COMPARISON OF SPINAL BLOCK CHARACTERISTICS BETWEEN HEIGHT AND WEIGHT-BASED DOSAGE VERSUS FIXED DOSAGE OF INTRATHECAL ROPIVACAINE FOR ELECTIVE CESAREAN SECTION

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Abstract:

Background: Spinal anesthesia is commonly preferred for cesarean sections due to physiological changes in pregnancy, yet hypotension remains a challenge. This study aims to compare the efficacy of height and weight-adjusted doses of spinal ropivacaine with fentanyl versus a fixed dosage in elective cesarean sections.

Methods: A prospective, randomized, double-blind trial included 56 parturients undergoing elective cesarean sections under spinal anesthesia. Group A received height and weight-adjusted doses, and Group B received a fixed dose of hyperbaric ropivacaine with fentanyl. Baseline characteristics, sensory blockade levels, blockade achievement times, motor block duration, and hemodynamic parameters were recorded.

Results: While sensory blockade levels were similar between the two groups, Group B (fixed dose group) demonstrated significantly shorter times for achieving T6 (p = 0.007) and T4 (p = 0.034) levels. The group B had a higher fall in systolic blood pressure immediately after spinal (p=) and at 5 minutes (p=) and in diastolic blood pressure immediately after spinal (p=) and at 15 minutes (p=). However, the total vasopressor (ephedrine) usage was similar between both groups. The heart rate was statistically lower in the fixed dose group immediately post-spinal (p=0.0005) and 15 mins (p=0.0005). But none of the patients in either groups required atropine. Both groups reported 100% adequacy in block and intraoperative analgesia.

Conclusion: While the fixed dose has the advantage of providing a significantly faster onset compared to dosing based on height and weight, the variable dosing group had more stable hemodynamics. Apart from this the highest sensory level, the duration of sensory and motor blockade, the quality of block as assessed by surgeon and patient's satisfaction were similar between the groups.

INTRODUCTION

Spinal anesthesia is the preferred choice for cesarean sections due to its rapid onset, reliable sensory and motor block, and minimal fetal exposure to anesthetic drugs. In obstetric patients, the dosage of local anesthetics is often reduced due to heightened sensitivity of neural tissue, alterations in cerebrospinal fluid (CSF) volume, weight gain, and an exaggerated lordosis. These physiological changes lead to a significant cephalad spread of the anesthetic agent, resulting in a higher level of blockade which can cause maternal discomfort and hypotension (1).

Hypotension remains a significant challenge associated with spinal anesthesia, particularly in cesarean sections. Various strategies are employed to mitigate this issue, including preloading with intravenous fluids, elevating the legs, prophylactic administration of vasopressors, using lower doses of local anesthetic agents, and incorporating additives such as clonidine and opioids (2). Despite these measures, managing hypotension effectively remains crucial for maternal and fetal well-being.

Ropivacaine is increasingly preferred for spinal anesthesia in obstetric patients due to its lower cardiotoxicity and neurotoxicity compared to bupivacaine. Many investigators have reported the safe and effective use of ropivacaine for spinal anesthesia in cesarean sections. The dose requirements for plain ropivacaine in cesarean sections vary, ranging from 8 to 22.5 mg, with a previous dose-response study estimating the 95% effective dose (ED95) to be 26.8 mg (3,4). However, determining the optimal dosage regimen for spinal hyperbaric

ropivacaine in cesarean sections remains challenging. It is essential to tailor the dosage based on individual patient characteristics, such as height and weight, to ensure effective anesthesia while minimizing adverse effects.

Furthermore, data from non-obstetric patients cannot be directly applied to obstetrics due to differences in dose requirements and increased sensitivity to local anesthetics. Obstetric patients often require lower doses due to the physiological changes mentioned earlier, which can significantly affect the spread and duration of the anesthetic block (5).

The objective of this study is to analyze the characteristics of the block achieved with a height and weight-adjusted dose of ropivacaine with fentanyl compared to a fixed dosage of ropivacaine with fentanyl in elective cesarean section patients. The aim is to determine the optimum drug dosage required for adequate anesthesia, ultimately reducing the reliance on vasopressors. By optimizing the dosage, we can enhance patient comfort, reduce the incidence of hypotension, and improve overall maternal and fetal outcomes.

