***

Table 2. SIH incidence in the Pre-load versus Co-load group

Variable	**SIH Incidence**		**p-value**
	Group P	**Group C**	
SIH Incidence			0.010*
Yes	35 (47.30%)	20 (27%)	
No	39 (52.70%)	54 (73%)	
Age			
20-40 years	5 (25%)	0	0.010*
41-60 years	30 (55.60%)	20 (40%)	0.110
Gender			
Male	22 (59.50%)	10 (28.60%)	0.010*
Female	13 (35.10%)	10 (25.60%)	0.360
Duration of Surgery			
< 2 hours	28 (50%)	10 (34.50%)	0.170
≥2 hours	7 (38.90%)	10 (22.20%)	0.170
Diabetes Mellitus Type II			
Yes	7 (35%)	5 (15.20%)	0.09
No	28 (51.90%)	15 (36.60%)	0.130
Smoking Status			
Yes	0	3 (17.60%)	0.010*
No	35 (53.80%)	17 (29.80%)	0.010*

*p-value significant at < 0.05

Discussion

SA can cause severe hypotension due to pharmacological sympathectomy, resulting in potential deleterious consequences for the patient. Prevention of this SIH is of utmost importance. Several techniques and methodologies have been adopted to prevent neuraxial hypotension, with varying degrees of success. The administration of intravenous fluids to optimize the blood volume during sympathectomy has been the most popular and widely used as the first line of therapy among these techniques, appropriately named 'pre-loading' and 'co-loading', respectively. (3, 6) So, our study aimed to evaluate the efficacy of pre-loading versus co-loading to prevent the incidence of SIH.

Our study found that there was a significant difference between the P and C groups in the incidence of SIH, as 47.30% of patients in the P group developed SIH compared to 27% in the C group. Additionally, a significant difference was observed in our study between P and C groups in the

incidence of SIH in the 20-40-year-old age group, males, smokers and non-smokers (p = 0.01). A study by Saadoon et al. found that the incidence of SIH in the C group was significantly less compared to the P group (0.001), which is similar to our finding. In contrast, a study by Khan et al. was conducted in Pakistan among non-obstetric patients; it included sixty patients who were randomly divided into P and C groups of 30 each. SIH occurred in 70% and 50% in the P and C groups; however, the difference was non-significant (p=0.187). Ephedrine requirement for SIH was significantly high in the P group (p=0.017). The C group had a lower incidence of SIH and significantly less vasopressor requirement. (12) Another study by Parmar et al. found that the total incidence of hypotension in group P and group C was 13.33% and 10%, respectively (p=0.463). (11) Bose et al. conducted an RCT to compare the efficacy of preloading versus coloading in preventing SIH. There was no significant difference between the P and C groups in SIH incidence (0.140). The timing of haemodynamic processes following SA explains the concept of coloading. After bupivacaine is administered in the subarachnoid space, sympathetic nerve blocking is finished within the first ten minutes. Haemodynamic alterations are quite likely to occur, such as bradycardia and hypotension throughout this time. Although there is a significant danger of volume overload, preloading prior to the start of SA may be beneficial. However, when there is the greatest chance of haemodynamic abnormalities brought on by SA, coloading makes additional fluids available in the intravascular region. Thus, it reduces the risk of fluid overload, inhibits fluid redistribution and excretion, and causes prompt compensatory adjustments in the cardiovascular system. Coloading is therefore a physiologically more suitable approach. (13)

Conclusion

SIH incidence was lower in the co-load group compared to the preload group in our study, highlighting the beneficial effects of co-loading during SA in lower limb surgeries. However, literature suggests mixed findings of both superior and comparable effects of coloading. Future studies with larger sample sizes and more robust methodologies are needed to establish a more generalizable result. Whatever strategy is to be used, SIH must always be considered a warning sign of a critical hemodynamic situation.

References

1. Tamilselvan P, Fernando R, Bray J, Sodhi M, Columb MJOAD. The Effects of Crystalloid and Colloid Preload on Cardiac Output in the Parturient Undergoing Planned Cesarean Delivery Under Spinal Anesthesia: A Randomized Trial. 2011;31(1):54-6.
2. Bhar D, Bharati S, Sarathi Halder P, Mondal S, Sarkar M, Jana SJJotIMA. Efficacy of prophylactic intramuscular ephedrine in prevention of hypotension during caesarean section under spinal anaesthesia: A comparative study. 2011;109(5):300.
3. Siddik-Sayyid S, Nasr V, Taha S, Zbeide R, Shehade J, Al Alami A, et al. A Randomized Trial Comparing Colloid Preload to Coload During Spinal Anesthesia for Elective Cesarean Delivery. 2010;30(4):239-40.
4. Jeon Y-T, Hwang J-W, Kim M-H, Oh A-Y, Park KH, Park H-P, et al. Positional blood pressure change and the risk of hypotension during spinal anesthesia for cesarean delivery: an observational study. 2010;111(3):712-5.
5. Bose M, Kini GJJoACP. Comparison of crystalloid preloading versus crystalloid coloading to prevent hypotension and bradycardia following spinal anaesthesia. 2008;24(1):53-6.
6. Oh A-Y, Hwang J-W, Song I-A, Kim M-H, Ryu J-H, Park H-P, et al. Influence of the timing of administration of crystalloid on maternal hypotension during spinal anesthesia for cesarean delivery: preload versus coload. 2014;14(1):36.
7. Lotfy ME, Moustafa AM, El Feky EM, Mowafy IAJJAS. Colloid versus crystalloid co-load with spinal anesthesia during emergent cesarean section and their effect on hemodynamic changes. 2014;10(11):158-63.

8. Khan M, Nisai W, Farooqi A, Ahmad N, Qaz SJIJA. Crystalloid coload: a better option than crystalloid pre-load for prevention of postspinal hypotension in elective caesarean section. 2013;32(1):6-13.
9. Teoh W, Sia AJOAD. Colloid Preload Versus Coload for Spinal Anesthesia for Cesarean Delivery: The Effects on Maternal Cardiac Output. 2010;30(1):36-7.
10. KlÖHR S, Roth R, Hofmann T, Rossaint R, Heesen MJAAS. Definitions of hypotension after spinal anaesthesia for caesarean section: literature search and application to parturients. 2010;54(8):909-21.
11. Parmar SB, Sheikh A, Shalu PSJJEMDS. A comparative study of preloading versus coloading of crystalloid to prevent spinal anaesthesia induced hypotension. 2012;5(1):746-53.
12. Khan MU, Memon AS, Ishaq M, Aqil MJJCPSP. Preload versus coload and vasopressor requirement for the prevention of spinal anesthesia induced hypotension in nonobstetric patients. 2015;25(12):851-5.
13. Dyer R, Farina Z, Joubert I, Du Toit P, Meyer M, Torr G, et al. Crystalloid preload versus rapid crystalloid administration after induction of spinal anaesthesia (coload) for elective caesarean section. 2004;32(3):351-7.