e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(7); 1001-1009

Original Research Article

A Comparative Study of Haemodynamic Changes in IHD Patients after Fractional Dose or Bolus Dose of Spinal Anaesthesia in Lower Limb Surgery Patients - A Double Blind Randomised Trial

Satish Shankar Kelageri[1], Adilakshmi N.[2]

[1]Assistant Professor, Department of Anaesthesiology, SDM College of Medical Sciences and Hospital, Dharwad

[2]Senior Resident, Department of Anaesthesiology, Koppal Institute of Medical Sciences, Koppal

Received: 01-04-2026 / Revised: 15-05-2026 / Accepted: 21-06-2026

Corresponding author: Dr. Satish Shankar Kelageri

Conflict of interest: Nil

Abstract

Background: Patients with ischaemic heart disease (IHD) are highly susceptible to haemodynamic instability during spinal anaesthesia because abrupt sympathetic blockade may precipitate hypotension, bradycardia, and myocardial ischaemia. Fractional-dose spinal anaesthesia has been proposed as a safer alternative to conventional bolus administration.

Methods: This prospective double-blind randomised controlled trial included 70 patients with documented IHD, randomly allocated into Group F (fractional-dose, n=35) and Group B (bolus-dose, n=35). The primary outcome was intraoperative haemodynamic stability assessed by heart rate, mean arterial pressure (MAP), and the incidence of hypotension and bradycardia. Secondary outcomes included vasopressor requirement, sensory and motor block characteristics, postoperative analgesia, adverse events, PACU stay, and patient satisfaction.

Results: Baseline characteristics were comparable between the groups. Group F demonstrated significantly higher lowest MAP (80.6 ± 7.8 vs. 70.2 ± 8.4 mmHg; $p<0.001$), smaller MAP reduction (16.7 ± 5.1% vs. 27.8 ± 6.4%; $p<0.001$), lower incidences of hypotension (17.1% vs. 45.7%; $p=0.010$) and bradycardia (11.4% vs. 34.3%; $p=0.022$), and reduced mephentermine and atropine requirements. Fractional spinal anaesthesia also produced longer sensory and motor block duration, prolonged postoperative analgesia, shorter PACU stay, and higher patient satisfaction without increasing adverse events.

Conclusion: Fractional-dose spinal anaesthesia provides superior haemodynamic stability and improved perioperative outcomes compared with conventional bolus spinal anaesthesia in patients with ischaemic heart disease undergoing lower limb orthopaedic surgery, making it a safe and effective technique for this high-risk population.

Keywords: Fractional Spinal Anaesthesia; Bolus Spinal Anaesthesia; Ischaemic Heart Disease; Haemodynamic Stability; Lower Limb Orthopaedic Surgery; Randomised Controlled Trial.

DOI: 10.25258/ijcpr.18.7.153

Introduction

Spinal anaesthesia is the preferred regional anaesthetic technique for lower limb orthopaedic surgery because it provides rapid onset, reliable sensory and motor blockade, excellent muscle relaxation, effective postoperative analgesia, and a lower incidence of pulmonary and thromboembolic complications than general anaesthesia[1]. It also avoids airway manipulation, attenuates the surgical stress response, facilitates early mobilisation, and supports Enhanced Recovery After Surgery (ERAS) protocols. These advantages are particularly important in elderly patients and those with cardiovascular disease, in whom avoiding general anaesthesia may reduce perioperative morbidity and improve recovery. [2,3]The increasing prevalence of ischaemic heart disease (IHD) has led to a growing number of patients with coronary artery disease presenting for lower limb orthopaedic procedures. Owing to impaired coronary perfusion reserve and limited cardiovascular compensatory mechanisms, these patients are highly susceptible to haemodynamic fluctuations during anaesthesia [4]. Even brief episodes of hypotension or bradycardia can reduce coronary perfusion, disrupt myocardial oxygen supply-demand balance, and precipitate myocardial ischaemia, arrhythmias, heart failure, or perioperative myocardial infarction. Consequently,

maintaining haemodynamic stability is a major objective during anaesthetic management in this high-risk population. [5,6]Although conventional single-shot spinal anaesthesia is widely used in patients with stable coronary artery disease, rapid intrathecal administration of local anaesthetic often causes abrupt sympathetic blockade, resulting in vasodilatation, reduced venous return, decreased cardiac output, hypotension, and bradycardia[7,8]. These effects frequently require vasopressor therapy and intravenous fluid administration, which may be undesirable in patients with compromised myocardial function. Therefore, modifications of spinal anaesthetic techniques that preserve anaesthetic efficacy while reducing cardiovascular instability have attracted considerable attention. [9,10]Fractional-dose spinal anaesthesia has emerged as a promising alternative. In this technique, the total intrathecal dose is administered in two or more divided aliquots separated by a short interval rather than as a single bolus. This approach is thought to produce a slower cephalad spread of local anaesthetic and a more gradual sympathetic blockade, thereby reducing sudden decreases in blood pressure and heart rate while maintaining adequate surgical anaesthesia. [11,12]

