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Original Research Article

A Randomized Controlled Study to Evaluate the Efficacy on Sensory and Motor Block on Aspiration and Reinjection of 0.2 Ml of Cerebrospinal Fluid after Completion of Injection 0.5% Hyperbaric Bupivacaine into Subarachnoid Space in Lower Segment Caesarean Section Surgery in the Department of Anaesthesia, SMS Medical College, Jaipur

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Abstract

Background: Lower Segment Caesarean Section is one of the most common surgical procedures performed globally, providing a safe means of delivering neonates when vaginal delivery is contraindicated or not feasible[1]. Regional anaesthesia is generally a safer option than general anaesthesia and is associated with reduced maternal morbidity and mortality compared to general anaesthesia**.** The current standard practice of administering hyperbaric bupivacaine without any manipulation of the cerebrospinal fluid volume may not consistently provide the desired level of sensory and motor block in all patients. Quality compared to standard administration methods. This study holds the potential to provide valuable insights into refining the approach to spinal anaesthesia for Lower Segment Caesarean Section and enhancing the overall childbirth experience for both patients and healthcare providers.

Methods: In this randomized, single-blind, interventional study, 60 normotensive pregnant female undergoing elective cesarian section under spinal anesthesia were allocated into two groups (30 in each). Patients in Group A administered with aspiration of 0.2 ml of cerebrospinal fluid after completion of injection of 0.5% hyperbaric bupivacaine, followed by reinjection into the subarachnoid space. Group B administered using 0.5% hyperbaric bupivacaine injected into the subarachnoid space. Mean of Onset time of sensory block, Motor block using the Modified Bromage score and highest level of sensory block achieved Mean Two-segment regression time of sensory block Mean of Duration of sensory and motor block. Hemodynamic parameters, including Mean heart rate (HR), Mean systolic blood pressure (SBP), Mean diastolic blood pressure (DBP), Mean arterial pressure (MAP) and Mean SpO2 levels Proportion of adverse effects were measured.

Results: The onset time of sensory block to T10 level was slightly faster in Group A (3.91 ± 0.45 minutes) than in Group B (4.13 ± 0.48 minutes), but the difference was not statistically significant (P = 0.080).The onset time of motor block was comparable between the groups, with Group A at 5.94 ± 0.47 minutes and Group B at 6.09 ± 0.48 minutes (P = 0.240), indicating similar motor block initiation. A higher proportion of participants in Group A achieved a sensory block level of T6 compared to Group B, but the difference was not statistically significant (P = 0.796).Two-segment sensory regression time was similar between the groups, with Group A at 74.81 ± 6.06 minutes and Group B at 76.43 ± 8.22 minutes (P = 0.350), indicating comparable sensory block duration. The duration of sensory block was 105.97 ± 14.10minutes in Group A and 110.07 ± 14.65minutes in Group B. No statistically significant difference was observed (P = 0.274).The duration of motor block was comparable between Group A (103.70 ± 9.18 minutes) and Group B (105.70 ± 10.51 minutes), with no significant difference (P = 0.452).Overall hemodynamic stability was well maintained in both groups, with no clinically significant differences in heart rate, blood pressure (SBP, DBP, MAP), or oxygen saturation throughout the intraoperative and postoperative periods.

Conclusion: Study evaluated the effects of aspiration and reinjection of 0.2 ml of cerebrospinal fluid after the administration of 0.5% hyperbaric bupivacaine on sensory and motor block characteristics during Lower Segment Caesarean Section surgery. The findings demonstrated no significant difference in the onset time of sensory and motor block, duration of sensory and motor block, highest level of sensory an block between the test group and the control group, indicating that cerebrospinal fluid manipulation does not enhance the efficacy of sensory and motor blockade.

Keywords: Bupivacaine, Spinal Anaesthesia, Hemodynamics, Aspiration.

Introduction

Lower Segment Caesarean Section is one of the most common surgical procedures performed globally, providing a safe means of delivering neonates when vaginal delivery is contraindicated or not feasible [1]. The incidence of Lower Segment Caesarean Section has been steadily rising due to various maternal and foetal indications, including dystocia, foetal distress, and elective maternal request [2]. The choice of anaesthesia for Lower Segment Caesarean Section plays a crucial role in maternal and neonatal outcomes [3]. Lower Segment Caesarean Section can be performed under general or regional anaesthesia.