Aim & Objectives:
- To compare the efficacy of height and weight-adjusted doses of spinal versus fixed dosage of intrathecal Ropivacaine for elective cesarean section.

Materials and Methods:
This prospective, randomized, double-blind trial was conducted in term parturients who underwent elective LSCS under subarachnoid blockade. The inclusion criteria were as follows: patients undergoing elective LSCS, aged 18-40 years, classified as ASA II, with a weight between 50-90 kg, height between 140-180 cm, and having a singleton pregnancy. Exclusion criteria included those undergoing emergency caesarean section, patients refusing spinal anesthesia, presence of infection at the site of regional blockade, bleeding diathesis, hypersensitivity to the study drug, allergy to local anesthetics, neurological diseases, and spinal deformities.

Figure 1: Flowchart
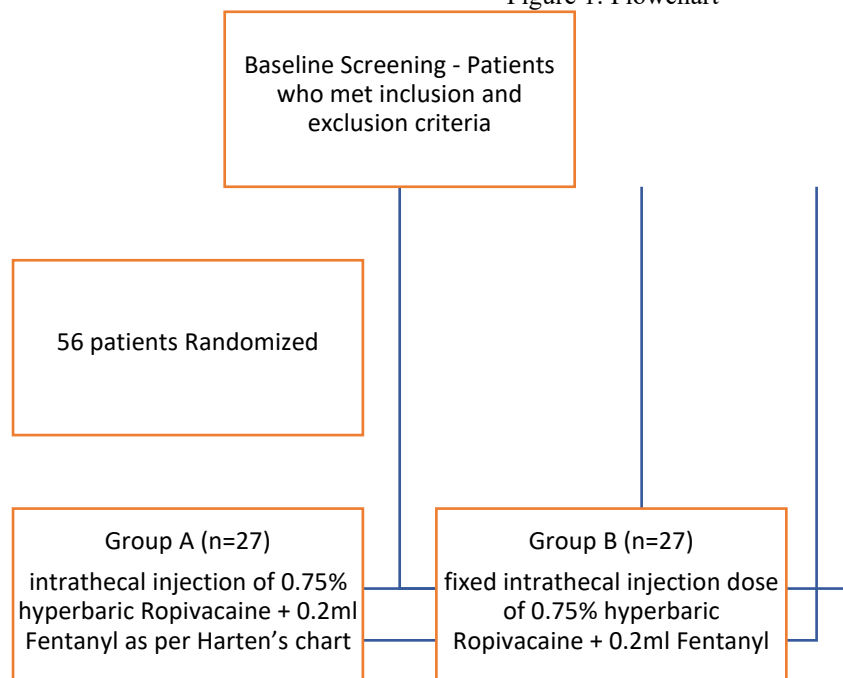
Fifty-six parturients who underwent elective LSCS under spinal anesthesia were included in the study. The patients were randomly allocated to 2 groups by computer-generated numbers.

GROUP A - The patients received an intrathecal injection of 0.75% hyperbaric Ropivacaine + 0.2ml Fentanyl (10mcg) to a combined total volume based on the weight and height of the patient as per Harten's chart given below.

GROUP B - The patients receive a fixed intrathecal injection dose of (2ml/10mg) 0.75% hyperbaric Ropivacaine + 0.2ml Fentanyl (10mcg).

Preoperative assessment was conducted on the previous day, and the patients were explained about spinal anesthesia and the measurements required for the study. On the day of the surgery, after shifting the patient onto the operating table, monitors (ECG, NIBP, Pulse oximetry) were connected, and baseline parameters were

recorded. The patient was started on intravenous fluids (Ringer Lactate). The drug was loaded, and spinal anesthesia was administered by the anaesthesiologist, who did not monitor the study parameters to ensure blinding. Under aseptic precautions, spinal anesthesia was given in the L3-L4 interspace as per the group and dosage, using a 25G QUINCKE spinal needle in the sitting position. The time taken to achieve the T6 level and T4 level was noted down. The maximum level of sensory and motor blockade achieved, and the time taken for the same were recorded. The sensory blockade was checked by using a cotton swab to assess the loss of sensation in response to light touch. Specifically, the area of the blockade was gently stroked with a cotton swab, and the patient was asked to report any sensation felt. This process was repeated at regular intervals to determine the highest dermatome level where the sensory blockade was effective.