Several randomised and observational studies in elderly and high-risk patients have demonstrated that fractional spinal anaesthesia is associated with improved haemodynamic stability, a lower incidence of hypotension and bradycardia, reduced vasopressor requirements, and prolonged postoperative analgesia compared with conventional bolus administration. However, evidence specifically involving patients with established IHD remains limited, and findings from heterogeneous surgical populations cannot be directly extrapolated to this group. [13,14]Therefore, this prospective double-blind randomised controlled trial was undertaken to compare fractional-dose and conventional bolus-dose spinal anaesthesia in patients with ischaemic heart disease undergoing elective lower limb orthopaedic surgery.

Materials and Methods

This prospective, double-blind, randomised controlled trial was conducted in the Department of Anaesthesiology of a tertiary care teaching hospital.

Study Population: A total of 70 patients with documented ischaemic heart disease (IHD) who were scheduled to undergo elective lower limb orthopaedic surgery under spinal anaesthesia were enrolled in the study. Patients were randomly allocated into two equal groups comprising 35 patients each:

Group F (Fractional-dose spinal anaesthesia): Patients received the calculated intrathecal dose of hyperbaric bupivacaine in two divided fractions.

Group B (Bolus-dose spinal anaesthesia): Patients received the same total dose of hyperbaric bupivacaine as a single intrathecal bolus.

Eligibility Criteria

Inclusion Criteria

- Patients fulfilling all of the following criteria were included in the study:
- Age between 45 and 80 years.
- Either sex.
- Documented ischaemic heart disease diagnosed by a cardiologist based on previous myocardial infarction, stable angina, positive stress test, previous coronary angioplasty, or coronary artery bypass graft surgery.
- American Society of Anesthesiologists (ASA) Physical Status III.
- Scheduled for elective lower limb orthopaedic surgery under spinal anaesthesia.
- Ability to provide written informed consent.

Exclusion Criteria

Patients were excluded if they had any of the following:

- Patient refusal.
- Contraindications to spinal anaesthesia.
- Coagulopathy or anticoagulant therapy not discontinued according to guidelines.
- Local infection at the puncture site.
- Severe valvular heart disease.
- Uncontrolled arrhythmias.
- Left ventricular ejection fraction below 35%.
- Severe pulmonary hypertension.
- Second- or third-degree atrioventricular block without permanent pacemaker.
- Allergy to local anaesthetic agents.
- Emergency surgery.
- Body mass index >35 kg/m².
- Pregnancy.
- Neurological disorders affecting spinal cord function.

Randomisation and Allocation Concealment: Patients were randomly assigned to one of the two study groups in a 1:1 ratio using a computer-generated randomisation sequence.

Allocation concealment was ensured using sequentially numbered, opaque, sealed envelopes that were opened immediately before administration of spinal anaesthesia.

Blinding: The study was conducted in a double-blind manner. The anaesthesiologist who prepared the study drug was not involved in patient management or data collection.

The anaesthesiologist performing intraoperative monitoring and recording haemodynamic variables, the operating surgeon, postoperative assessor, and the patients remained blinded to group allocation throughout the study.

Preoperative Assessment: All patients underwent detailed pre-anaesthetic evaluation one day before surgery. Demographic characteristics, medical history, cardiovascular risk factors, previous cardiac interventions, current medications, and physical examination findings were recorded. Routine laboratory investigations included complete blood count, renal function tests, serum electrolytes, coagulation profile, fasting blood glucose, electrocardiography, and transthoracic echocardiography whenever indicated. Cardiology consultation was obtained for optimisation of cardiac status before surgery. Patients continued prescribed anti-anginal medications, β-blockers, calcium channel blockers, and statins until the day of surgery unless otherwise advised by the treating cardiologist.

Anaesthetic Technique: After arrival in the operating room, standard monitoring including electrocardiography, non-invasive blood pressure, pulse oximetry, and heart rate monitoring was instituted. Baseline haemodynamic parameters were recorded before administration of spinal anaesthesia.

