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Effect of Patient Weight on Hemodynamic Responses to Intrathecal 0.5% Hyperbaric Bupivacaine: A Cross-Sectional Study at a Tertiary Care Center in Indore, Madhya Pradesh

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ABSTRACT

Background: The study assessed the effect of the patient's weight on hemodynamic variables after intrathecal administration of a fixed dose of 0.5% hyperbaric bupivacaine.

Methods: This descriptive cross-sectional study included 200 patients in tertiary health care. All patients were monitored for 1 hour to assess blood pressure and heart rate. Systolic blood pressure, mean blood pressure and heart rate were recorded at the following periods: preoperatively, just after giving a supine position following SAB, after 5 min, 10 min, 15 min, 30 min, and 1 hour and observations were recorded on a pre-structured proforma.

Results: The effect of weight was clinically and statistically significant with p value<0.05 after intrathecal administration of the fixed dose of 0.5% hyperbaric bupivacaine. However, the height impact is clinically essential but statistically non-significant with a p-value>0.05.

Conclusion: From the observations, results, and statistical analysis of this study, we concluded that patients with higher weight achieve more blood pressure falls than thin patients after administering a fixed dose of intrathecal bupivacaine 0.5%, 3 ml.

Key-words: Body Weight, Fixed-Dose, Bupivacaine, Heart Rate, Intrathecal anesthesia

INTRODUCTION

Intrathecal anesthesia, commonly known as spinal anesthesia, is a widely used technique in various surgical procedures, particularly in lower abdominal, pelvic, and lower extremity surgeries [1,2]. Among the different local anesthetics available, 0.5% hyperbaric bupivacaine is a commonly preferred agent due to its efficacy, safety profile, and predictable hemodynamic effects [3].

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However, patient-specific factors such as body weight may significantly influence intrathecally administered drugs' distribution and efficacy, leading to hemodynamic response variations [4].

The relationship between patient weight and the hemodynamic outcomes following intrathecal administration of hyperbaric bupivacaine is of particular interest in clinical practice [5]. Obesity and variations in body mass index (BMI) have been identified as potential factors that can alter the pharmacokinetics and pharmacodynamics of anesthetic agents [6]. The distribution of the local anesthetic in the cerebrospinal fluid (CSF) and its subsequent spread within the intrathecal space may be influenced by patient weight, thereby impacting the onset, duration, and intensity of the block, as well as the hemodynamic stability of the patient [5,6].

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Hemodynamic stability is a critical consideration during spinal anesthesia, as significant fluctuations in blood pressure and heart rate can lead to adverse outcomes, particularly in high-risk populations. Understanding the impact of patient weight on these variables is essential for optimizing anesthetic management, tailoring doses, and reducing the risk of complications [4-7].

This study is done to assess the effect of the weight of patients on intrathecal drug spread. Studies done earlier were comparative studies between weight-adjusted doses versus fixed doses. In all studies done earlier, plain hyperbaric 0.5% bupivacaine was not used. Instead, adjuvants were added, and most studies were done in the caesarian section [8,9]. Most earlier studies were on foreign populations and term parturients planned for cesarean section [10-12]. So, this study is done in patients going for lower limb and lower abdominal surgeries to know the effect of plain hyperbaric 0.5% bupivacaine on hemodynamic variables.

MATERIALS AND METHODS

Research Design- The study was conducted at the Department of Anesthesia, Sri Aurobindo Medical College and Hospital, Indore, M.P. from 01 July 2018 to 31 October 2019. After obtaining ethical committee approval, written informed consent was acquired from all participants, followed by a detailed pre-anesthetic evaluation. The study involved the American Society of Anesthesiologists (ASA) grade 1 and 2 patients, aged 18 to 70 years, who were scheduled for lower limb, lower abdominal, and urology surgeries. These patients had an average coagulation profile and were deemed suitable for the study based on the inclusion criteria.