Regional anaesthesia is generally a safer option than general anaesthesia and is associated with reduced maternal morbidity and mortality compared to general anaesthesia [4]. Among the regional techniques available—spinal anaesthesia, epidural anaesthesia, and combined spinal-epidural anaesthesia—spinal anaesthesia is most favored for elective Lower Segment Caesarean Section surgery due to its rapid onset of action, simpler technique, more complete sensory and motor block, greater maternal comfort, enhanced infant safety, and less risk of aspiration of gastric content [5].

Hyperbaric bupivacaine is the most commonly used local anaesthetic agent for spinal anaesthesia during Lower Segment Caesarean Section due to its long duration of action and profound sensory and motor blockade [6] However, the extent and duration of the sensory and motor block are influenced by various factors such as the volume, dosage, and concentration of the anaesthetic drug, patient positioning, and cerebrospinal fluid dynamics [7]. After confirming free flow of CSF through the spinal needle, the syringe containing the local anaesthetic was attached, and a small volume of CSF was gently aspirated into the syringe and then re-injected into the subarachnoid space, mixing with the anaesthetic solution.

By manipulating the cerebrospinal fluid volume and composition, it may be possible to influence the extent and duration of sensory and motor block, thereby improving anaesthesia quality and patient comfort during Lower Segment Caesarean Section. Recent studies have shown significant variability in the spread and duration of sensory and motor blocks with spinal anaesthesia.

The current standard practice of administering hyperbaric bupivacaine without any manipulation of the cerebrospinal fluid volume may not consistently provide the desired level of sensory and motor block in all patients. Variability in lumbosacral cerebrospinal fluid volume is a significant factor contributing to the inconsistency in the spread of spinal sensory anaesthesia [8].

Materials and Methods

This hospital-based, single-blind, randomized interventional study was conducted at the Department of Anaesthesiology, Sawai Man Singh Medical College and its affiliated hospitals in Jaipur, Rajasthan. Approval from the Institutional Ethics Committee was obtained (No: 342/MC/EC/2023) prior to patient recruitment.

Study Population and Duration: Pregnant female patients (age 20–35years), belonging to ASA physical status I or II, scheduled for elective cesarean section under spinal anesthesia, were considered. Recruitment continued until a total of 60 participants were enrolled (30 in each of two groups), fulfilling the calculated sample size requirement. Patients on anticoagulant, h\o neurological disorder or a known allergy to bupivacain were excluded.

Randomization and Blinding: A simple randomization via opaque sealed envelopes was used. A total of 60 envelopes (30per group) were prepared, each specifying one of the drug dosing regimens. A colleague opened the envelope, and patients were allocated to one of the following groups:

Group A: administered with aspiration of 0.2 ml of cerebrospinal fluid after completion of injection of 0.5% hyperbaric bupivacaine, followed by reinjection into the subarachnoid space

Group B: administered using 0.5% hyperbaric bupivacaine injected into the subarachnoid space.

This was a single-blind study in which neither the participant nor the medical personnel (including anesthesiologists and operating room staff) were aware of the dose being administered. The study drug was prepared by a member of the research team not involved in the clinical management. Unblinding occurred only in the event of a severe adverse incident.

Anesthetic Protocol

1. Pre-Anesthetic Checkup: Included thorough medical history, physical examination, and routine investigations (hematological profile, renal and liver function tests, ECG).

2. Informed Consent: Written informed consent was obtained after explaining the study and anesthesia procedure.

3. Monitoring: Standard noninvasive monitors (ECG, NIBP, pulse oximeter) were attached upon arrival in the operating room. Baseline hemodynamic parameters were noted.

4. Administration of Study Drug: According to the allocated envelope, patients received a

Group A: after injecting 2 ml of 0.5% hyperbaric bupivacaine, 0.2 ml of cerebrospinal fluid was carefully aspirated using the same spinal needle. The aspirated cerebrospinal fluid was then re injected into the subarachnoid space at the same site.