An intravenous cannula (18G) was secured, and patients received preload with 500 mL of Ringer's lactate solution over 15–20 minutes unless contraindicated because of impaired ventricular function. With the patient in the sitting position and under strict aseptic precautions, spinal anaesthesia was performed at the L3–L4 or L4–L5 intervertebral space using a 25-G Quincke spinal needle. Spinal dose in both groups given was - 0.2mg/kg hyperbaric bupivacaine

Group F (Fractional Dose): Patients received hyperbaric bupivacaine administered in two equal fractions. The first half of the dose was injected slowly over approximately 10 seconds, followed by a 90-second interval, after which the remaining half of the dose was injected intrathecally.

Group B (Bolus Dose): Patients received hyperbaric bupivacaine as a single continuous intrathecal injection over approximately 10 seconds. Immediately after injection, patients were placed in the supine position with a neutral head position.

Intraoperative Monitoring: Heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, oxygen saturation, and electrocardiographic changes were recorded at baseline, immediately after spinal injection, every two minutes for the first 10 minutes, every five minutes until 30 minutes, and every 10 minutes thereafter until completion of surgery.

Assessment of Sensory and Motor Block: Sensory block was assessed using pinprick sensation along the mid-clavicular line every two minutes until the maximum sensory level was achieved and thereafter every 15 minutes until regression.

Motor blockade was evaluated using the Modified Bromage Scale:

- Grade 0: Full movement of hip, knee, and ankle.
- Grade 1: Unable to raise extended leg.
- Grade 2: Unable to flex knee.
- Grade 3: Unable to flex ankle or foot.

The onset, highest sensory level, duration of sensory block, onset of motor block, duration of motor block, and time to first rescue analgesia were recorded.

Management of Haemodynamic Events: Hypotension was defined as a decrease in mean arterial pressure of more than 20% from baseline or systolic blood pressure below 90 mmHg. Hypotension was treated with intravenous fluid bolus and incremental doses of mephentermine 6 mg intravenously until blood pressure returned to acceptable levels. Bradycardia was defined as heart rate below 50 beats/minute and was treated with intravenous atropine 0.6 mg. Any episode of desaturation (SpO_2 <94%), nausea, vomiting, shivering, high spinal block, respiratory depression, arrhythmias, or conversion to general anaesthesia was recorded and managed according to standard institutional protocols.

Outcome Measures

Primary Outcome

- Intraoperative haemodynamic stability assessed by changes in heart rate and mean arterial pressure.
- Incidence of hypotension.
- Incidence of bradycardia.

Secondary Outcomes

- Vasopressor requirement.
- Total dose of mephentermine administered.
- Sensory block characteristics.
- Motor block characteristics.
- Duration of postoperative analgesia.
- Time to first rescue analgesic.
- Intraoperative adverse events.
- Patient satisfaction score.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range) depending on data distribution, while categorical variables were presented as frequencies and percentages. Normality of continuous data was assessed using the Shapiro–Wilk test. Continuous variables between groups were compared using the independent Student's t-test for normally distributed data or the Mann–Whitney U test for non-normally distributed data. Repeated haemodynamic measurements were analysed using repeated-measures analysis of variance (RM-ANOVA) with Bonferroni post hoc correction. Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. A p-value <0.05 was considered statistically significant.

Results

A total of 70 patients with documented ischaemic heart disease undergoing elective lower limb orthopaedic surgery were enrolled and randomly allocated into two groups of 35 patients each. All enrolled patients completed the study and were included in the final analysis. The baseline demographic and clinical characteristics of the two study groups were comparable (Table 1). The mean age was 65.8 ± 8.2 years in Group F and 66.4 ± 8.7 years in Group B (p=0.76). The majority of patients were male (65.7% vs. 62.9%; p=0.81). There were no statistically significant differences between the groups with respect to weight, height, body mass index, prevalence of hypertension or diabetes mellitus, previous myocardial infarction, previous PCI/CABG, left ventricular ejection fraction, or duration of surgery (all p>0.05), indicating comparable baseline characteristics (Table 1).Patients receiving fractional-dose spinal anaesthesia demonstrated significantly better intraoperative haemodynamic stability than those receiving conventional bolus spinal anaesthesia (Table 2, Figure 1).

