Section: Anaesthesiology

Original Research Article

SEQUENTIAL COMBINED SPINAL–EPIDURAL VERSUS SPINAL ANAESTHESIA IN LOWER ABDOMINAL AND LOWER LIMB SURGERY: A COMPARATIVE STUDY

Angel Vellut G[1], Sriraman Balakrishnan[2], Mathana V[3], Jerome J[4]

[1]Associate Professor, Department of Anaesthesiology, Government Thoothukudi Medical College, Thoothukudi, Tamilnadu, India.
[2]Assistant Professor, Department of Anaesthesiology, Government Thoothukudi Medical College, Thoothukudi, Tamilnadu, India.
[3]Assistant Professor, Department of Anaesthesiology, Kanyakumari Government Medical College, Nagercoil, Tamilnadu, India.
[4]Senior Resident, Department of Emergency Medicine, Kanyakumari Government Medical College, Nagercoil, Tamilnadu, India.

Received : 19/06/2026
Received in revised form : 10/08/2026
Accepted : 27/08/2026

Keywords:
Combined spinal–epidural anaesthesia; Haemodynamic parameters; Spinal anaesthesia; Motor block; Sensory block; Ephedrine; Bradycardia.

Corresponding Author:
Dr. Mathana V,
Email: mathanajerom@gmail.com

DOI: 10.47009/jamp.2026.8.4.296

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (4); 1740-1747

ABSTRACT

Background: Spinal anaesthesia is widely used for lower abdominal and lower limb surgery but may be associated with hypotension, bradycardia, and other perioperative adverse effects. Sequential combined spinal–epidural (CSE) anaesthesia has been proposed as an alternative technique that may provide more controlled haemodynamic changes while maintaining satisfactory surgical anaesthesia. This study compared the haemodynamic profile, sensory and motor block characteristics, analgesic duration, and complications associated with sequential CSE and conventional spinal anaesthesia. **Materials and Methods:** This double-blinded, randomized controlled trial included 60 patients aged 16–70 years with American Society of Anaesthesiologists physical status I–II undergoing elective lower abdominal or lower limb surgery under regional anaesthesia. Participants were randomly allocated to Group A (sequential combined spinal–epidural anaesthesia, n=30) or Group B (spinal anaesthesia, n=30). Haemodynamic parameters, sensory and motor block characteristics, requirement for vasopressor/anticholinergic medication, and perioperative complications were assessed and compared between groups. Data were analysed using SPSS version 23. **Results:** Baseline demographic characteristics and haemodynamic parameters were comparable between groups. Group A demonstrated significantly higher systolic blood pressure at several early and late intraoperative time points compared with Group B. Diastolic blood pressure and mean arterial pressure were also significantly better maintained at multiple time points in the CSE group. Patients receiving CSE achieved a slower motor block, with a shorter duration of motor blockade. Requirement for ephedrine and atropine was substantially lower in Group A. Shivering occurred in 3.33% of CSE patients compared with 100% of spinal anaesthesia patients, while vomiting occurred in 23.33% and 0% of patients, respectively. **Conclusion:** Sequential CSE provided greater haemodynamic stability with reduced requirement for rescue medications and fewer perioperative adverse effects compared with conventional spinal anaesthesia. Although motor block developed more gradually, its shorter duration may offer advantages for postoperative recovery. Sequential CSE may therefore be a useful alternative for selected patients undergoing lower abdominal and lower limb surgery.

INTRODUCTION

Regional anaesthesia is widely used for lower abdominal and lower limb surgeries because it provides effective surgical anaesthesia while avoiding many of the physiological effects associated with general anaesthesia.[1] Spinal anaesthesia remains a commonly employed technique because of its simplicity, rapid onset, and reliable sensory and motor blockade.[2] However, sympathetic blockade following spinal anaesthesia may result in clinically significant haemodynamic alterations, particularly hypotension and bradycardia, which can require pharmacological intervention.[3]

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Combined spinal–epidural (CSE) anaesthesia combines the rapid onset and dense block of spinal anaesthesia with the flexibility of epidural anaesthesia. The sequential CSE technique allows initial administration of a spinal dose followed by epidural supplementation, potentially permitting more controlled development and maintenance of the block. This approach may therefore reduce abrupt haemodynamic changes while providing adequate surgical anaesthesia.[4]

Despite the established use of both techniques, differences in haemodynamic stability, evolution of sensory and motor blockade, requirement for rescue medications, and perioperative adverse effects remain clinically relevant.[5] The present randomized controlled study was therefore undertaken to compare sequential CSE anaesthesia with conventional spinal anaesthesia in patients undergoing lower abdominal and lower limb surgery, with particular emphasis on haemodynamic parameters, sensory and motor block characteristics, and associated complications.