Group B: 2 ml of 0.5% hyperbaric bupivacaine was slowly injected into the subarachnoid space without any manipulation of the cerebrospinal fluid.

Outcome Measures

Primary Outcomes:

1. To determine and compare the onset time of sensory and motor block between the two study
2. To determine and compare the duration of sensory and motor block in both groups.
3. To assess and compare the highest level of sensory block achieved in both groups

Secondary Outcomes:

1. To compare hemodynamic parameters (Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure, Mean Arterial Pressure and SpO2 levels) between the two groups.
2. To assess and compare the proportion of side effects in both groups (Nausea, Vomiting).

Statistical Analysis: Data were entered into a Microsoft Excel spreadsheet and analyzed using appropriate statistical software. Continuous variables (HR, BP) are presented as mean} standard deviation, and intergroup comparisons were performed using one-way ANOVA with post hoc analyses. Categorical data (incidence of adverse events) were analyzed using chi-square or Fisher's exact test. A p-value ≤ 0.05 was considered statistically significant.

Results

A total of 94 patients were screened; 22 were excluded for not meeting inclusion criteria, and 12 declined participation.

Finally, 60 patients (30 per group) were enrolled and randomized into Groups A, B.

Group A: after injecting 2 ml of 0.5% hyperbaric bupivacaine, 0.2 ml of cerebrospinal fluid was carefully aspirated using the same spinal needle. The aspirated cerebrospinal fluid was then re injected into the subarachnoid space at the same site.

Group B: 2 ml of 0.5% hyperbaric bupivacaine was slowly injected into the subarachnoid space without any manipulation of the cerebrospinal fluid.

Overall Findings: In general, administration of 2 ml of 0.5% hyperbaric bupivacaine, 0.2 ml of cerebrospinal fluid was carefully aspirated using the same spinal needle. The aspirated cerebrospinal fluid was then re injected into the subarachnoid space at the same site. Administered before skin incision significantly improved postoperative analgesia in caesarean section patients under spinal anaesthesia.Additionally, provided better hemodynamic stability in the immediate post-spinal period, with fewer instances of hypotension.

Participant Demographics (2–4 Paragraphs): Overall, the demographic and anthropometric parameters including age, gender distribution, weight, height, and body mass index (BMI) were comparable in both groups.

The mean age ranged between 26.97 ± 04.62in Group A and28.27 ± 05.23 in Group B, and all patient were female. Most participants had a normal BMI, and the distribution of ASA Grades I and II was similar in each group, indicating well matched cohorts without statistically significant differences. A notable proportion of participants fell in the 20–35 years age range, ensuring a relatively healthy adult population suitable for evaluation.

Nearly 60–67% of each group were classified as ASA Grade II, reflecting the presence of mild systemic disease in some patients but without significant compromise. As these variables did not differ significantly among the groups, any differences in outcomes can be attributed more confidently to the dosing strategies rather than demographic confounders

Hemodynamic Changes:

1. Heart Rate (HR):

- **At baseline**, mean HR was comparable (≈74-75 bpm) across all groups (Table 1).
- **After spinal**, HR increased slightly in both groups, reaching 79.03 ± 12.29 bpm in Group A and 78.77 ± 11.73 bpm in Group B
- **2 min**, HR peaked (Group A: 81.45 bpm, Group B: 79.7 bpm,
- **5min,** HR remained elevated, especially in Group A (≈20% above baseline), while Group B showed a relatively smaller increase (≈16.7%).
- **By 10 to 60 minutes**, the heart rate showed minor fluctuations in both groups.

2. Systolic Blood Pressure (SBP):

- **At baseline**, mean SBP was comparable (≈131-132 mmHg) across all groups (Table2).
- **After spinal**, a significant decrease in SBP in Group B compared to Group A
- **2 min**, SBP peaked (Group A: 129mmHg, Group B: 118mmHg,
- **5min,** SBP remained elevated, especially in Group A. (≈20% above baseline), while Group B showed a relatively smaller increase (≈16.7%).
- **By 10 to 60 minutes**, SBP differences between the groups became statistically non-significant.

