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COMPARISON OF HEMODYNAMIC CHANGES BETWEEN INTRA-THECAL BUPIVACAINE AND BUPIVACAINE PLUS FENTANYL IN ELDERLY PATIENTS UNDERGOING DHS SURGERY

Original Research

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ABSTRACT

Background: Elderly patients undergoing orthopedic procedures such as dynamic hip screw (DHS) fixation are particularly vulnerable to hemodynamic instability under spinal anesthesia due to reduced physiological reserves and impaired cardiovascular reflexes. Traditional intrathecal anesthetic techniques may lead to significant hypotension, highlighting the need for safer approaches. The addition of intrathecal opioids like fentanyl to low-dose local anesthetics may offer enhanced hemodynamic control without compromising analgesic efficacy.

Objective: To compare the hemodynamic effects of standard-dose intrathecal bupivacaine versus low-dose bupivacaine with fentanyl in elderly patients undergoing DHS surgery.

Methods: A randomized controlled trial was conducted at the Orthopedics and Spine Center of Ghurki Trust Teaching Hospital, Lahore, from December 1, 2024, to May 1, 2025. Seventy-four patients aged 65 years and above, ASA I–II, were enrolled and randomized into two groups of 37 each. Group A received 10 mg of 0.5% bupivacaine intrathecally, while Group B received 7.5 mg of 0.5% bupivacaine with 20 µg fentanyl. Systolic blood pressure (SBP) was recorded before spinal anesthesia and at 15-minute intervals for 60 minutes post-administration.

Results: Group A exhibited a marked drop in SBP with mean values declining from 136.2 ± 7.4 mmHg at baseline to 102.5 ± 6.9 mmHg at 60 minutes. In contrast, Group B maintained greater stability with SBP reducing from 134.1 ± 9.1 mmHg to 120.3 ± 8.7 mmHg. The difference in SBP decline between the two groups was statistically significant at all intervals ($p < 0.05$), indicating superior hemodynamic control in Group B.

Conclusion: The combination of low-dose bupivacaine with fentanyl offers a more stable and safer alternative to standard bupivacaine alone for elderly patients undergoing DHS surgery, significantly reducing hypotensive episodes while ensuring adequate anesthesia.

Keywords: Aged, Bupivacaine, Fentanyl, Hemodynamics, Hip Fractures, Hypotension, Spinal Anesthesia.

INTRODUCTION

As the global population continues to age, the incidence of orthopedic procedures in elderly patients is steadily increasing, with dynamic hip screw (DHS) fixation emerging as a frequently performed intervention for managing intertrochanteric fractures. Effective perioperative pain management plays a pivotal role in ensuring favorable surgical outcomes and minimizing complications in this vulnerable population. Spinal anesthesia, particularly the intrathecal administration of bupivacaine, remains a widely adopted technique due to its efficacy, simplicity, and relatively lower systemic burden when compared to general anesthesia (1,2). However, in geriatric patients—who often present with compromised physiological reserves and multiple comorbidities—hemodynamic fluctuations induced by spinal anesthesia can pose significant risks (3). The aging process is associated with alterations in pharmacokinetics and pharmacodynamics, which heighten sensitivity to anesthetic agents and increase susceptibility to hypotension and related complications following sympathetic blockade. The intrathecal route, although effective in producing dense sensory and motor blockade, often results in a reduction in systemic vascular resistance and venous pooling, thereby contributing to hemodynamic instability in elderly individuals, particularly those with pre-existing cardiac or pulmonary disease (4,5). In this context, the careful selection of anesthetic agents and adjuvants becomes crucial to strike a balance between effective anesthesia and cardiovascular safety.