MATERIALS AND METHODS

This double-blind, randomized controlled study was conducted in a Tertiary Care Medical College and Hospital over an 18-month period from December 2020 to June 2022. Patients scheduled for elective lower abdominal or lower limb surgery under regional anaesthesia were screened during pre-anaesthetic evaluation.

Patients aged 16–70 years of either sex with American Society of Anaesthesiologists (ASA) physical status I or II, scheduled for elective lower abdominal or lower limb surgery under regional anaesthesia, were eligible. Patients with ASA physical status III or IV, age <16 or >70 years, refusal to participate, peripheral neuropathy, coagulopathy, spinal deformity, infection at the injection site, pregnancy, allergy to study drugs, or current antiplatelet or anticoagulant therapy were excluded.

The sample size was calculated based on previously reported pulse-rate data, with a 95% confidence interval and 80% power. The calculated sample size was 29.5 participants per group and was rounded to 30 participants in each group, giving a total sample of 60. Participants were allocated into two groups using computer-generated random numbers: Group A received sequential combined spinal–epidural (CSE) anaesthesia, while Group B received conventional spinal anaesthesia.

Institutional Ethics Committee approval was obtained before commencement of the study. Written informed consent was obtained from all participants. The study was self-funded, with no declared external source of funding or conflict of interest.

All participants underwent pre-anaesthetic evaluation one day before surgery, including assessment of systemic illness and review of relevant laboratory investigations and electrocardiography. Patients were premedicated with alprazolam 0.25 mg overnight and fasted for 8 hours. Standard monitoring with non-invasive blood pressure, pulse oximetry, and electrocardiography was instituted, and two 18-gauge intravenous accesses were secured. Emergency equipment and drugs, including atropine, ephedrine, adrenaline, and dopamine, were kept readily available.

In Group A, the epidural space was identified at the L2–L3 or L3–L4 interspace using an 18-gauge Tuohy needle by the loss-of-resistance technique following local infiltration with 2 mL of 2% lignocaine. A 27-gauge pencil-point spinal needle was introduced through the epidural needle, and 2 mL (10 mg) of 0.5% hyperbaric bupivacaine with 0.5 mL (25 µg) fentanyl was administered intrathecally. An epidural catheter was subsequently inserted and fixed 6 cm within the epidural space. Five minutes after spinal administration, 8 mL of 0.5% isobaric bupivacaine was administered epidurally.

In Group B, spinal anaesthesia was performed at the L3–L4 interspace using 3.5 mL (17.5 mg) of 0.5% hyperbaric bupivacaine with 0.5 mL (25 µg) fentanyl.

Sensory blockade was assessed using the pin-prick method at 2, 3, and 5 minutes after block administration, every 5 minutes until 60 minutes, and subsequently every 15 minutes until 150 minutes. Motor blockade was assessed at identical time points using the modified Bromage score (0–3).

Systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate, and oxygen saturation were recorded at 2, 3, and 5 minutes after block administration, every 5 minutes until 60 minutes, and every 15 minutes thereafter until 150 minutes. Hypotension was defined as a 20% reduction in baseline blood pressure and was treated with intravenous ephedrine 6 mg. Bradycardia was defined as a 25% reduction in baseline heart rate and was treated with intravenous atropine 0.6 mg. The requirement for ephedrine and atropine, as well as the occurrence of shivering and vomiting, was recorded and compared between groups.

Numerical variables were summarized using appropriate measures including mean, standard deviation, median, and mode, while categorical variables were expressed as frequencies and percentages. Data were entered into Microsoft Excel and analysed using SPSS version 23. Categorical variables were compared between groups using the chi-square test or Fisher's exact test, as appropriate. Continuous variables measured between groups at different time points were compared using the independent-samples t test. A P value ≤ 0.05 was considered statistically significant.

RESULTS

Sixty patients were enrolled and equally allocated to Group A (sequential combined spinal-epidural anaesthesia; n = 30), who received 2 ml (10 mg) of 0.5% hyperbaric bupivacaine with 25 µg fentanyl

ISSN (O): 2687-5365; ISSN (P): 2753-6556

intrathecally followed by 8 ml of 0.5% plain bupivacaine via an epidural catheter 5 minutes after the spinal block, and Group B (spinal anaesthesia; n = 30), who received 3.5 ml (17.5 mg) of 0.5% hyperbaric bupivacaine with 25 µg fentanyl as a single spinal injection.

The two groups were comparable in baseline demographic and clinical characteristics. Mean age was 50.5 ± 16.21 years in Group A and 45.4 ± 15.85 years in Group B (P = 0.223). Gender distribution did not differ significantly between groups (Group A: 80% male, 20% female; Group B: 70% male, 30% female; P = 0.372). Mean height (156.53 ± 5.75 cm vs 155.73 ± 7.46 cm, P = 0.644) and mean weight (58.57 ± 4.85 kg vs 60.53 ± 7.41 kg, P = 0.229) were similar between Group A and Group B, respectively. ASA physical status distribution was also comparable (Group A: 60% ASA I, 40% ASA II; Group B: 73.33% ASA I, 26.66% ASA II; P = 0.274) (Table 1).