3. Diastolic Blood Pressure (DBP) and Mean Arterial Pressure (MAP):

- A similar pattern was noted for DBP and MAP, with Group B exhibiting the largest initial drop and sustaining the greatest reduction relative to baseline during the intraop period.
- By 10 minutes, MAP in Group B fell by ≈28% from baseline, while Groups A reductions of ≈21%

Table 1: Comparison of mean Onset time of Sensory Block- T10 level (Minutes) of study groups

Group	N	Mean Onset time of Sensory Block- T10 level (Minutes)	P value
Group A	30	03.91 ± 00.45	0.080
Group B	30	04.13 ± 00.48	

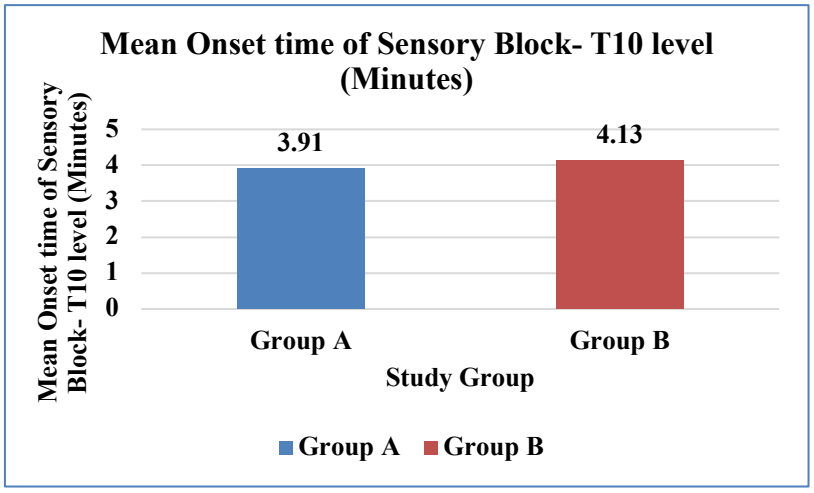

Figure 1: Mean Onset time of Sensory Block- T10 level (Minutes)

Table 2: Comparison of mean Onset time of Motor Block- Modified Bromage Score 3 (Minutes) of study groups Figure no 2

Group	N	Mean Onset time of Motor Block- Modified Bromage Score 3 (Minutes)	P value
Group A	30	05.94 ± 00.47	0.240
Group B	30	06.09 ± 00.48	

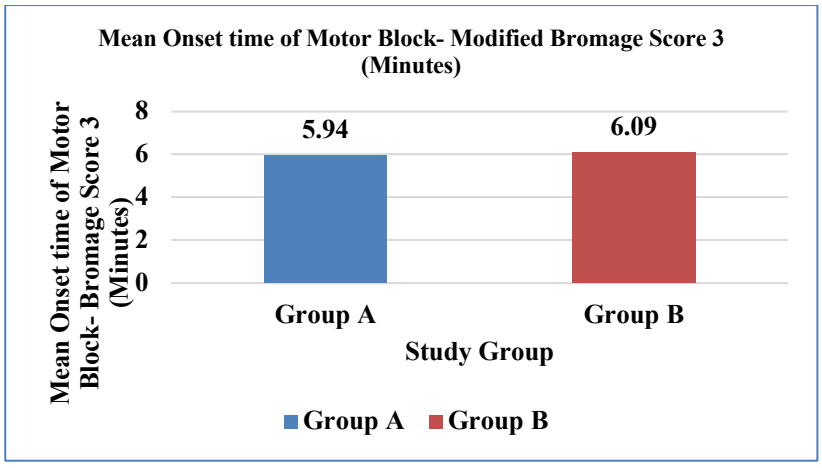

Figure 2: Mean Onset time of Motor Block- Modified Bromage Score 3 (Minutes)

Table 3: Distribution of study subjects according to Highest Level of Sensory Block

Highest Level of Sensory Block	Group A		Group B		Total	
	N	%	N	%	N	%
T6	20	66.66	12	40.00	32	53.33
T8	10	33.34	18	60.00	28	66.67
Total	30	100	30	100	60	100
Chi Square Test P value = 0.796						