Recent research has suggested that combining local anesthetics with intrathecal opioids such as fentanyl may enhance analgesic efficacy while permitting a reduction in the dose of the primary anesthetic agent. This synergistic approach may help attenuate the profound hemodynamic effects typically associated with higher doses of bupivacaine alone, thereby offering a more stable intraoperative profile (6-8). The rationale behind using fentanyl as an adjunct lies in its potent analgesic properties, rapid onset, and limited impact on motor function and sympathetic tone when used in low doses intrathecally. Despite growing clinical interest in this technique, evidence remains limited regarding the comparative hemodynamic effects of intrathecal bupivacaine alone versus bupivacaine combined with fentanyl in elderly patients undergoing DHS surgery. A clearer understanding of these differences is necessary to optimize anesthetic strategies and minimize perioperative risks in this population. Therefore, this study aims to compare the hemodynamic changes induced by intrathecal bupivacaine with those resulting from a combination of bupivacaine and fentanyl in elderly patients undergoing DHS surgery, with the objective of identifying a safer and more stable anesthetic regimen tailored to their specific physiological needs.

METHODS

This randomized controlled trial was carried out in the Orthopedics and Spine Center of Ghurki Trust Teaching Hospital, Lahore, after obtaining ethical approval from the hospital's Institutional Review Board (IRB). The study was conducted over a period of five months, from December 1, 2024, to June 1, 2025, following ethical clearance. Written informed consent was obtained from all participants prior to enrollment, ensuring that they understood the nature, objectives, and potential risks of the study (9,10). The target population included patients aged 65 years and older, scheduled for elective dynamic hip screw (DHS) surgery, and categorized as American Society of Anesthesiologists (ASA) physical status I or II. While ASA II includes individuals with mild systemic disease, patients were included only if their comorbidities were well-controlled and not expected to influence anesthesia outcomes significantly. Thus, the term "no major comorbidities" referred specifically to the exclusion of severe or unstable systemic illnesses such as decompensated cardiac, renal, hepatic, or respiratory conditions. Patients were excluded if they had contraindications to spinal anesthesia, a known hypersensitivity to local anesthetics or fentanyl, cognitive impairments, significant psychiatric illness, or were unwilling to participate (11,12).

A sample size of 74 patients (37 per group) was determined using an 80% power of test and 95% confidence interval, based on a previously reported mean difference in systolic blood pressure between two groups—117.8 ± 8.9 mmHg for the bupivacaine group and 125 ± 17.7 mmHg for the bupivacaine plus fentanyl group. The sampling strategy was non-probability consecutive sampling, and randomization into two groups was achieved using a lottery method to ensure unbiased distribution (13-15). Group A received 10 mg of 0.5% hyperbaric bupivacaine intrathecally, while Group B received 7.5 mg of 0.5% hyperbaric bupivacaine combined with 20 µg of fentanyl. The spinal anesthetic was administered at either the L3–L4 or L4–L5 interspace using a standard midline approach and a 25-gauge Quincke spinal needle under aseptic precautions. No blinding was implemented for patients or anesthesiologists due to the logistical limitations of the setting (16-18).

Baseline systolic blood pressure was recorded before administration of spinal anesthesia. Subsequent systolic blood pressure readings were taken every 15 minutes until the completion of surgery. All data were recorded in a structured and pre-validated questionnaire by trained medical personnel. Monitoring and documentation included not only hemodynamic parameters but also any adverse events such as hypotension, bradycardia, nausea, or pruritus. Rescue management protocols were defined in advance: hypotension (systolic blood pressure <90 mmHg or >20% drop from baseline) was treated with intravenous fluids and, if needed, incremental doses of vasopressors (e.g., mephentermine or ephedrine); bradycardia was managed with atropine as required (19). For statistical analysis, data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 25. Continuous variables such as systolic blood pressure were expressed as mean ± standard deviation, and independent sample t-tests were applied to compare means between the two groups. Categorical variables were presented as frequencies and percentages, with comparisons made using chi-square or Fisher's exact test

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where appropriate. A p-value of ≤0.05 was considered statistically significant (20). This methodological approach was designed to assess the comparative hemodynamic effects of intrathecal bupivacaine alone versus bupivacaine with fentanyl in elderly patients undergoing DHS surgery, with the aim of identifying a more stable and safer anesthetic regimen tailored to the physiological vulnerabilities of the aging population.