Baseline SBP was similar between groups (135.27 ± 6.96 vs 132.13 ± 10.01 mmHg, P = 0.165). SBP was significantly higher in Group A from 2 to 10 minutes (119.67 ± 4.3 vs 110.93 ± 5.87 mmHg at 2 min; 99.47 ± 3.15 vs 89.67 ± 3.49 mmHg at 10 min; all P < 0.001), with no significant between-group difference from 15 to 45 minutes (P > 0.05 throughout). From 50 minutes onward, SBP was again significantly higher in Group A at every time point through 150 minutes (103 ± 3.51 vs 98.23 ± 6 mmHg at 50 min; 119.2 ± 4.83 vs 115.13 ± 5.93 mmHg at 150 min; P < 0.05 for all). In both groups, SBP fell progressively between 2 and 10 minutes (Group A: 119.67 ± 4.3 to 99.47 ± 3.15 mmHg; Group B: 110.93 ± 5.87 to 89.67 ± 3.49 mmHg) before recovering between 50 and 150 minutes (Group A: 103 ± 3.51 to 119.2 ± 4.83 mmHg; Group B: 98.23 ± 6 to 115.13 ± 5.93 mmHg) (Figure 1).

Baseline DBP was comparable between groups (92.73 ± 5.24 vs 88.93 ± 6.47 mmHg, P = 0.055). DBP was significantly higher in Group A from 2 to 10 minutes (78.07 ± 3.69 vs 71.4 ± 4.85 mmHg at 2 min; 62.33 ± 2.35 vs 55.93 ± 3.34 mmHg at 10 min; all P < 0.001), with no significant difference from 15 to 60 minutes (P > 0.05). DBP was again significantly higher in Group A from 75 to 120 minutes (66.07 ± 3.04 vs 63.27 ± 5.34 mmHg at 75 min; 73.2 ± 4.25 vs 70.53 ± 5.01 mmHg at 120 min; P < 0.05 for all), while the difference at 150 minutes was not significant (75.07 ± 3.74 vs 72.87 ± 5.4 mmHg, P = 0.072) (Figure 2).

Baseline MAP did not differ significantly between groups (106.91 ± 5.35 vs 103.33 ± 7.09 mmHg, P = 0.052). MAP was significantly higher in Group A from 2 to 10 minutes (91.93 ± 3.05 vs 84.58 ± 4.88 mmHg at 2 min; 74.71 ± 2.12 vs 67.18 ± 3.19 mmHg at 10 min; all P < 0.001), with no significant difference between 15 and 55 minutes (P > 0.05). From 60 minutes onward, MAP remained significantly higher in Group A through 150 minutes (78.2 ± 2.81 vs 75.36 ± 6.02 mmHg at 60 min; 89.78 ± 3.17 vs 86.96 ± 5.29 mmHg at 150 min; P < 0.05 for all) (Figure 3).

Heart rate was comparable between groups from baseline to 25 minutes (P > 0.05 for all comparisons; e.g., 91.4 ± 5.64 vs 91.53 ± 4.66 bpm at baseline). From 30 to 45 minutes, heart rate was significantly lower in Group A than Group B (68.63 ± 4.95 vs 76.8 ± 15.52 bpm at 30 min; 66.27 ± 5.17 vs 71.4 ± 12.45 bpm at 45 min; P < 0.05 for all). No significant difference was observed from 50 to 150 minutes (P > 0.05 throughout) (Figure 4).

By 10 minutes, sensory blockade in Group A had reached T4 in 1 patient (3.33%), T6 in 2 patients (6.6%), and T8 in 27 patients (90%), whereas all 30 patients (100%) in Group B had achieved a T4 sensory level by this time (Figure 6).

Motor block scores were significantly lower in Group A than Group B at 2 minutes (2.03 ± 0.18 vs 3 ± 0, P = 0.001), 3 minutes (3 ± 0.26 vs 4 ± 0, P = 0.001), and 5 minutes (3.03 ± 0.18 vs 4 ± 0, P = 0.001), reflecting a slower onset of motor blockade with the sequential technique. Scores were equivalent between groups from 10 to 120 minutes. At 150 minutes, motor block scores differed significantly between groups (Group A: 3.37 ± 0.49; Group B: 3.27 ± 0.45; P = 0.001) (Figure 5) (Table 2).

Ephedrine requirement differed significantly between groups (P < 0.05): 29 patients (96.66%) in Group A required no ephedrine, with only 1 patient (3.33%) requiring 12 mg. In Group B, 19 patients (63.33%) required 6 mg, 9 (30%) required 12 mg, 1 (3.33%) required 18 mg, and 1 (3.33%) required 24 mg. Atropine requirement was low in both groups and did not differ significantly (Group A: 0%; Group B: 6.66%; P = 0.246) (Table 3).