For motor blockade, the modified Bromage score was utilized to evaluate the degree of motor impairment. The modified Bromage score categorizes motor function as follows:

- 0: Full flexion of knees and feet.
- 1: Just able to move knees.
- 2: Able to move feet only.
- 3: Complete block (unable to move knees or feet).

Patients were asked to attempt specific movements, such as bending their knees and moving their feet, and their abilities were scored according to the modified Bromage scale. These assessments were conducted at regular intervals until the maximum level of motor blockade was established.

Hypotension was treated when systolic blood pressure fell 20% below the baseline value with ephedrine 3 mg IV bolus. Bradycardia was treated when the heart rate fell below 50/min, with IV atropine sulfate 0.6mg bolus. Inadequate levels of blockade at the end of 7 minutes were managed by giving general anesthesia. At the end of surgery, the quality of the block was assessed by the surgeon, and the satisfaction of intraoperative analgesia was evaluated by the patienton a two-point scale (adequate/inadequate). After completion of surgery the duration of sensory and motor blockade was assessed.

Figure 2: Harten's Chart

Patient weight; kg	Patient height; cm								
	140	145	150	155	160	165	170	175	180
50	1.5	1.7	1.8	1.9					
55	1.5	1.6	1.8	1.9	2.0				
60	1.4	1.6	1.7	1.8	2.0	2.1			
65	1.4	1.5	1.7	1.8	1.9	2.1	2.2		
70	1.3	1.5	1.6	1.8	1.9	2.0	2.2	2.3	
75		1.4	1.6	1.7	1.9	2.0	2.1	2.3	2.4
80		1.4	1.5	1.7	1.8	2.0	2.1	2.2	2.4
85			1.5	1.6	1.8	1.9	2.1	2.2	2.3
90			1.4	1.6	1.7	1.9	2.0	2.2	2.3
95				1.5	1.7	1.8	2.0	2.1	2.3
100				1.5	1.7	1.8	1.9	2.1	2.2
105					1.6	1.7	1.9	2.0	2.2
110						1.7	1.8	2.0	2.2

RESULTS

The results presented in Table 1 outline the baseline characteristics of the study participants, comparing two groups labelled Group A and Group B. Group A (height and weight adjusted group) has a mean age of 27.44 ± 2.32 years, while Group B (fixed dose group) has a mean age of 28.42 ±3.21 years. The difference is statistically significant (p = 0.074). Group A has a mean gestational age of 38.4 ±0.8 weeks, and Group B has a mean gestational age of 38.9 ±0.8 weeks. The difference is statistically significant (p = 0.054)

The highest levels of sensory blockade achieved among patients were recorded at thoracic vertebrae levels T2, T4, and T6. In Group 1, 2 patients (7.4%) reached the T2 level, 24 patients (88.9%) reached the T4 level, and 1 patient (3.7%) reached the T6 level. Similarly, in Group 2, 3 patients (11.1%) reached the T2 level, 24 patients (88.9%) reached the T4 level, and no patients (0%) reached the T6 level. The statistical analysis yielded a p-value of 0.549, indicating no significant difference in the distribution of the highest levels of sensory blockade between the two groups. The majority of patients in both groups achieved the highest sensory blockade at the T4 level, with no significant variations observed between the groups.