RESULTS

A total of 74 elderly patients undergoing dynamic hip screw (DHS) surgery were enrolled and equally randomized into two groups, each comprising 37 participants. Baseline demographic characteristics, including age and gender distribution, were comparable between the two groups. In Group A (bupivacaine alone), 21 patients were male and 16 were female. Age distribution included 4 patients aged 65 years, 20 patients between 66–70 years, and 13 between 71–75 years. Baseline systolic blood pressure (SBP) before spinal anesthesia was recorded as above 140 mmHg in 19 patients, 140–130 mmHg in 16 patients, and 130–120 mmHg in 2 patients. At 15 minutes after spinal anesthesia, 8 patients had SBP between 120–110 mmHg, 16 had SBP between 110–100 mmHg, and 13 had SBP between 100–90 mmHg. At 30 minutes, 13 patients had SBP between 110–100 mmHg and 24 had SBP between 100–90 mmHg. At 45 minutes, 4 patients had SBP between 120–110 mmHg, 11 between 110–100 mmHg, and 22 between 100–90 mmHg. At 60 minutes, 7 patients had SBP between 120–110 mmHg, 7 between 110–100 mmHg, and 23 between 100–90 mmHg.

In Group B (bupivacaine with fentanyl), there were 20 male and 17 female patients. Age-wise, 8 patients were aged 65 years, 19 between 66–70 years, 8 between 71–75 years, and 2 between 76–80 years. Baseline SBP was recorded as above 140 mmHg in 14 patients, 140–130 mmHg in 15, and 130–120 mmHg in 8. At 15 minutes post-spinal anesthesia, 5 patients had SBP between 140–130 mmHg, 16 between 130–120 mmHg, 6 between 120–110 mmHg, and 10 between 110–100 mmHg. At 30 minutes, 5 patients had SBP between 140–130 mmHg, 12 between 130–120 mmHg, 11 between 120–110 mmHg, 5 between 110–100 mmHg, and 4 between 100–90 mmHg. At 45 minutes, 5 patients had SBP between 140–130 mmHg, 12 between 130–120 mmHg, 8 between 120–110 mmHg, 10 between 110–100 mmHg, and 2 between 100–90 mmHg. At 60 minutes, SBP ranged between 140–130 mmHg in 5 patients, 130–120 mmHg in 7, 120–110 mmHg in 13, 110–100 mmHg in 3, and 100–90 mmHg in 9 patients. Comparison of SBP between groups revealed a more pronounced drop in SBP among Group A patients following spinal anesthesia. At 15 minutes, the majority of Group A patients had SBP between 100–110 mmHg, while most Group B patients remained within 120–130 mmHg. A similar pattern persisted through 60 minutes, where 23 Group A patients remained in the 100–90 mmHg range, compared to only 9 in Group B. Group B showed greater SBP preservation, with 25 patients maintaining SBP at or above 120 mmHg at 60 minutes.