Shivering occurred significantly less often in Group A than in Group B (3.33% vs 100%, P = 0.001). Vomiting occurred in 7 patients (23.33%) in Group B compared with none in Group A (P = 0.001).

Table 1: Distribution of participants according to ASA (American Society of Anaesthesiologists) physical status classification in Group A and Group B. Values are expressed as n (%). The difference in ASA grade distribution between the two groups was not statistically significant (χ^2 test, p = 0.274)

ASA grade	Group A	Group B	Total	Chi sq. p value
ASA grade I	18 (60%)	22 (73.33%)	40 (66.66%)	0.274
ASA grade II	12 (40%)	8 (26.66%)	20 (33.33%)	
Total	30 (100%)	30 (100%)	60 (100%)	

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 2: Comparison of Bromage motor blockade scores at different time points between Group A and Group B. Values are expressed as mean ± standard deviation (SD). The mean difference in score between the two groups was assessed using an independent samples t-test

Time point	Group A: Mean (± SD)	Group B: Mean (± SD)	Mean diff.	p value (t-test)
2 min	2.03 (± 0.18)	3 (± 0)	0.967	0.001
3 min	3 (± 0.26)	4 (± 0)	1	0.001
5 min	3.03 (± 0.18)	4 (± 0)	0.967	0.001
10 min	4 (± 0)	4 (± 0)	0	---
15 min	4 (± 0)	4 (± 0)	0	---
20 min	4 (± 0)	4 (± 0)	0	---
25 min	4 (± 0)	4 (± 0)	0	---
30 min	4 (± 0)	4 (± 0)	0	---
35 min	4 (± 0)	4 (± 0)	0	---
40 min	4 (± 0)	4 (± 0)	0	---
45 min	4 (± 0)	4 (± 0)	0.967	---
50 min	4 (± 0)	4 (± 0)	1	---
55 min	4 (± 0)	4 (± 0)	0.967	---
60 min	4 (± 0)	4 (± 0)	0	---
75 min	4 (± 0)	4 (± 0)	0	---
90 min	4 (± 0)	4 (± 0)	0	---
105 min	4 (± 0)	4 (± 0)	0	---
120 min	4 (± 0)	4 (± 0)	0	---
150 min	3.37 (± 0.49)	3.27 (± 0.45)	0	0.001

Table 3: Comparison of atropine requirement and ephedrine dose received between Group A and Group B. Values are expressed as n (%). The requirement for atropine (0.6 mg) and the distribution of ephedrine doses received were compared between the two groups using Fisher's exact test. A p value <0.05 was considered statistically significant

Atropine (0.6 mg)	Group A	Group B	Total	Fisher exact p value
Yes	0 (0%)	2 (6.66%)	2 (3.33%)	0.246
No	30 (100%)	28 (93.33%)	58 (96.66%)	
Total	30 (100%)	30 (100%)	60 (100%)	
Ephedrine Dose Received	**Group A**	**Group B**	**Total**	**Fisher exact p value**
Nil	29 (96.66%)	0 (0%)	29 (48.33%)	0.001
6 mg	0 (0%)	19 (63.33%)	19 (31.66%)	
12 mg	1 (3.33%)	9 (30%)	10 (16.66%)	
18 mg	0 (0%)	1 (3.33%)	1 (1.66%)	
24 mg	0 (0%)	1 (3.33%)	1 (1.66%)	

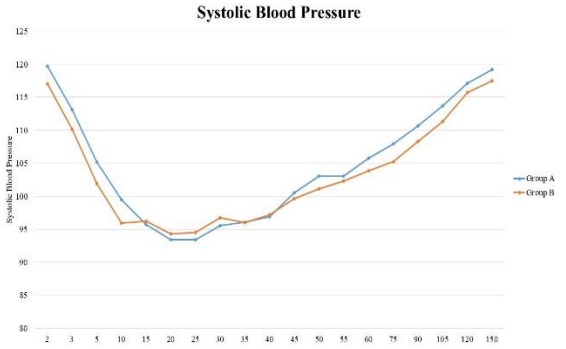

Figure 1: Trend in systolic blood pressure (SBP) at different time points in Group A and Group B. Values represent the mean systolic blood pressure (mmHg) measured at baseline and at specified time intervals following the intervention. The figure demonstrates the temporal changes and comparative trends in SBP between the two groups

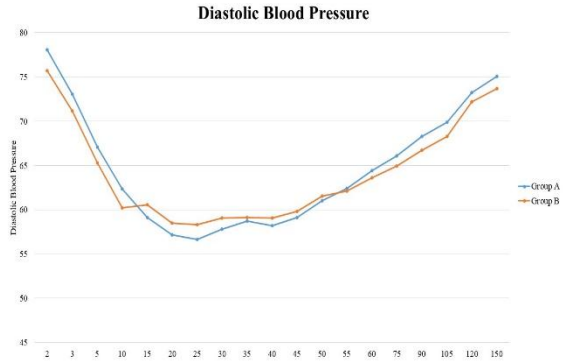

Figure 2: Changes in diastolic blood pressure (DBP) over time. Comparison of mean DBP (mmHg) measured at baseline and at specified time intervals up to 150 minutes post-intervention between Group A (blue line) and Group B (orange line)