On the day of surgery, all patients were preloaded with fluids at a rate of 10 ml/kg. Routine monitoring, including ECG, NIBP, SpO_2, and respiratory rate, was initiated in the operating theatre. After explaining the procedure, patients were positioned in a sitting posture. Following proper antiseptic precautions, the L3-L4 intervertebral space was identified, and local infiltration with 2% lignocaine was performed. A 25G (Quincke's) spinal needle was used to ensure the free flow of CSF. Subsequently, 3 ml of 0.5% hyperbaric bupivacaine was administered over 30 to 40 seconds, without any adjuvant. Barbotage was performed once to confirm the intrathecal space before administering the drug. The patient was then positioned supine without any tilt, and intravenous midazolam was administered.

Hemodynamic parameters, including systolic blood pressure, mean blood pressure, and heart rate, were monitored for one-hour post-administration. These measurements were recorded at specific intervals: preoperatively, immediately after assuming the supine position following subarachnoid block (SAB), and at 5 minutes, 10 minutes, 15 minutes, 30 minutes, and 1 hour post-SAB. Patients were categorized into two groups based on their weight:

Group A: 40 kg-65 kg.

Group B: >65 kg.

Inclusion Criteria

- ASA grade 1 and 2 patients.
- Age range of 18 to 70 years.
- Scheduled for lower limb, lower abdominal, and urology surgeries.
- Average coagulation profile.

Exclusion Criteria

- Patients with contraindications for regional anesthesia, such as coagulopathy, pre-existing neurological defects, or cardiac disease.
- Patients with known allergies to any drugs.
- Patients undergoing emergency procedures.
- Pregnant females.
- Surgeries lasting more than 90 minutes.
- Failed spinal blocks that were converted to general anesthesia.
- Spinal blocks whose effects wore off intra-operatively and required supplementation with general anesthesia.

Statistical Analysis- Data was collected and presented by using MS Excel. Data was tabulated through IBM software SPSS version 21.0. Statistical analysis was done using the student t-test and the Karl Pearson correlation test. A p-value<0.05 was considered statistically significant.

Ethical Approval- Approval for this study was obtained from the relevant ethical committee, ensuring that all research procedures adhered to ethical standards and guidelines for protecting participants' rights and confidentiality.

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RESULTS

The study included 200 patients divided into two weight groups: 115 patients (57.5%) in the 40-65 kg group and 85 patients (42.5%) in the >65 kg group. Pre-operative mean SBP was 128.50 mmHg for the 40-65 kg group and 129.05 mmHg for the >65 kg group. SBP decreased slightly immediately after supine positioning and continued to drop over the next 30 minutes, reaching 113.96 mmHg for the 40-65 kg group and 111.92 mmHg for the >65 kg group. By 60 minutes, SBP rebounded slightly to 118.80 mmHg in the 40-65 kg group and increased to 120.75 mmHg in the >65 kg group (Table 1).

Table 1: Frequency distribution of study participants based on weight band and mean SBP at different time intervals

Time Interval	Weight Groups	N (%)	Mean SBP (mmHg)
Pre-op	40-65 KG	115 (57.5)	128.50
	>65KG	85 (42.5)	129.05
Immediate After Supine	40-65 KG	115 (57.5)	125.75
	>65 KG	85 (42.5)	125.29
After 5min	40-65 KG	115 (57.5)	120.19
	>65 KG	85 (42.5)	120.55
After 10 min	40-65 KG	115 (57.5)	118.98
	>65 KG	85 (42.5)	116.16
After 15min	40-65 KG	115 (57.5)	116.31
	>65 KG	85 (42.5)	113.25
After 30 min	40-65 KG	115 (57.5)	113.96
	>65KG	85 (42.5)	111.92
After 60 min	40-65 KG	115 (57.5)	118.80
	>65KG	85 (42.5)	120.75

Table 2 described that significant differences in SBP were observed at the 10 and 15-minute marks post-administration, with the >65 kg group showing lower SBP compared to the 40-65 kg group. These findings suggest that patients in the higher weight category experience more pronounced hemodynamic changes shortly after intrathecal administration of bupivacaine. No significant differences were found at pre-operative, immediate post-supine, 5-minute, 30-minute, and 60-minute intervals, indicating that initial and later hemodynamic responses are similar across weight groups.