Baseline heart rate and mean arterial pressure (MAP) were comparable between the groups (p>0.05). However, Group F had a significantly higher lowest heart rate (66.9 ± 7.3 vs. 60.5 ± 8.2 beats/min; p=0.001) and higher lowest MAP (80.6 ± 7.8 vs. 70.2 ± 8.4 mmHg; p<0.001). The maximum reduction in MAP was significantly smaller in Group F (16.7 ± 5.1% vs. 27.8 ± 6.4%; p<0.001). Similarly, heart rate and MAP at 10 minutes after spinal anaesthesia were significantly better maintained in the fractional-dose group (both p<0.001). Although heart rate at the end of surgery was comparable (p=0.19), MAP remained significantly higher in Group F (91.2 ± 7.1 vs. 87.4 ± 7.8 mmHg; p=0.034) (Table 2, Figure 1).The characteristics of sensory and motor blockade are summarised in Table 3 and Figure 2. The onset of sensory block and attainment of T10 sensory level were slightly slower in Group F than Group B (p=0.008 and p=0.041, respectively). However, fractional-dose spinal anaesthesia resulted in a significantly longer duration of sensory block (179.5 ± 18.4 vs. 163.6 ± 17.8 minutes; p<0.001) and motor block (152.8 ± 16.2 vs. 141.4 ± 15.8 minutes; p=0.004). Furthermore, the time to first rescue analgesia was significantly prolonged in Group F (244.6 ± 36.8 vs. 208.3 ± 34.2 minutes; p<0.001), indicating improved postoperative analgesia (Table 3, Figure 2).The incidence of haemodynamic complications was significantly lower in the fractional-dose group (Table 4). Hypotension occurred in 17.1% of patients in Group F compared with 45.7% in Group B (p=0.010). Similarly, bradycardia was significantly less frequent in Group F (11.4% vs. 34.3%; p=0.022). Consequently, significantly fewer patients in Group F required mephentermine (20.0% vs. 51.4%; p=0.006) or atropine (8.6% vs. 25.7%; p=0.049). The mean total mephentermine dose and intravenous fluid requirement were also significantly lower in Group F (both p<0.001), reflecting superior haemodynamic stability (Table 4).The frequency of perioperative adverse events is presented in Table 5 and Figure 3. Although nausea, vomiting, shivering, cardiac arrhythmias, oxygen desaturation, and post-dural puncture headache occurred less frequently in the fractional-dose group, none of these differences reached statistical significance (all p>0.05). One patient in the bolus-dose group experienced a high spinal block and oxygen desaturation, while no such events occurred in the fractional-dose group. No patient in either group developed respiratory depression or required conversion to general anaesthesia (Table 5, Figure 3).

Recovery characteristics are summarised in Table 6. The duration of surgery and time to ambulation were comparable between the two groups (p>0.05). However, patients in Group F had a significantly shorter stay in the post-anaesthesia care unit (42.6 ± 7.4 vs. 48.8 ± 8.5 minutes; p=0.002) and a significantly longer duration before requiring rescue analgesia (244.6 ± 36.8 vs. 208.3 ± 34.2 minutes; p<0.001). Patient satisfaction scores were also significantly higher in the fractional-dose group (9.1 ± 0.7 vs. 8.3 ± 0.9; p<0.001), with a greater proportion of patients reporting excellent satisfaction (91.4% vs. 74.3%; p=0.049) (Table 6).

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population

Variable	Group F (Fractional) (n=35)	Group B (Bolus) (n=35)	p-value
Age (years), mean ± SD	65.8 ± 8.2	66.4 ± 8.7	0.76
Male, n (%)	23 (65.7)	22 (62.9)	0.81
Female, n (%)	12 (34.3)	13 (37.1)	
Weight (kg), mean ± SD	68.4 ± 8.6	67.8 ± 8.9	0.77
Height (cm), mean ± SD	165.1 ± 6.5	164.6 ± 6.9	0.74
BMI (kg/m²), mean ± SD	25.1 ± 2.8	25.0 ± 3.0	0.91
Hypertension, n (%)	27 (77.1)	28 (80.0)	0.76
Diabetes Mellitus, n (%)	18 (51.4)	19 (54.3)	0.81
Previous MI, n (%)	11 (31.4)	10 (28.6)	0.79
Previous PCI/CABG, n (%)	13 (37.1)	12 (34.3)	0.81
Left Ventricular Ejection Fraction (%)	51.8 ± 4.6	51.1 ± 5.1	0.54
Duration of Surgery (min)	94.5 ± 18.6	96.2 ± 19.1	0.71

Table 2: Intraoperative Haemodynamic Parameters

Variable	Group F (n=35)	Group B (n=35)	p-value
Baseline Heart Rate (beats/min)	74.8 ± 8.4	75.3 ± 8.9	0.81
Lowest Heart Rate	66.9 ± 7.3	60.5 ± 8.2	**0.001**
Baseline MAP (mmHg)	96.8 ± 8.5	97.2 ± 8.8	0.84
Lowest MAP (mmHg)	80.6 ± 7.8	70.2 ± 8.4	**<0.001**
Maximum MAP Reduction (%)	16.7 ± 5.1	27.8 ± 6.4	**<0.001**
Heart Rate at 10 min	70.8 ± 7.4	63.5 ± 8.1	**<0.001**
MAP at 10 min	84.9 ± 7.6	73.1 ± 8.3	**<0.001**
Heart Rate at End of Surgery	73.4 ± 6.8	71.2 ± 7.1	0.19
MAP at End of Surgery	91.2 ± 7.1	87.4 ± 7.8	**0.034**