ISSN (O): 2687-5365; ISSN (P): 2753-6556

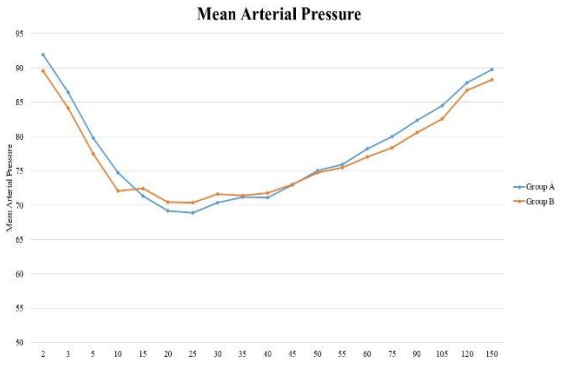

Figure 3: Time course of mean arterial pressure (MAP) post-intervention. Comparison of mean arterial pressure (mmHg) measured from baseline through 150 minutes in Group A (blue line) and Group B (orange line)

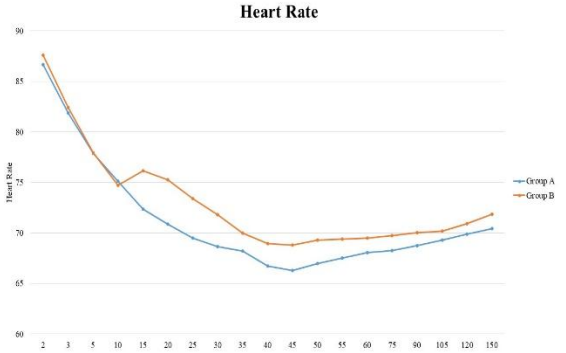

Figure 4: Changes in heart rate (HR) over time post-intervention. Comparison of mean heart rate in beats per minute (bpm) measured from baseline through 150 minutes between Group A (blue line) and Group B (orange line)

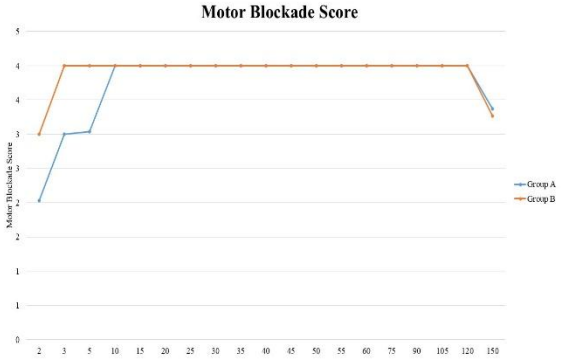

Figure 5: Progression and duration of motor block score over time. Comparison of mean motor block scores evaluated from 2 to 150 minutes post-intervention between Group A (blue line) and Group B (orange line). Group B achieved complete motor block (score of 4) rapidly by 3 minutes, whereas Group A demonstrated a more gradual onset, reaching a score of 3 at 3–5 minutes and a peak score of 4 at 10 minutes; both groups maintained complete block until 120 minutes before initiating regression at 150 minutes

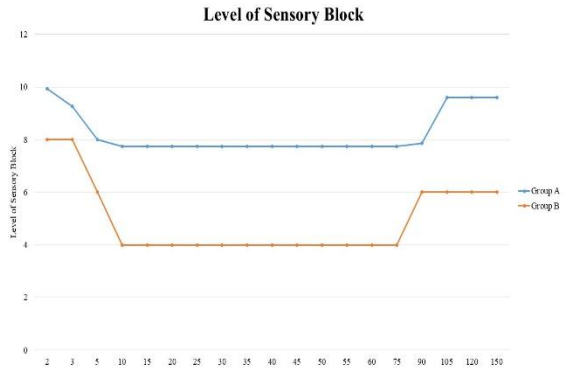

Figure 6: Comparison of Level of Sensory Block Over Time Between Group A and Group B. The line graph illustrates the progression and regression of the level of sensory block over time (in minutes, x-axis) across two study cohorts

DISCUSSION

The present randomized study demonstrated that sequential combined spinal–epidural (CSE) anaesthesia was associated with a more favourable early haemodynamic profile than conventional single-shot spinal anaesthesia. The principal findings were higher systolic, diastolic and mean arterial pressures during the early post-block period, markedly lower requirement for ephedrine, slower development of sensory and motor blockade, and lower observed incidences of shivering and vomiting in the sequential CSE group. These findings are broadly consistent with several randomized studies evaluating low-dose sequential CSE techniques, although the literature is not entirely uniform.