Table 2: Descriptive statistics showing a comparison of Mean SBP versus weight band after injecting bupivacaine at different time intervals

Time Interval	Weight Groups	N	Mean	Std. Deviation	T-test	p-value
Pre-op	40-65 KG	115	128.50	12.20	0.34	0.73
	>65KG	85	129.05	9.94		
Immediate After Supine	40-65 KG	115	125.75	8.77	0.35	0.72
	>65 KG	85	125.29	8.97		
After 5 min	40-65 KG	115	120.19	9.47	0.27	0.78

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	>65 KG	85	120.55	9.21		
After 10 min	40-65 KG	115	118.98	9.11	2.09	0.03
	>65 KG	85	116.16	9.78		
After 15 min	40-65 KG	115	116.31	10.30	2.04	0.04
	>65 KG	85	113.25	10.75		
After 30 min	40-65 KG	115	113.96	10.22	1.40	0.16
	>65KG	85	111.92	9.98		
After 60 min	40-65 KG	115	118.80	8.24	1.67	0.09
	>65KG	85	120.75	8.00		

Table 3 shows that the mean BP decreased in both weight groups following intrathecal administration, with the most significant reductions occurring within the first 15 minutes. The >65 kg group experienced a more substantial initial drop in BP compared to the 40-65 kg group, particularly notable at the 10 and 15-minute marks. By 30 and 60 minutes, the BP values in both groups began to stabilize and showed slight increases, with minimal differences at the 60-minute interval. These findings highlight the need for careful monitoring of BP, especially in heavier patients, to manage potential hemodynamic fluctuations effectively following spinal anesthesia.

Table 3: Frequency distribution of study participants based on weight band and mean BP at different time intervals

Time Interval	Weight Group (Kg)	N (%)	Mean BP (mm Hg)
Pre-op	40-65	115 (57.5)	86.73
	>65	85 (42.5)	85.14
Immediate After Supine	40-65	115 (57.5)	83.58
	>65	85 (42.5)	83.11
After 5 min	40-65	115 (57.5)	80.30
	>65	85 (42.5)	79.67
After 10 min	40-65	115 (57.5)	78.79
	>65	85 (42.5)	75.73
After 15 min	40-65	115 (57.5)	76.03
	>65	85 (42.5)	72.60
After 30 min	40-65	115 (57.5)	77.02
	>65	85 (42.5)	76.16
After 60 min	40-65	115 (57.5)	79.38
	>65	85 (42.5)	79.16

The study included 200 patients, divided into two weight groups: 115 patients (57.5%) in the 40-65 kg group and 85 patients (42.5%) in the >65 kg group. Pre-operative mean BP was 86.73 mmHg for the 40-65 kg group and 85.14 mmHg for the >65 kg group, with no significant difference (p=0.25). Immediately after supine positioning, mean BP was similar between groups (83.58 mmHg vs. 83.11 mmHg, p=0.65). At 5 minutes, mean BP

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showed no significant difference (80.30 mmHg vs. 79.67 mmHg, p=0.58). Significant differences emerged at 10 minutes (78.79 mmHg vs. 75.73 mmHg, p=0.01) and 15 minutes (76.03 mmHg vs. 72.60 mmHg, p=0.004), with the >65 kg group showing lower BP. At 30 and 60 minutes, mean BP differences were not significant (77.02 mmHg vs. 76.16 mmHg, p=0.47; 79.38 mmHg vs. 79.16 mmHg, p=0.83, respectively) (Table 4).