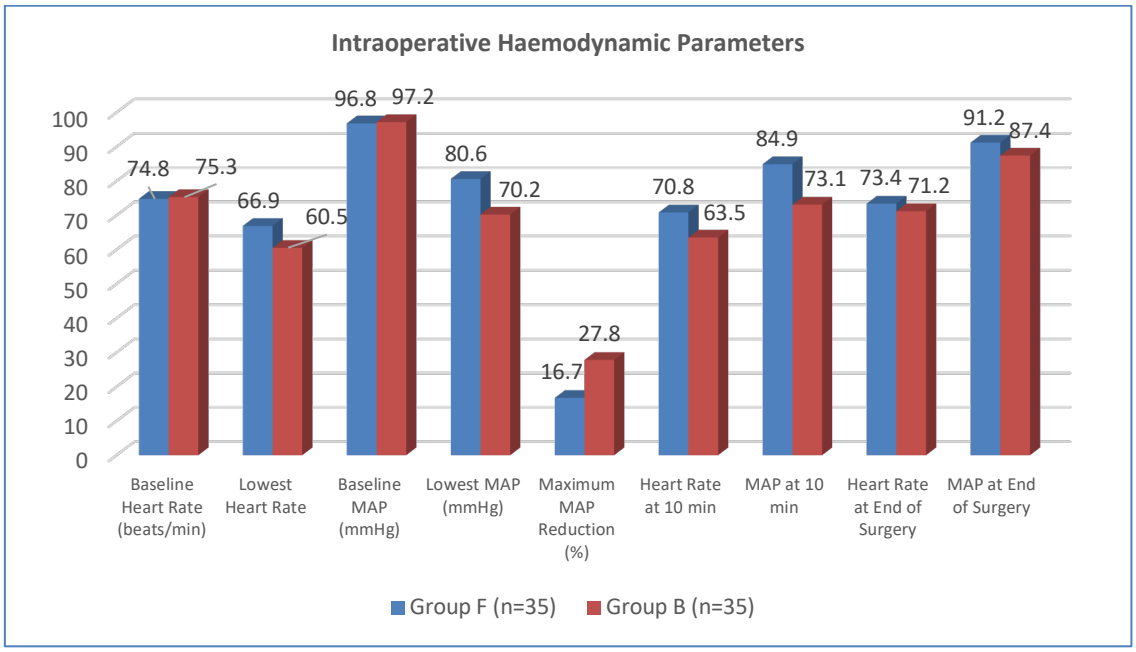

Figure 1: Intraoperative Haemodynamic Parameters

Table 3: Sensory and Motor Block Characteristics

Variable	Group F (n=35)	Group B (n=35)	p-value
Onset of Sensory Block (min)	3.8 ± 0.8	3.3 ± 0.7	**0.008**
Time to T10 Block (min)	5.4 ± 1.1	4.9 ± 1.0	**0.041**
Duration of Sensory Block (min)	179.5 ± 18.4	163.6 ± 17.8	**<0.001**
Onset of Motor Block (min)	4.5 ± 0.9	4.1 ± 0.8	**0.047**
Duration of Motor Block (min)	152.8 ± 16.2	141.4 ± 15.8	**0.004**
Time to First Rescue Analgesia (min)	244.6 ± 36.8	208.3 ± 34.2	**<0.001**