Group B demonstrated significantly lower times to achieve blockade at T6 and T4 levels compared to Group A (p = 0.007 and p = 0.034, respectively). The mean time for the return of motor block to a modified Bromage score of 0 was 115.8 minutes with a standard deviation of 21.2 minutes in Group A, in Group B, the mean time was 129.9 minutes with a standard deviation of 34.4 minutes. The p-value for this comparison is 0.074, suggesting that there is no statistically significant difference between the two groups regarding the time taken for the return of motor block. The quality of the block was considered adequate in all cases assessed by the surgeon, with 27 out of 27 patients (100%) in both groups having adequate block quality. The p-value for this assessment is 0.54, indicating no statistically significant difference between the groups in terms of block quality. The fixed dose had a higher fall in systolic blood pressure immediately after spinal (p=) and at 5 minutes (p=) and in diastolic blood pressure immediately after spinal (p=) and at 15 minutes (p=). However, the total vasopressor (ephedrine) usage was similar between both the groups. The heart rate was statistically lower in the fixed dose group immediately post-spinal (p=0.0005) and 15 mins (p=0.0005). But none of the patients in either groups required atropine. There was a statistically significant difference between the two groups at Post-spinal (p=0.005), 15 mins (p=0.048), and 120 (p = .037).

Table 1: Baseline characteristics of the study participants

Parameter	Group A n=27 (%)	Group B n=27 (%)	P-value
Age in years (mean ± SD)	27.44 ± 2.32	28.42 ± 3.21	0.074
Gestational age/Weeks (mean ± SD)	38.4 ± 0.8	38.9 ± 0.8	0.054
Highest level of sensory blockade **T2** **T4** **T6**	 2 (7.4) 24 (88.9) 1 (3.7)	 3 (11.1) 24 (88.9) 0 (0)	 0.549
Time			
Time taken to achieve sensory blockage (Sec) (mean ± SD) **T6 level** **T4 level**	 134.8 ± 44 194.7 ± 67.5	 176 ± 61.6 239.4 ± 82.7	 **0.007** **0.034**
Time taken for 2-segment regression			
Time for the return of motor block modified Bromage 0/mins (mean ± SD)	115.8 ± 21.2	129.9 ± 34.4	0.074
The quality of the block assessed by the surgeon **Adequate**	 27 (100)	 27 (100)	0.54

Quality of intraoperative analgesia- assessed by the patient			0.54
Adequate	27 (100)	27 (100)	
Total vasopressor given ephedrine (mg)			0.249
3	5 (18.5)	9 (33.3)	
6	0 (0)	1 (3.7)	
Nil	22 (81.5)	17 (63)	
Total atropine given (mg)			0.54
Nil	27 (100)	27 (100)	

p-value < 0.05 is considered statistically significant

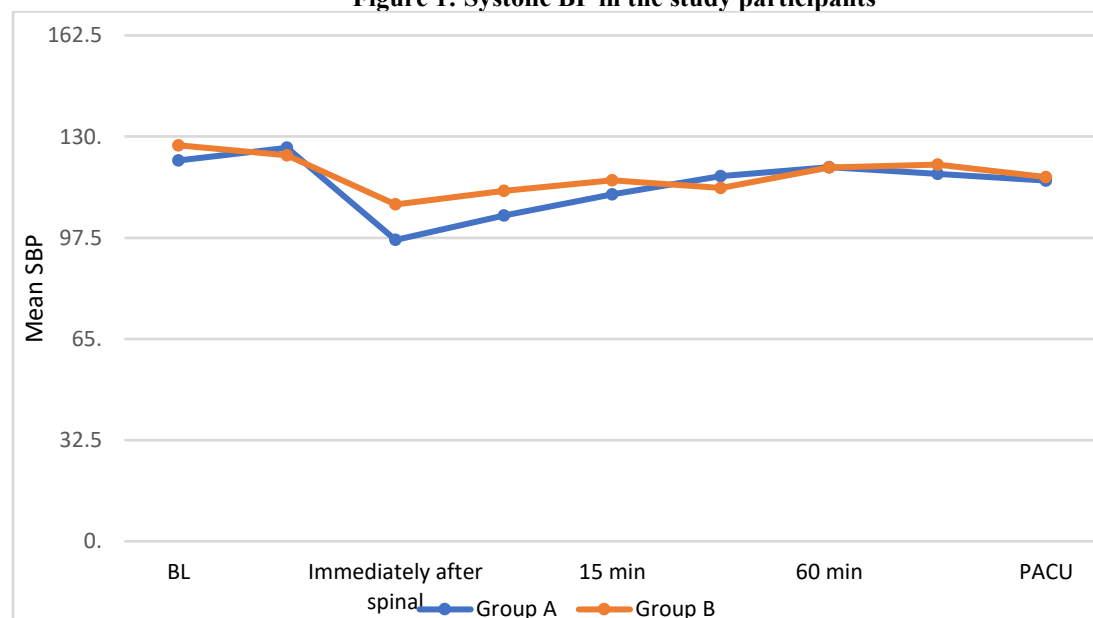**Figure 1: Systolic BP in the study participants**

Figure 1 indicates systolic blood pressure between the two groups at various time points.