The haemodynamic findings are particularly relevant because hypotension remains one of the most important limitations of conventional spinal anaesthesia.[6] In the present study, baseline haemodynamic parameters were comparable, but the fall in SBP, DBP and MAP during the first 10 minutes was significantly less pronounced with sequential CSE. At 10 minutes, SBP was approximately 10 mmHg higher and MAP approximately 7.5 mmHg higher in the CSE group. This difference was accompanied by a striking reduction in vasopressor requirement: 96.7% of patients receiving sequential CSE required no ephedrine, whereas every patient in the conventional spinal group required ephedrine.

These findings are consistent with the randomized study by Mahima et al., which compared sequential CSE with spinal anaesthesia in 134 patients undergoing lower-limb orthopaedic surgery. The investigators reported a slower onset of sensory blockade with sequential CSE but significantly better haemodynamic stability than conventional spinal anaesthesia. They also observed a more pronounced fall in systolic and diastolic blood pressure after spinal anaesthesia, together with greater vasopressor requirements. The similarity between their findings and ours is noteworthy because both studies involved lower-limb surgery and used a deliberately lower

ISSN (O): 2687-5365; ISSN (P): 2753-6556

intrathecal dose with subsequent epidural supplementation.[7]

Similarly, a prospective randomized study by Patil et al. comparing sequential CSE with unilateral spinal anaesthesia for lower-limb orthopaedic surgery found significantly fewer episodes of hypotension and a lower mean ephedrine requirement with sequential CSE. Importantly, both techniques provided satisfactory surgical anaesthesia, suggesting that the haemodynamic advantage of sequential CSE does not necessarily compromise the adequacy of the surgical block.[8]

The physiological basis for these findings is plausible. Conventional spinal anaesthesia in the present study involved 17.5 mg of hyperbaric bupivacaine, whereas sequential CSE used 10 mg intrathecal bupivacaine followed by epidural supplementation. The smaller initial intrathecal dose is likely to produce a more gradual sympathetic blockade, allowing controlled extension of the block through the epidural catheter.[9] Previous pharmacodynamic work supports the importance of dose selection: Goy et al. demonstrated that the median effective intrathecal dose of hyperbaric bupivacaine was greater with single-shot spinal anaesthesia than with CSE.[10]

However, this interpretation needs to be balanced against studies reporting no haemodynamic advantage for CSE. Macfarlane et al., in a randomized trial comparing CSE and single-shot spinal anaesthesia for elective caesarean delivery using the same intrathecal dose, found no significant difference in ephedrine requirements, MAP, cardiac index or systemic vascular resistance.[11] A separate randomized study assessing sequential versus standard CSE in caesarean delivery likewise found no cardiovascular benefit when more detailed cardiac-output measurements were used.[12] These contrasting results suggest that the haemodynamic advantage observed in our study may relate not simply to the presence of an epidural catheter, but to the low-dose sequential strategy used in conjunction with epidural supplementation.

This distinction is important when interpreting our results. The present study compares two complete anaesthetic regimens rather than two techniques using identical intrathecal doses. Therefore, the observed haemodynamic superiority of sequential CSE should not be attributed solely to the CSE technique itself. The lower initial intrathecal bupivacaine dose and the ability to subsequently titrate the block through the epidural catheter are integral components of the intervention. This limitation should be explicitly acknowledged when comparing our findings with studies in which equivalent intrathecal doses were administered.

The sensory-block findings also agree with previous investigations. In our study, conventional spinal anaesthesia produced a more rapid cephalad spread, with all patients in the spinal group reaching T4 by 10 minutes. In contrast, 90% of patients in the sequential CSE group had reached T8 at 10 minutes, while only one patient had reached T4. This slower development of sensory blockade is an expected consequence of the lower initial intrathecal dose and controlled epidural supplementation.[13]

Mahima et al. similarly reported that the time required to achieve the target sensory level was significantly longer with sequential CSE than with conventional spinal anaesthesia. Nevertheless, both techniques ultimately achieved adequate surgical anaesthesia.[7] Patil et al. also reported satisfactory T10 sensory and Bromage motor blockade in all patients receiving sequential CSE, while demonstrating better haemodynamic stability with the sequential technique.[14] Thus, the slower onset of sensory blockade should not necessarily be interpreted as inferior anaesthesia; rather, it represents a more gradual establishment of the desired block.

The motor-block findings showed a similar pattern. Motor blockade was significantly less intense during the first 5 minutes with sequential CSE, but the groups became comparable from 10 minutes onward. The mean motor score was 2.03 ± 0.18 versus 3.00 ± 0 at 2 minutes and 3.03 ± 0.18 versus 4.00 ± 0 at 5 minutes in the CSE and spinal groups, respectively. This suggests that sequential CSE primarily modified the rate of development rather than the eventual achievement of motor blockade.