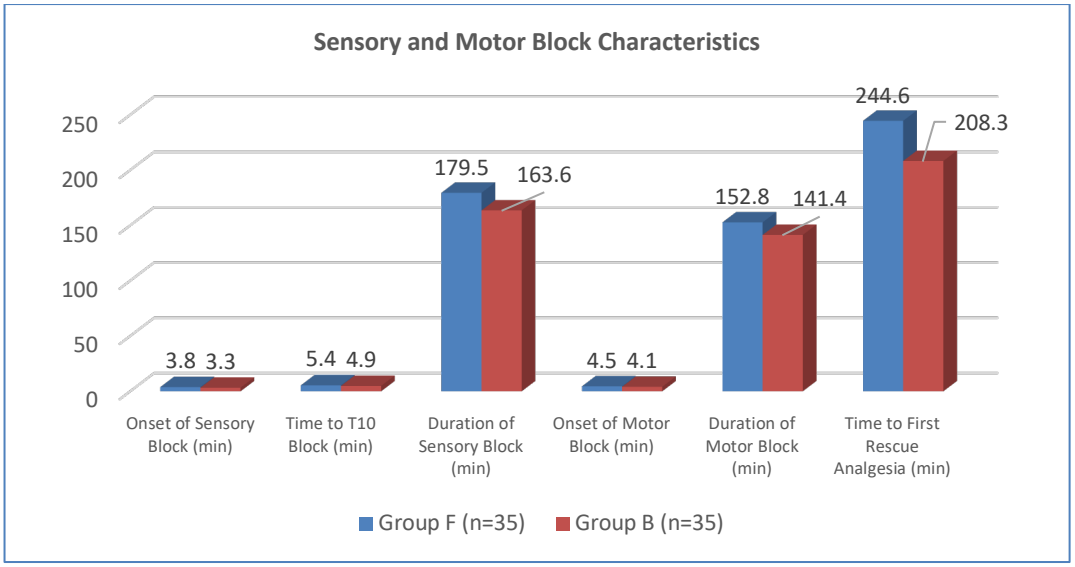

Figure 2: Sensory and Motor Block Characteristics

Table 4: Haemodynamic Complications and Vasopressor Requirement

Variable	Group F (n=35)	Group B (n=35)	p-value
Hypotension	6 (17.1%)	16 (45.7%)	**0.010**
Bradycardia	4 (11.4%)	12 (34.3%)	**0.022**
Mephentermine Required	7 (20.0%)	18 (51.4%)	**0.006**
Total Mephentermine Dose (mg)	3.8 ± 2.9	9.7 ± 5.6	**<0.001**
Atropine Required	3 (8.6%)	9 (25.7%)	**0.049**
Total Intravenous Fluid (mL)	792 ± 128	958 ± 176	**<0.001**

Table 5: Perioperative Adverse Events

Adverse Event	Group F (n=35)	Group B (n=35)	p-value
Nausea	3 (8.6%)	8 (22.9%)	0.10
Vomiting	1 (2.9%)	4 (11.4%)	0.16
Shivering	2 (5.7%)	7 (20.0%)	0.08
High Spinal Block	0	1 (2.9%)	0.31
Respiratory Depression	0	0	—
Oxygen Desaturation	0	1 (2.9%)	0.31
Cardiac Arrhythmia	1 (2.9%)	3 (8.6%)	0.30
Post-dural Puncture Headache	0	1 (2.9%)	0.31
Conversion to General Anaesthesia	0	0	—

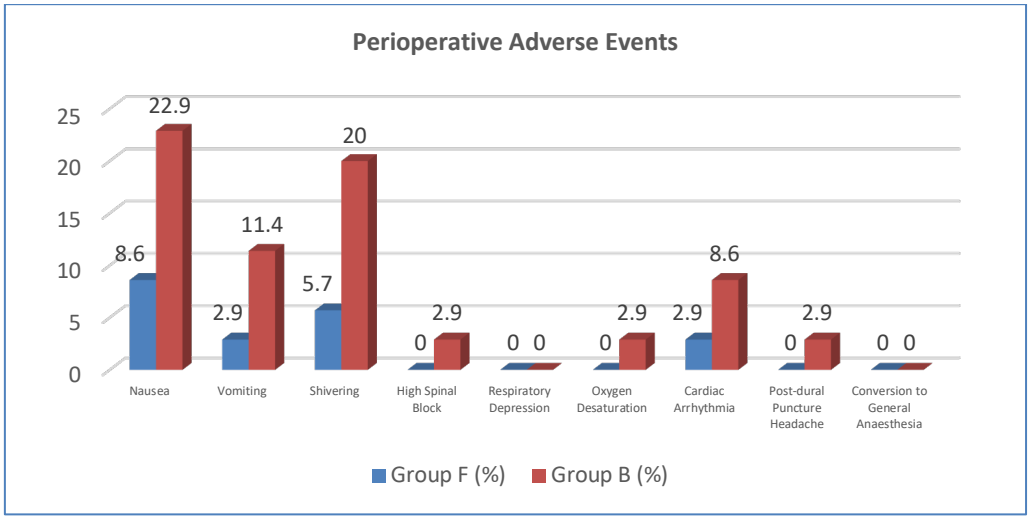

Figure 3: Perioperative Adverse Events

Table 6: Recovery Characteristics and Patient Satisfaction

Variable	Group F (n=35)	Group B (n=35)	p-value
Duration of Surgery (min)	94.5 ± 18.6	96.2 ± 19.1	0.71
Time to Ambulation (hours)	6.8 ± 0.9	6.5 ± 0.8	0.14
PACU Stay (min)	42.6 ± 7.4	48.8 ± 8.5	**0.002**
Time to First Rescue Analgesia (min)	244.6 ± 36.8	208.3 ± 34.2	**<0.001**
Patient Satisfaction Score (0–10)	9.1 ± 0.7	8.3 ± 0.9	**<0.001**
Excellent Satisfaction (≥8), n (%)	32 (91.4%)	26 (74.3%)	**0.049**