Table 4: Descriptive statistics showing a comparison of Mean BP versus weight band after injecting bupivacaine at different time intervals

Time Interval	Weight Group (Kg)	N (%)	Mean BP (mm Hg)	SD	T-test	p-value
Pre-op	40-65	115 (57.5)	86.73	10.50	1.13	0.25
	>65	85 (42.5)	85.14	8.67		
Immediate After Supine	40-65	115 (57.5)	83.58	7.18	0.44	0.65
	>65	85 (42.5)	83.11	7.88		
After 5 min	40-65	115 (57.5)	80.30	8.29	0.55	0.58
	>65	85 (42.5)	79.67	7.64		
After 10 min	40-65	115 (57.5)	78.79	9.17	2.36	0.01
	>65	85 (42.5)	75.73	8.91		
After 15 min	40-65	115 (57.5)	76.03	8.69	2.87	0.004
	>65	85 (42.5)	72.60	7.84		
After 30 min	40-65	115 (57.5)	77.02	9.03	0.70	0.47
	>65	85 (42.5)	76.16	7.49		
After 60 min	40-65	115 (57.5)	79.38	7.68	0.20	0.83
	>65	85 (42.5)	79.16	7.01		

The study analyzed the mean heart rate (HR) of 200 patients divided into two weight groups: 115 (57.5%) in the 40-65 kg group and 85 (42.5%) in the >65 kg group, following bupivacaine administration. Pre-operatively, the mean HR was 83.23 bpm for the 40-65 kg group and 81.32 bpm for the >65 kg group (p=0.11). Immediately after supine positioning, the mean HR decreased to 81.27 bpm and 79.12 bpm, respectively (p=0.06). At 5 minutes, HR further decreased to 78.57 bpm and 76.02 bpm, respectively (p=0.05). Significant differences were observed at 10 minutes (77.16 bpm vs. 72.74 bpm, p=0.004) and 15 minutes (75.60 bpm vs. 71.72 bpm, p=0.01), with the >65 kg group showing lower HR. By 30 and 60 minutes, HR differences were not significant (73.49 bpm vs. 71.99 bpm, p=0.2456; 76.00 bpm vs. 74.74 bpm, p=0.27, respectively) (Table 5).

Table 5: Table showing comparison of mean HR Based on Weight at different time intervals

Time Interval	Weight Group	N (%)	Mean HR (bpm)	SD	T-test	p-value
Pre-op	40-65	115 (57.5)	83.23	8.63	1.60	0.11
	>65	85 (42.5)	81.32	8.00		
Immediate After Supine	40-65	115 (57.5)	81.27	8.60	1.83	0.06
	>65	85 (42.5)	79.12	7.67		
After 5 min	40-65	115 (57.5)	78.57	9.99	1.90	0.05

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	>65	85 (42.5)	76.02	8.31		
After 10 min	40-65	115 (57.5)	77.16	11.10	2.90	0.004
	>65	85 (42.5)	72.74	9.93		
After 15 min	40-65	115 (57.5)	75.60	11.13	2.47	0.01
	>65	85 (42.5)	71.72	10.74		
After 30 min	40-65	115 (57.5)	73.49	8.97	1.16	0.24
	>65	85 (42.5)	71.99	9.03		
After 60 min	40-65	115 (57.5)	76.00	7.91	1.10	0.27
	>65	85 (42.5)	74.74	8.11		

DISCUSSION

The analysis of the hemodynamic responses following the intrathecal administration of 0.5% hyperbaric bupivacaine in patients grouped by weight revealed significant findings that have important clinical implications.

The comparison of mean SBP across different time intervals indicated that both weight groups experienced a decrease in SBP following administration. Pre-operatively, there was no significant difference in SBP between the 40-65 kg and >65 kg groups (p=0.73). However, at 10- and 15-minutes post-administration, the >65 kg group exhibited significantly lower SBP compared to the 40-65 kg group (p=0.03 and p=0.04, respectively). This suggests that heavier patients may be more prone to hypotensive episodes shortly after receiving spinal anesthesia. Similar findings have been reported by Subedi *et al.* [11-13], Harten *et al.* [14,15], and Siddiqui *et al.* [14-16], where higher body mass has been associated with greater hemodynamic variability due to altered pharmacokinetics and pharmacodynamics of local anesthetics in obese patients.

Descriptive statistics comparing mean BP also showed a general trend of BP reduction post-administration. Significant differences were noted at the 10 and 15-minute marks, with the >65 kg group having significantly lower mean BP (p=0.01 and p=0.004, respectively). By 30 and 60 minutes, the BP values began to stabilize, showing no significant differences between the groups [17]. This stabilization may be attributed to compensatory physiological mechanisms restoring vascular tone and cardiac output over time. Similar observations have been noted in the studies by several studies [15-18].