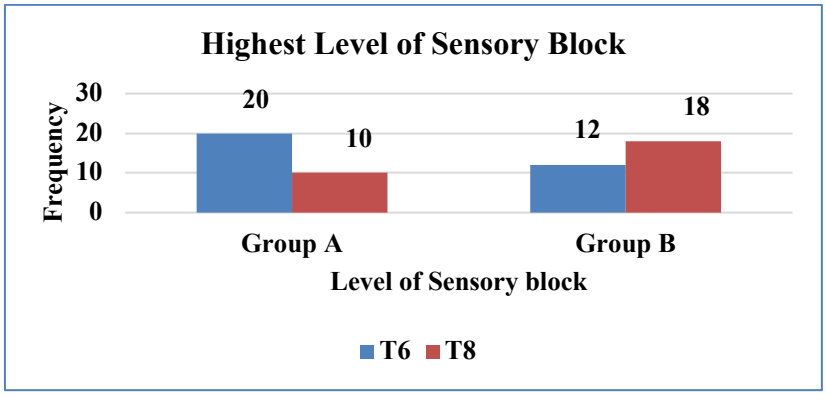

Figure 3: Highest Level of Sensory Block

Table 4: mean two segment sensory regression time (Minutes) of study groups

Group	N	Mean Two Segment Sensory Regression Time (Minutes)	P value
Group A	30	74.81 ± 06.06	0.350
Group B	30	2.13 ± 1.61	

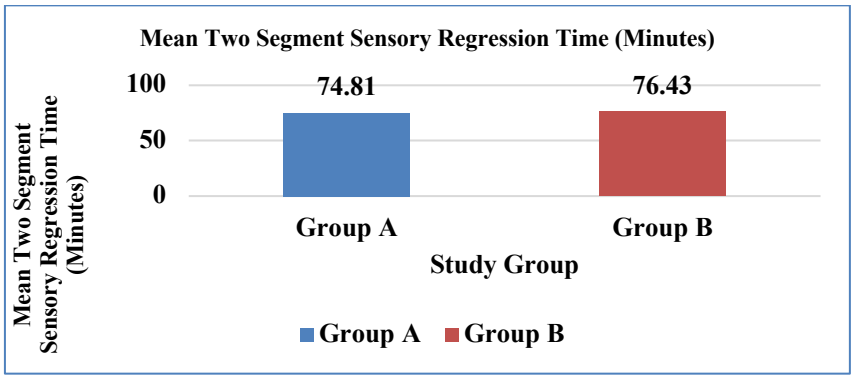

Figure 4: Mean Two Segment Sensory Regression Time (Minutes)

Table 5: Comparison of mean Duration of Sensory Block

Group	N	Mean Duration of Sensory Block (Minutes)	P value
Group A	30	105.97 ± 14.10	0.274
Group B	30	110.07 ± 14.65	

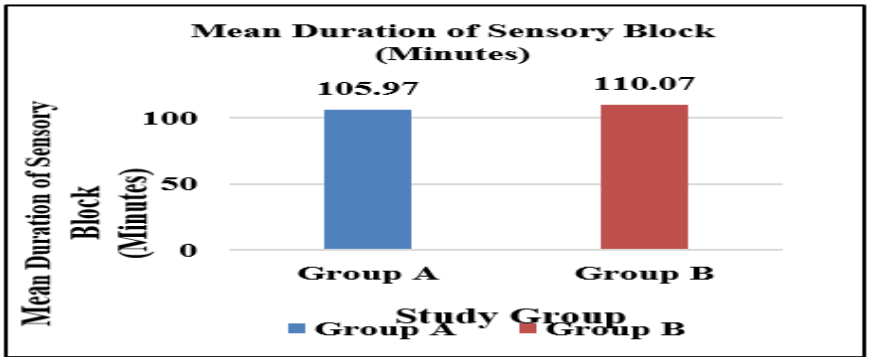

Figure 5: (Minutes) of study groups

Table 6: Comparison of mean Duration of Motor Block

Group	N	Mean Two Segment Sensory Regression Time (Minutes)	P value
Group A	30	103.70 ± 09.18	0.452
Group B	30	105.70 ± 10.51	
Group			