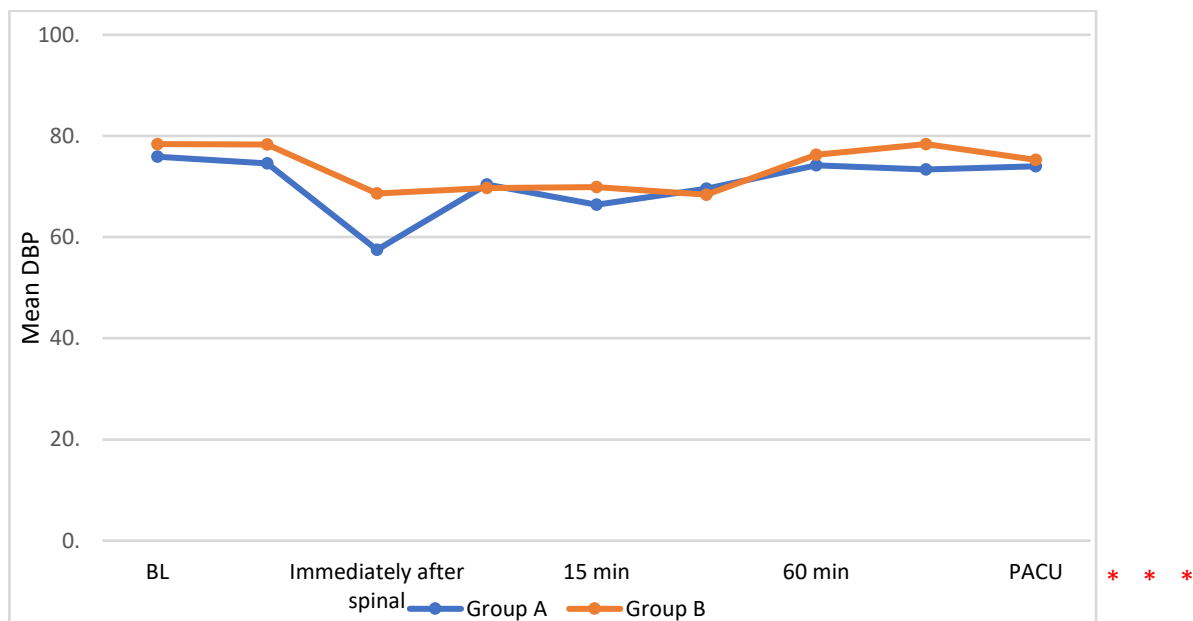**Figure 2: Diastolic BP in the study participants**