The relatively rapid establishment of complete motor blockade after the initial few minutes is clinically reassuring because delayed onset is unlikely to compromise surgery when an appropriate interval is allowed for block development. Previous comparative work has similarly demonstrated that conventional spinal anaesthesia generally produces faster and denser initial motor blockade, whereas sequential CSE permits a more controlled progression of blockade.[15]

The lower requirement for atropine in the sequential CSE group did not reach statistical significance. No patient in the CSE group received atropine compared with two patients (6.67%) in the spinal group ($P = 0.246$). This finding should therefore not be presented as evidence that sequential CSE prevents bradycardia. Previous studies have similarly demonstrated that differences in bradycardia between CSE and spinal techniques may be small and statistically nonsignificant.[16]

An interesting secondary finding was the markedly lower incidence of shivering in the sequential CSE group. Shivering occurred in only one patient (3.33%) receiving sequential CSE compared with all patients in the spinal group. Vomiting was also absent in the CSE group but occurred in seven patients (23.33%) receiving conventional spinal anaesthesia. A reduction in hypotension-related symptoms provides a plausible explanation for at least part of this difference. In support of this concept, a randomized study of sequential spinal dosing with plain and hyperbaric bupivacaine demonstrated markedly lower rates of hypotension as well as nausea and vomiting when the initial dose was

ISSN (O): 2687-5365; ISSN (P): 2753-6556

administered sequentially.[17] Nevertheless, the very large difference in shivering observed in the present study should be interpreted cautiously because of the small sample size and the possibility that factors other than anaesthetic technique may influence perioperative shivering.

The existing literature therefore presents a nuanced picture. Some randomized trials and observational studies have demonstrated improved haemodynamic stability with sequential CSE, particularly when a lower intrathecal dose is followed by controlled epidural supplementation.[8] Conversely, studies using equal intrathecal doses have not consistently demonstrated a cardiovascular advantage of CSE over single-shot spinal anaesthesia.[11] Even larger observational data have reported a higher incidence of clinically relevant hypotension with CSE than with spinal anaesthesia, emphasizing that CSE should not automatically be assumed to be haemodynamically superior.[18] Differences in patient population, surgical procedure, intrathecal dose, definition of hypotension, timing of epidural supplementation and method of haemodynamic assessment may account for these apparently conflicting findings.

The present study adds to this evidence by demonstrating that, in patients undergoing elective lower abdominal and lower-limb surgery, a specific low-dose sequential CSE regimen was associated with less early blood-pressure reduction and substantially lower vasopressor use than the conventional spinal regimen used in the study. The findings are therefore most appropriately interpreted as evidence supporting the use of a controlled, low-dose sequential neuraxial strategy rather than as proof that CSE is universally superior to spinal anaesthesia.

Several limitations should be considered. First, the sample size was relatively small and the study was conducted at a single institution. Second, only ASA I–II patients undergoing elective surgery were included, limiting extrapolation to elderly, high-risk, emergency or haemodynamically unstable patients. Third, the intrathecal bupivacaine dose differed between groups, making it impossible to determine whether the observed benefits were attributable to the CSE technique, the lower spinal dose, or their combination. Fourth, although multiple haemodynamic time points were compared, the analysis did not appear to use a repeated-measures model to account for within-patient correlations across time. This should be considered when interpreting the numerous individual P values. Finally, the study focused predominantly on intraoperative outcomes and did not comprehensively evaluate patient satisfaction, postoperative functional recovery, length of stay or long-term outcomes.

CONCLUSION

In this double-blind, randomized controlled study involving 60 patients undergoing elective lower abdominal and lower limb surgery, sequential combined spinal–epidural (CSE) anaesthesia demonstrated a more stable haemodynamic profile compared with conventional spinal anaesthesia. Patients receiving sequential CSE experienced less reduction in systolic blood pressure, diastolic blood pressure, and mean arterial pressure at several perioperative time points, with relatively lower heart rates during selected periods of observation.

Sequential CSE was also associated with a slower onset of motor blockade and comparatively earlier recovery of motor function. The requirement for rescue ephedrine was substantially lower with sequential CSE, while atropine requirement was numerically lower but did not reach statistical significance. Furthermore, shivering and vomiting occurred significantly less frequently in the CSE group than in the spinal anaesthesia group.

Overall, the findings suggest that sequential CSE provides effective anaesthesia with greater haemodynamic stability and a lower incidence of selected perioperative adverse effects compared with conventional spinal anaesthesia in appropriately selected patients undergoing elective lower abdominal and lower limb surgery. These findings support sequential CSE as a useful alternative to conventional spinal anaesthesia when haemodynamic stability is an important consideration. However, the results should be interpreted within the context of the study population and its limitations, including the absence of separate assessment of the duration and regression of sensory and motor blockade and the lack of comparative evaluation of different anaesthetic drugs and their doses.