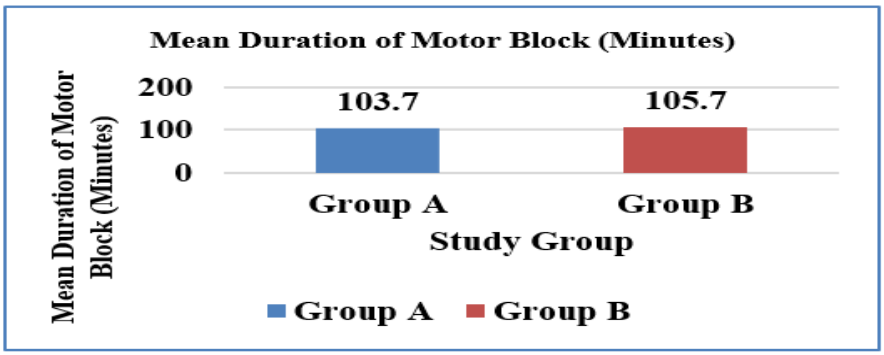

Figure 6: (Minutes) of study groups

Table 7: Comparison of intraoperative Baseline parameters among study groups

Time	Group A	Group B	P value
Mean HR (/min)	91.63 ± 11.22	91.03 ± 11.48	0.839
Mean SBP(mmHg)	121.13 ± 9.90	121.70 ± 9.39	0.821
Mean DBP(mmHg)	79.13 ± 8.24	79.17 ± 6.45	0.986
Mean MAP(mmHg)	93.13 ± 7.44	93.34 ± 7.02	0.910
Mean SpO_2 (%)	98.03 ± 00.84	98.90 ± 00.80	1.000

Table 8: Comparison of intraoperative mean heart rate (bpm) among study groups Figure no 8

Time	Group A	Group B	P value
Baseline	91.63 ± 11.22	91.03 ± 11.48	0.839
After spinal 0 min	98.97 ± 12.28	99.83 ± 11.75	0.781
2 min	98.27 ± 9.48	96.03 ± 13.63	0.464
5 min	96.30 ± 8.03	98.27 ± 14.31	0.514
10 min	88.10 ± 8.73	88.87 ± 12.00	0.778
15 min	87.57 ± 8.90	87.83 ± 8.54	0.906
30 min	96.00 ± 12.15	96.20 ± 11.07	0.947
45 min	92.13 ± 11.37	92.45 ± 11.04	0.914
60 min	89.44 ± 11.10	90.04 ± 8.16	0.829
Unpaired T Test			

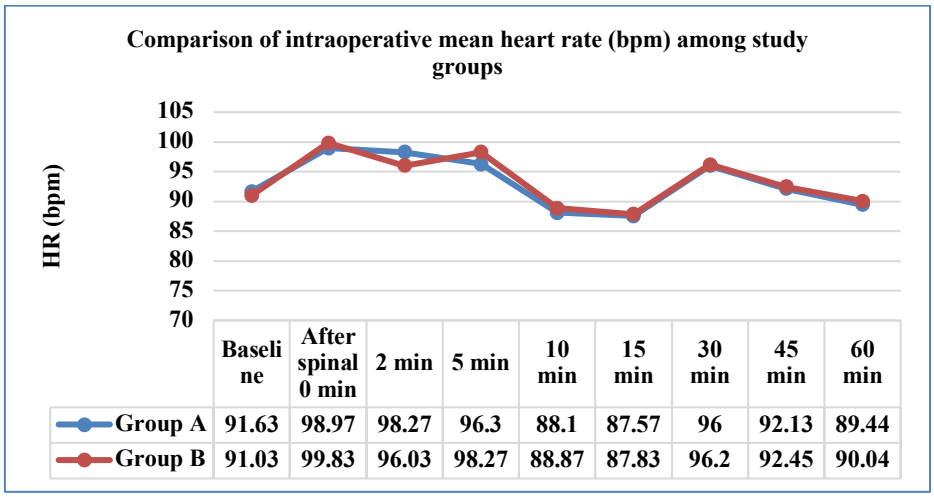

Figure 7: Comparison of intraoperative mean heart rate (bpm) among study groups

Table 9: Comparison of intraoperative mean SBP (mmHg) among study groups Figure no 9