Heart rate (HR) analysis revealed that pre-operative HR values were not significantly different between the groups (p=0.11). Immediately after supine positioning and at 5 minutes, HR approached significance (p=0.06 and p=0.05). Significant reductions in HR were observed at 10 and 15 minutes (p=0.004 and p=0.01), with the >65 kg group showing lower HR. These findings align with existing studies that highlight the bradycardic effects of spinal anesthesia, particularly in patients with higher body mass indices, as reported by many studies [17-20].

RECOMMENDATIONS

To improve patient safety and the effectiveness of spinal anesthesia with intrathecal 0.5% hyperbaric bupivacaine, doses should be tailored based on patient weight and height. Close hemodynamic monitoring, particularly within the first 15 minutes post-administration, is essential. The use of adjuncts such as vasopressors and atropine can help manage significant drops in blood pressure and heart rate. Gradual positioning changes should be implemented to mitigate abrupt hemodynamic responses. Further research is needed to refine dosing protocols and explore optimal anesthetic combinations, and ongoing training should be provided for anesthesiology staff on individualized dosing and vigilant monitoring practices.

CONCLUSIONS

This study provides valuable insights into the hemodynamic effects of intrathecal 0.5% hyperbaric bupivacaine, demonstrating significant differences in blood pressure and heart rate responses based on patient weight. The results highlight the need for tailored

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anesthesia plans to ensure patient safety and optimal outcomes, particularly for heavier patients.

Future research should explore strategies to mitigate these risks and further refine dosing protocols based on patient-specific factors.

LIMITATIONS

The study was limited by its single-centre design and relatively small sample size, which may affect the generalizability of the findings.

CONTRIBUTION OF AUTHORS

Research concept- Preeti Tiwari
Research design- Vikas Pandey
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Materials- Vikas Pandey, Tejpratap Singh
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REFERENCES

[1] Naz F, Kumar S, Nasir KK. Effect of Volume on Height of Sensory Blockade Keeping Dose Constant with Hyperbaric Bupivacaine in Patients Undergoing Orthopedic Procedure. Pak J Med Health Sci., 2022; 16(05): 780-99.

[2] Huang J, Wen G, Huang Q, Huang B. Anesthesia characteristic of an algorithm of bupivacaine dose based on height in caesarean section under spinal anesthesia: a retrospective cohort study. BMC Anesthesiol., 2023; 23(1): 146-61.

[3] Fawaz AA, Elie TY, Abdelwahab WA, Mattar AA. Comparative study between intrathecal fentanyl and midazolam as adjuvant to local anesthetics in spinal anesthesia in elective cesearean section in post-operative anesthesia and post-operative analgesia. Ain Shams Med J., 2020; 71(4): 841-52.

[4] Huang Q, Wen G, Hai C, Zheng Z, Li Y, et al. A height-based dosing algorithm of bupivacaine in spinal anesthesia for decreasing maternal hypotension in cesarean section without prophylactic fluid preloading and vasopressors: a randomized-controlled non-inferiority trial. Front Med., 2022; 9: 858115.

[5] Visavakul O, Leurcharusmee P, Pipanmekaporn T, Khorana J, Patumanond J, et al. Effective Dose Range of Intrathecal Isobaric Bupivacaine to Achieve T5–T10 Sensory Block Heights for Elderly and Overweight Patients: An Observational Study. Medicina., 2023; 59(3): 484-92.

[6] Subedi A, Tripathi M, Bhattarai BK, Gupta PK, Pokharel K, et al. The Effect of Height and Weight Adjusted Dose of Intrathecal Hyperbaric Bupivacaine for Elective Caesarean Section. JNMA J Nepal Med Assoc., 2011; 51(181): 1-6.

[7] Harten JM, Boyne I, Hannah P, Varveris D, Brown A. Effects of a height and weight adjusted dose of local anaesthetic for spinal anaesthesia for elective Caesarean section. Eur Soc Anaesth., 2004; 5(7): 99-121.