Figure 2 indicates diastolic blood pressure between the two groups at various time points.
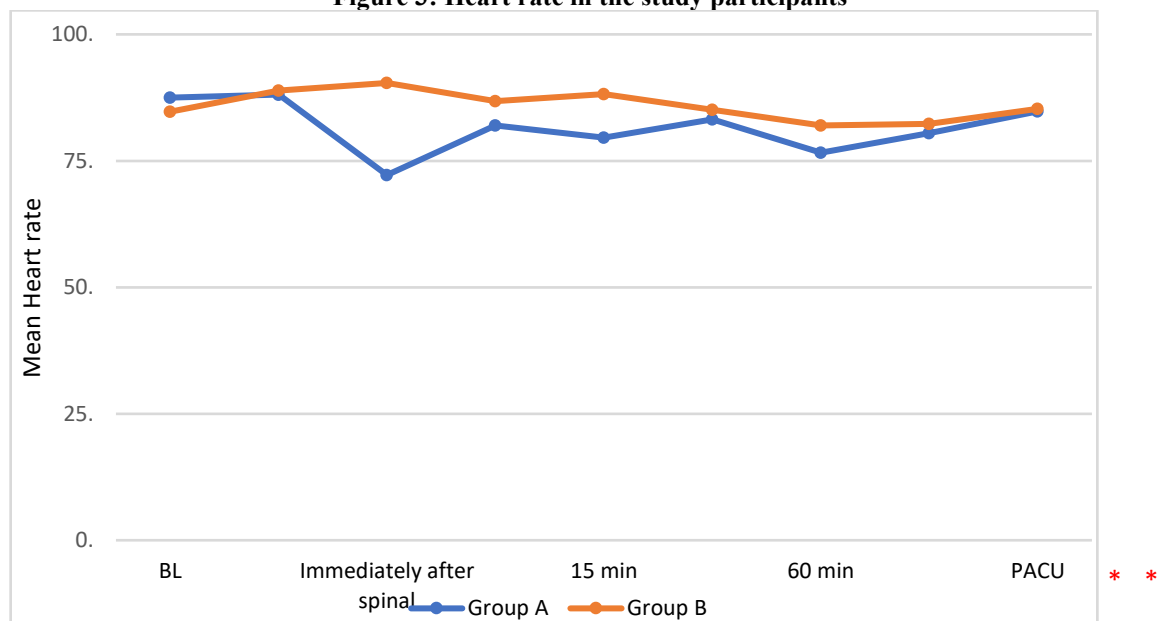
Figure 3: Heart rate in the study participants

Figure 3 indicates differences in heart rate between the two groups at various time points.

DISCUSSION

The results of this study indicate that the distribution of the highest level of sensory blockade was similar between Group A (height and weight-adjusted dose) and Group B (fixed dose), suggesting that both dosing strategies resulted in comparable spinal anesthesia procedures. This similarity is important as it reflects the consistency and reliability of the sensory blockade achieved with both dosing regimens, ensuring that patients received adequate anesthesia for cesarean sections.

One of the notable findings is the faster onset of sensory blockade in the fixed dose group (Group B), which demonstrated significantly shorter times to achieve blockade at both the T6 and T4 levels. This indicates that the fixed dose regimen may provide a quicker onset of anesthesia, which can be advantageous in clinical settings where rapid anesthesia onset is crucial. The efficiency of achieving sensory blockade more swiftly could potentially enhance the overall surgical experience by reducing the waiting time before the procedure can

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commence. A faster onset of blockade also aligns with studies that emphasize the benefits of timely anesthesia in surgical efficiency and patient comfort (1).

The quality of the block and intraoperative analgesia was considered adequate in all cases, with 100% of patients in both groups reporting satisfactory outcomes. This high level of satisfaction, assessed by both surgeons and patients, underscores the overall effectiveness of ropivacaine regardless of whether the dosage is based on a fixed amount or adjusted for height and weight. This finding is particularly relevant for ensuring patient comfort and successful surgical outcomes, as it highlights that both dosing strategies can achieve reliable and satisfactory anesthesia for cesarean sections.

However, the study revealed that Group B (fixed dose) experienced a higher fall in systolic and diastolic blood pressure immediately after spinal anesthesia and at subsequent time points such as 5 and 15 minutes post-spinal. This suggests that the fixed dose regimen may pose a greater risk of hemodynamic instability compared to the height and weight-adjusted dosing (Group A). Hemodynamic stability is crucial during cesarean sections to maintain adequate uteroplacental perfusion and ensure the safety of both the mother and fetus. The findings imply that individualized dosing based on patient characteristics such as height and weight may offer better hemodynamic stability, which is advantageous in maintaining stable blood pressure levels during surgery (5).

Despite these differences in blood pressure changes, the total vasopressor (ephedrine) usage was similar between both groups, indicating that the initial hypotension was effectively managed with vasopressors and other measures such as fluid administration. This reflects the clinical capability to promptly correct blood pressure drops, regardless of the dosing regimen used. It is reassuring that the fall in blood pressure, although more pronounced in the fixed dose group, was rapidly correctable by simple measures, thus minimizing potential adverse effects.