Discussion

The present prospective double-blind randomized trial compared fractional-dose and conventional bolus-dose spinal anaesthesia in patients with ischaemic heart disease (IHD) undergoing lower limb surgery. The findings demonstrated that fractional spinal anaesthesia provided superior haemodynamic stability, reduced the incidence of hypotension and bradycardia, decreased vasopressor and atropine requirements, prolonged sensory and motor blockade with extended postoperative analgesia, shortened PACU stay, and improved patient satisfaction without increasing perioperative adverse events.

These findings are particularly important in patients with IHD, in whom abrupt reductions in systemic vascular resistance and coronary perfusion may precipitate myocardial ischaemia. Baseline demographic and clinical characteristics were comparable between the two groups, with no significant differences in age, cardiovascular comorbidities, previous myocardial infarction, left ventricular ejection fraction, or other operative variables, indicating that the observed differences were attributable to the anaesthetic technique. Similar baseline comparability has been reported by Derakhshan et al.[11] and Mishra et al.[15].

The primary objective of the study was to evaluate intraoperative haemodynamic stability. Fractional spinal anaesthesia maintained significantly higher intraoperative heart rate and mean arterial pressure (MAP), with a markedly smaller reduction in MAP compared with conventional bolus administration. Haemodynamic parameters at 10 minutes after spinal anaesthesia also remained significantly more stable in the fractional group, suggesting that gradual intrathecal administration attenuates abrupt sympathetic blockade while preserving preload, systemic vascular resistance, and coronary perfusion.

These findings are consistent with Derakhshan et al.[11], who demonstrated superior maintenance of blood pressure and heart rate with fractional spinal anaesthesia, and Mishra et al.[15], who reported significantly higher intraoperative MAP and reduced vasopressor intervention with fractionated hyperbaric bupivacaine. The improved haemodynamic profile translated into significantly fewer cardiovascular complications. Hypotension and bradycardia occurred less frequently in the fractional group, with corresponding reductions in mephentermine and atropine requirements. The total vasopressor dose was also significantly lower. Similar reductions in vasopressor and atropine use have been reported by Mishra et al.[15] and Derakhshan et al.[11], supporting the cardiovascular benefits of fractionated spinal anaesthesia. Regarding block characteristics, fractional administration produced a marginally slower onset of sensory and motor blockade but significantly prolonged the duration of both blocks and delayed the requirement for first rescue analgesia.

These findings agree with Derakhshan et al.[11], who also demonstrated prolonged sensory blockade following fractionated spinal anaesthesia, suggesting that gradual intrathecal drug distribution results in sustained neural blockade without compromising surgical conditions. Recovery characteristics also favoured fractional spinal anaesthesia.

Although the time to ambulation was similar between groups, PACU stay was significantly shorter, reflecting improved haemodynamic recovery and reduced postoperative intervention. Patient satisfaction was significantly higher in the fractional group, likely because of greater cardiovascular stability, prolonged analgesia, and reduced intraoperative pharmacological support.

These findings are consistent with previous randomized studies demonstrating improved perioperative quality with fractionated spinal anaesthesia.[11,15]Perioperative adverse events, including nausea, vomiting, shivering, and cardiac arrhythmias, were numerically less frequent in the fractional group, although the differences were not statistically significant.

No patient required conversion to general anaesthesia, and no respiratory depression occurred. Similar safety outcomes have been reported by Derakhshan et al.[11], confirming that fractionated spinal anaesthesia does not increase neurological or respiratory complications. A major strength of the present study is its exclusive inclusion of patients with established ischaemic heart disease, a population particularly vulnerable to haemodynamic instability during neuraxial anaesthesia. The significantly better preservation of

MAP, lower incidence of hypotension, reduced vasopressor requirement, prolonged postoperative analgesia, and higher patient satisfaction indicate that fractional spinal anaesthesia offers clinically meaningful cardiovascular advantages while maintaining excellent anaesthetic efficacy. These findings extend the observations of Derakhshan et al.[11] and Mishra et al.[15] and support fractional spinal anaesthesia as a preferred neuraxial technique for high-risk patients with IHD undergoing lower limb surgery.