REFERENCES

1. Loban AH, Mirza AK, Islam S. Spinal Anaesthesia in Lower Abdominal and Limb Surgery for Adult in Tertiary Care Hospital, Dhaka, Bangladesh.
2. Pierson D, Certoma R, Hobbs J, et al. A narrative review on multimodal spinal anesthesia: Old technique and new use. Journal of Anesthesia and Translational Medicine 2025; 4: 25–32.
3. Ferré F, Martin C, Bosch L, et al. Control of Spinal Anesthesia-Induced Hypotension in Adults. Local Reg Anesth 2020; 13: 39–46.
4. Themes UFO. Epidural and Spinal Anesthesia. Anesthesia Key, https://aneskey.com/epidural-and-spinal-anesthesia-4/ (2016, accessed 18 August 2026).
5. Sorout D, Mahajan N, Singh RK, et al. Lower Limb Orthopedic Anesthesia: A Randomized Trial Comparing Ropivacaine and Bupivacaine for Sensory-Motor Block and Hemodynamic Stability. Cureus 2025; 17: e84377.
6. Halawi MAM, dafaalla AMA, Weam Mohamed Elhadi Bashir Eltayeb EBE, et al. Incidence of Hypotension in Obstetric Patients Undergoing Cesarean Section: Conventional vs. Segmental Spinal Anesthesia at Kassala Al- Saudi Maternity Hospital (July 2025 – December 2025)-A cross sectional study. Epub ahead of print 9 April 2026. DOI: 10.21203/rs.3.rs-8457290/v1.
7. LN M, Madhusudhana R. A Study of the Clinical Effects of Sequential Combined Spinal Epidural Anesthesia and Spinal Anesthesia in Patients Undergoing Orthopedic Surgeries. Cureus; 15: e39171.
8. Magar JS, Bawdane KD, Patil R. Comparison of Efficacy and Safety of Unilateral Spinal Anaesthesia with Sequential Combined Spinal Epidural Anaesthesia for Lower Limb

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Orthopaedic Surgery. J Clin Diagn Res 2017; 11: UC17–UC20.
9. Sobreira Fernandes D, Theron A, Beley N, et al. Editorial comment to the letter to editor "Cesarean section in COVID-19 patient with mitral stenosis: Fast-track spinal anaesthesia is an option." Non-standard anaesthetic techniques during covid-19 pandemic: is it worth the risk? Trends Anaesth Crit Care 2021; 39: 1–2.
10. Goy RW-L, Chee-Seng Y, Sia AT-H, et al. The median effective dose of intrathecal hyperbaric bupivacaine is larger in the single-shot spinal as compared with the combined spinal-epidural technique. Anesth Analg 2005; 100: 1499–1502.
11. Macfarlane AJR, Pryn A, Litchfield KN, et al. Randomised controlled trial of combined spinal epidural vs. spinal anaesthesia for elective caesarean section: vasopressor requirements and cardiovascular changes. Eur J Anaesthesiol 2009; 26: 47–51.
12. Bray JK, Fernando R, Patel NP, et al. Suprasternal Doppler estimation of cardiac output: standard versus sequential combined spinal epidural anesthesia for cesarean delivery. Anesth Analg 2006; 103: 959–964.
13. Shatil B, Smiley R. Neuraxial analgesia for labour. BJA Education 2020; 20: 96–102.
14. Magar JS, Bawdane KD, Patil R. Comparison of Efficacy and Safety of Unilateral Spinal Anaesthesia with Sequential Combined Spinal Epidural Anaesthesia for Lower Limb Orthopaedic Surgery. J Clin Diagn Res 2017; 11: UC17–UC20.
15. The clinical effects of combined spinal –epidural anaesthesia versus spinal anaesthesia in patients undergoing major orthopaedic surgery, https://www.worldwidejournals.com/indian-journal-of-applied-research-(IJAR)/article/the-clinical-effects-of-combined-spinal-epidural-anaesthesia-versus-spinal-anaesthesia-in-patients-undergoing-major-orthopaedic-surgery/MTIwOTk=/?is=1 (accessed 19 August 2026).
16. Brizzi A, Greco F, Malvasi A, et al. Comparison of sequential combined spinal-epidural anesthesia and spinal anesthesia for cesarean section. Minerva Anestesiol 2005; 71: 701–709.
17. Cesur M, Alici HA, Erdem AF, et al. Spinal anesthesia with sequential administration of plain and hyperbaric bupivacaine provides satisfactory analgesia with hemodynamic stability in cesarean section. Int J Obstet Anesth 2008; 17: 217–222.
18. Klasen J, Junger A, Hartmann B, et al. Differing incidences of relevant hypotension with combined spinal-epidural anesthesia and spinal anesthesia. Anesth Analg 2003; 96: 1491–1495.

ISSN (O): 2687-5365; ISSN (P): 2753-6556