[8] Siddiqui KM, Ali MA, Ullah H. Comparison of spinal anesthesia dosage based on height and weight versus height alone in patients undergoing elective cesarean section. Korean J Anesthesiol., 2016; 69(2): 143-48.

[9] Jain K, Sethi SK, Jain R. Comparison of efficacy of intrathecal dexmedetomidine and magnesium sulfate as an adjuvant to 0.5% hyperbaric bupivacaine in patients undergoing infraumbilical surgeries under spinal anesthesia. J Dr. NTR Univ Health Sci., 2020; 9(2): 116-23.

[10] Iqbal F, Faridi MA, Saeed A, Shah I. The comparison between hyperbaric bupivacaine plus fentanyl and hyperbaric bupivacaine alone in spinal anesthesia for caesarean section. Pak Armed Forces Med J., 2021; 71(3): 1033-36.

[11] Yang C, Dong W, Luo J, Ma M, Gao Y, et al. The median effective dose of intrathecal hyperbaric bupivacaine for cesarean section at moderately high-altitude. Drug Des Dev Ther., 2024; 18:1313-1319. doi: 10.2147/DDDT.S455844.

[12] Huang YY, Chang KY. Sensory block level prediction of spinal anaesthesia with 0.5% hyperbaric bupivacaine: a retrospective study. Sci Rep., 2021; 14(1): 91-105.

[13] Kumar RA, Preetha I. Comparing the efficacy and haemodynamic response between intrathecal hyperbaric 0.5% bupivacaine with isobaric 0.75% ropivacaine using fentanyl as adjuvant in patients

DOI: 10.21276/SSR-IIJLS.2024.10.4.40

undergoing infra umbilical surgeries. Indian J Clin Anaesth., 2020; 7(3): 444-49.

[14]Manasa M, Petkar J, Jois SM, Sudheer R, Srinivasan R, et al. Height adjusted dose versus height-weight adjusted dose of intrathecal hyperbaric bupivacaine for caesarean delivery for preventing maternal hypotension: a prospective, double-blinded, randomized controlled study. J Obstet Anaesth Crit Care., 2024; 14(2): 131-37.

[15]Orlando BS, Stein D, Donovan J, White J, Bandovic I, et al. Optimal dose of spinal bupivacaine on maternal and fetal outcomes in parturients undergoing combined technique for labor analgesia: a randomized double blinded prospective study. J Sci Innov Med., 2023; 6(1): 140-59.

[16]Tang Y, Yang M, Fu F, Huang X, Feng Y, et al. Comparison of the ED50 of intrathecal hyperbaric ropivacaine co-administered with or without intrathecal dexmedetomidine for cesarean section: a prospective, double-blinded, randomized dose-response trial using up-down sequential allocation method. J Clin Anesth., 2020; 62: 109-25.

[17]Sachdeva S, Parekh KM, Malawat A, Jethava D, Mansuri T. Comparison of intrathecal dexmedetomidine and intrathecal fentanyl as an adjuvant with hyperbaric bupivacaine for spinal anaesthesia in lower limb surgeries: a prospective randomized clinical trial. Indian J Clin Anaesth., 2020; 7(2): 226-32.

[18]Huang YY, Chang KY. Sensory block level prediction of spinal anaesthesia with 0.5% hyperbaric bupivacaine: a retrospective study. Sci Rep., 2021; 11(1): 88-102.

[19]Goffard P, Leloup R, Vercruysse Y, Fils JF, Gautier PE, et al. Comparison of equipotent doses of intrathecal hyperbaric prilocaine 2% and hyperbaric bupivacaine 0.5% for elective caesarean section: a prospective, randomised, controlled, two-centre clinical trial. Eur J Anaesthesiol., 2022; 39(3): 227-35.

[20]Manouchehrian N, Rahimi-Bashar F, Pirdehghan A, Shahmoradi F. Comparison between 10 and 12 mg doses of intrathecal hyperbaric (0.5%) bupivacaine on sensory block level after first spinal failure in cesarean section: a double-blind, randomized clinical trial. Front Med., 2022; 9(6): 42-59.