Conclusion

Fractional-dose spinal anaesthesia provided significantly superior haemodynamic stability compared with conventional bolus-dose spinal anaesthesia in patients with ischaemic heart disease undergoing lower limb orthopaedic surgery. It was associated with a lower incidence of hypotension and bradycardia, reduced vasopressor and atropine requirements, prolonged postoperative analgesia, shorter PACU stay, and higher patient satisfaction without increasing perioperative adverse events. Although the onset of sensory and motor blockade was slightly slower, adequate surgical anaesthesia was achieved in all patients. Fractional-dose spinal anaesthesia may therefore be considered a safe and effective alternative to conventional bolus spinal anaesthesia for high-risk patients with ischaemic heart disease.

Limitations

This study was conducted at a single tertiary care centre with a relatively small sample size, which may limit the generalisability of the findings. Only patients with stable ischaemic heart disease undergoing elective lower limb orthopaedic surgery were included; therefore, the results may not be applicable to emergency surgeries or patients with more severe cardiac dysfunction. In addition, long-term postoperative cardiac outcomes, including perioperative myocardial injury and major adverse cardiac events, were not evaluated. Larger multicentre studies with extended follow-up are warranted to confirm these findings.

References

1. Miller RD, Cohen NH, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Young WL, et al. Miller's Anesthesia. 9th ed. Philadelphia: Elsevier; 2020.
2. Barash PG, Cullen BF, Stoelting RK, Cahalan MK, Stock MC, Ortega R, et al. Clinical Anesthesia. 8th ed. Philadelphia: Wolters Kluwer; 2017.
3. Rodgers A, Walker N, Schug S, McKee A, Kehlet H, van Zundert A, et al. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. BMJ. 2000;321:1493.
4. Kristensen SD, Knuuti J, Saraste A, Anker S, Bøtker HE, De Hert S, et al. 2014 ESC/ESA Guidelines on non-cardiac surgery: cardiovascular assessment and management. Eur Heart J. 2014;35(35):2383-431.
5. Fleisher LA, Fleischmann KE, Auerbach AD, Barnason SA, Beckman JA, Bozkurt B, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery. Circulation. 2014;130:e278-e333.
6. De Hert S, Staender S, Fritsch G, Hinkelbein J, Afshari A, Bettelli G, et al. Pre-operative evaluation of adults undergoing elective non-cardiac surgery. Eur J Anaesthesiol. 2018;35(6):407-465.
7. Butterworth JF, Mackey DC, Wasnick JD. Morgan & Mikhail's Clinical Anesthesiology. 7th ed. New York: McGraw-Hill Education; 2022.
8. Mitra JK, Roy J, Bhattacharyya P, Yunus M, Lyngdoh NM. Changing trends in the management of hypotension following spinal anesthesia in caesarean section. J Postgrad Med. 2013;59(2):121-126.
9. Kinsella SM, Carvalho B, Dyer RA, Fernando R, McDonnell N, Mercier FJ, et al. International consensus statement on the management of hypotension with vasopressors during caesarean section under spinal anaesthesia. Anaesthesia. 2018;73(1):71-92.
10. Butwick AJ, Columb MO, Carvalho B. Preventing spinal hypotension during caesarean delivery: what is the latest? Br J Anaesth. 2015;114(2):183-186.
11. Derakhshan P, Kheirabadi D, Moghadam SH. A comparison of the effect of fractionated and bolus dose injection on spinal anesthesia for lower limb surgery: a randomized clinical trial. Anesthesiol Pain Med. 2020;10(5):e102228.
12. Keera AA, Elnabtity AM. Two-syringe spinal anesthesia technique for caesarean section: a controlled randomized study of a simple way to achieve more satisfactory block and less hypotension. Anesth Essays Res. 2016;10(2):312-318.
13. Badheka JP, Prahaladray J, Patel V, Bhalodia R, Desai PM, Modi MP, et al. Comparison of fractionated dose versus bolus dose injection in spinal anaesthesia for patients undergoing elective caesarean section: a randomised double-blind study. Indian J Anaesth. 2017;61(1):55-60.
14. Patel DD, Patel C. Comparison of fractionated versus bolus dose of hyperbaric bupivacaine (0.5%) in spinal anesthesia for elective caesarean section: a prospective randomized

single-blind clinical trial. J Obstet Anaesth Crit Care. 2023;13(2):187-192.
15. Mishra S, Dubey N, Verma A, Sahu S. Comparison of fractionated dose versus bolus dose of hyperbaric bupivacaine injection in spinal anesthesia: hemodynamic stability in elderly patients undergoing lower limb surgeries. Cureus. 2025;17(7):e88714.