Time	Group A	Group B	P value
Baseline	121.13 ± 9.90	121.70 ± 9.39	0.821
After spinal 0 min	117.77 ± 13.01	116.57 ± 7.79	0.666
2 min	108.80 ± 10.91	108.40 ± 8.87	0.877
5 min	107.03 ± 12.08	107.57 ± 7.24	0.836
10 min	108.73 ± 9.02	109.10 ± 8.75	0.874
15 min	108.33 ± 12.43	106.83 ± 8.63	0.589
30 min	106.90 ± 15.17	106.60 ± 7.92	0.924
45 min	110.43 ± 16.78	112.17 ± 9.45	0.627
60 min	115.57 ± 31.09	113.08 ± 8.06	0.705
Unpaired T Test			

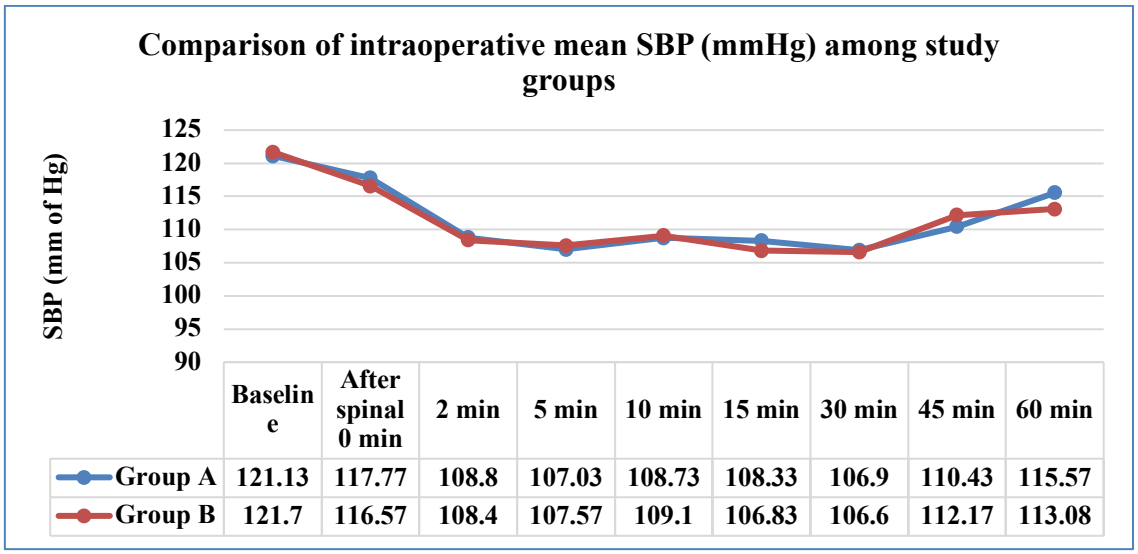

Figure 8: Comparison of intraoperative mean SBP (mmHg) among study groups

Discussion:

The present study was conducted in the Department of Anaesthesiology, Sawai Man Singh (SMS) Medical College and Attached Hospitals, Jaipur, with the aim of evaluating the effect of aspiration and reinjection of 0.2 ml cerebrospinal fluid following intrathecal administration of 0.5% hyperbaric bupivacaine on sensory and motor block characteristics in elective lower segment caesarean section. Sixty parturients fulfilling inclusion criteria were randomly allocated into two groups.

Group A received spinal anaesthesia with aspiration and reinjection of 0.2 ml CSF after completion of injection of 0.5% hyperbaric bupivacaine, while Group B received spinal anaesthesia with 0.5% hyperbaric bupivacaine alone without CSF manipulation.

The primary outcomes studied were onset and duration of sensory and motor block, highest level of sensory block achieved, and two-segment sensory regression time. Secondary outcomes included haemodynamic parameters and incidence of adverse effects. The results obtained in the present study are now discussed in comparison with existing literature.