Additionally, heart rate was statistically lower in the fixed dose group immediately post-spinal and at 15 minutes. This could be attributed to the higher volume of local anesthetic in the fixed dose regimen, which might lead to more pronounced sympathetic blockade. However, none of the patients in either group required atropine, indicating that the bradycardia observed was clinically manageable and did not necessitate intervention.

Several studies have emphasized the benefits of individualized dosing of local anesthetics for spinal anesthesia in cesarean sections, supporting our findings. Harten et al. found that adjusting the dose of bupivacaine based on height and weight resulted in more stable hemodynamics compared to fixed dosing. This approach reduced the incidence of hypotension and the need for vasopressors (6). Arzola et al. demonstrated that weight-adjusted dosing of ropivacaine significantly decreased the occurrence of hypotension and related side effects, enhancing patient safety and comfort during cesarean sections (7). Whiteside et al. showed that ropivacaine, when dosed according to patient characteristics, provided effective anesthesia with fewer hemodynamic disturbances, supporting our findings of adequate block quality and high patient satisfaction (3).

Ben-David et al. reported that height and weight-adjusted doses of ropivacaine resulted in reduced anesthetic requirements, minimizing adverse effects and improving patient outcomes (2). A study by Roofthooft et al. indicated that individualized dosing of local anesthetics led to better maternal outcomes, including lower rates of nausea and vomiting post-operatively (8). Hartmann et al. found that weight-adjusted dosing reduced the incidence of neonatal complications, supporting the safety and effectiveness of tailored anesthetic doses in obstetric patients (9).

Gogarten et al. noted that individualized dosing can be complex and time-consuming in a busy clinical setting. The need to calculate and adjust doses for each patient can delay anesthesia onset and complicate workflow (10). Olapour et al. highlighted that despite individualized dosing, significant variability in patient response to spinal anesthesia persists. Differences in body composition, metabolic rate, and individual sensitivity to anesthetics can lead to unpredictable outcomes, necessitating additional interventions (11).

Dyer et al. raised concerns about the cost and resource implications of individualized dosing. The requirement for additional monitoring and potential adjustments in dosing protocols could increase the overall cost of care and resource utilization in healthcare facilities (12).

A study by Fettes et al. warned that individualized dosing might increase the risk of overdosing in certain patients, leading to more profound hypotension and associated complications (4).

Luck et al. found that individualized dosing lacks standardization, which can lead to inconsistencies in anesthetic practice and patient outcomes (13). Lee et al. reported that tailored dosing requires more intensive monitoring to ensure patient safety, which can strain resources and increase the workload for anesthesia providers (14). Ngan Kee et al. discussed the practical challenges of implementing individualized dosing protocols, particularly in low-resource settings where equipment and trained personnel may be limited (5).

Ferrarezi et al. indicated that the efficacy of individualized dosing can vary, with some patients experiencing insufficient anesthesia or requiring additional doses during the procedure (15). A study by Olapour et al.

highlighted that individualized dosing could prolong the anesthesia preparation time, potentially delaying surgical procedures and affecting overall operating room efficiency (11). Dyer et al. noted that individualized dosing protocols require specialized training for anesthesia providers, which can be challenging to implement in all clinical settings (12).

Acknowledging the strengths of the study, it is crucial to address its limitations. The relatively small sample size may limit the generalizability of the findings. Additionally, the study's single-center design and potential confounding variables warrant cautious interpretation of the results.

The study's findings provide valuable insights for anesthetic management, particularly in tailoring hemodynamic interventions. Future research could explore larger, multicenter studies to validate these findings across diverse patient populations. Consideration of additional variables, such as comorbidities and perioperative complications, could enhance the comprehensiveness of future investigations. Moreover, prospective studies evaluating long-term outcomes and patient satisfaction would contribute to a more holistic understanding of the clinical impact of the observed differences.

CONCLUSION

While the fixed dose has the advantage of providing a significantly faster onset compared to dosing based on height and weight, the variable dosing group had more stable hemodynamics. Apart from this the highest sensory level, the duration of sensory and motor blockade, the quality of block as assessed by surgeon and patient's satisfaction were similar between the groups. Therfore an individualized dosing based on height and weight may offer advantages in achieving more stable hemodynamics which is advantageous in caesarean section.

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