Patient Characteristics (Age, Weight, Height, BMI): The mean age of participants in Group A was 26.97 ± 4.62 years and in Group B 28.27 ± 5.23 years, with no statistically significant difference (p = 0.312), confirming that the groups were comparable and minimizing the risk of age-related confounding.

The mean weight was 64.00 ± 10.13 kg in Group A and 65.77 ± 8.32 kg in Group B (p = 0.463), the mean height was 157.43 ± 4.69 cm in Group A and 157.40 ± 6.13 cm in Group B (p = 0.981), and the mean BMI was 25.89 ± 4.38 kg/m² in Group A and 26.65 ± 3.96 kg/m² in Group B (p = 0.487).

These results confirm that both groups were well matched with respect to body habitus, reducing the influence of anthropometric variability on block characteristics.

Onset of Sensory Block: In our study, the mean onset time of sensory block to T10 was 3.91 ± 0.45 minutes in Group A and 4.13 ± 0.48 minutes in Group B, with no statistically significant difference (p = 0.080). This suggests that CSF aspiration and reinjection had no measurable impact on the speed of sensory onset.

Onset of Motor Block: The onset time of motor block (Modified Bromage score 3) was comparable between Group A (5.94 ± 0.47 minutes) and Group B (6.09 ± 0.48 minutes; p = 0.240). This indicates that CSF aspiration and reinjection do not influence motor block initiation.

Highest Level of Sensory Block: In our study, most participants in Group A (66.7%) attained T6 as the highest sensory level, while the majority in Group B (60%) reached T8, with no statistically significant difference (p = 0.796).

Two Segment Sensory Regression Time: The mean two-segment sensory regression time in our study was 74.81 ± 6.06 minutes in Group A and 76.43 ± 8.22 minutes in Group B (p = 0.350). This shows that aspiration and reinjection of CSF did not alter two segment sensory regression. Similar findings have been reported across the literature.

Duration of Sensory Block: The mean duration of sensory block was 105.97 ± 14.10 minutes in Group A and 110.07 ± 14.65 minutes in Group B, with no statistically significant difference (p = 0.274). Kokki et al. (2016) found nearly identical durations, with regression below T10 occurring at 94 vs. 97 minutes.

Duration of Motor Block: In our study, the mean duration of motor block was 103.70 ± 9.18 minutes in Group A and 105.70 ± 10.51 minutes in Group B, with no statistically significant difference (p = 0.452).

Haemodynamic Parameters: In our study, intraoperative hemodynamic parameters including heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and oxygen saturation remained stable and comparable between the two groups at all recorded time points, with no statistically significant differences. Postoperative monitoring similarly demonstrated stable trends, confirming that CSF aspiration and reinjection did not significantly influence circulatory or respiratory function.

Side Effects & Complications: In our study, the overall incidence of side effects was low, but we observed that hypotension occurred more frequently in Group A (40%) compared with Group B (16.7%), while nausea and vomiting were reported equally in both groups (two patients each), and no cases of bradycardia were recorded.

This suggests that CSF aspiration and reinjection may predispose patients to a higher incidence of hypotension, possibly due to subtle alterations in intrathecal pressure or autonomic regulation.

Conclusion

The present study evaluated the effects of aspiration and reinjection of 0.2 ml of cerebrospinal fluid after the administration of 0.5% hyperbaric bupivacaine on sensory and motor block characteristics during Lower Segment Caesarean Section surgery. The findings demonstrated no significant difference in the onset time of sensory and motor block, duration of sensory and motor block, highest level of sensory an block between the test group and the control group, indicating that cerebrospinal fluid manipulation does not enhance the efficacy of sensory and motor blockade. Spinal anesthesia administered with or without cerebrospinal fluid (CSF) aspiration and reinjection resulted in comparable intraoperative and postoperative hemodynamic stability. No clinically significant differences were observed in heart rate, blood pressure, or oxygen saturation between the two groups, indicating that CSF aspiration and reinjection offers no additional hemodynamic advantage.

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