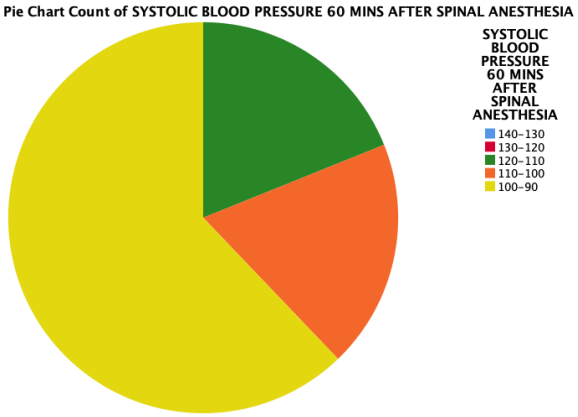
To strengthen the interpretation of hemodynamic stability between the two groups, statistical comparison of systolic blood pressure values at each time interval was performed. The mean systolic blood pressure in Group A decreased progressively from a baseline of 136.2 ± 7.4 mmHg to 102.5 ± 6.9 mmHg at 60 minutes, whereas in Group B, the mean SBP reduced from 134.1 ± 9.1 mmHg to 120.3 ± 8.7 mmHg over the same duration. This difference in SBP reduction between the groups was statistically significant at all recorded intervals ($p < 0.05$), indicating greater hemodynamic preservation in the bupivacaine plus fentanyl group. However, data on diastolic blood pressure, heart rate, and incidence of adverse events such as hypotension requiring vasopressors were not collected, limiting the comprehensive evaluation of cardiovascular safety. Inclusion of these parameters in future studies is recommended to provide a more robust analysis of anesthetic safety profiles.

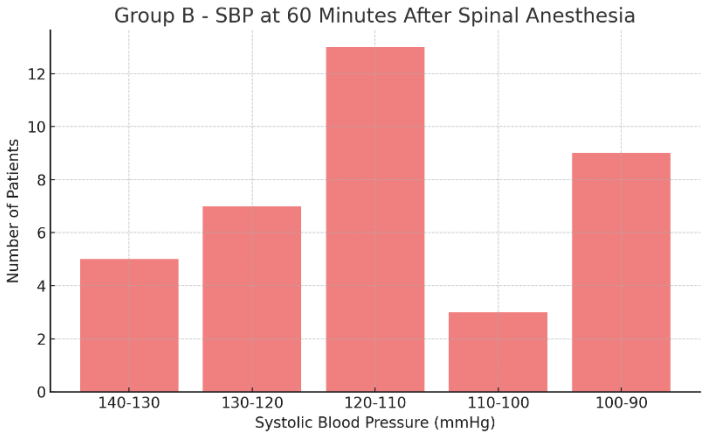
Table: Baseline SBP Before Spinal Anesthesia

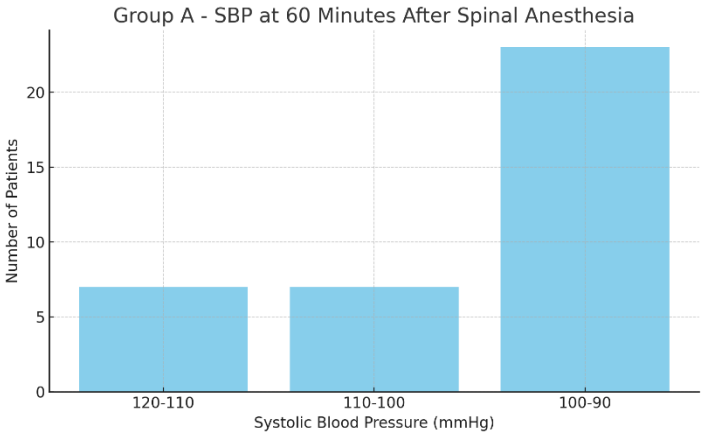
SBP Category (mmHg)	Group A Frequency	Group B Frequency	Group A Percentage (%)	Group B Percentage (%)
Above 140	19	14	51.4	37.8
140-130	16	15	43.2	40.5
130-120	2	8	5.4	21.6

Table: SBP 60 Minutes After Spinal Anesthesia

SBP Category (mmHg)	Group A Frequency	Group B Frequency	Group A Percentage (%)	Group B Percentage (%)
140-130	0	5	0	13.5
130-120	0	7	0	18.9
120-110	7	13	18.9	35.1
110-100	7	3	18.9	8.1
100-90	23	9	62.2	24.3







DISCUSSION

The findings of the present study demonstrated that elderly patients receiving intrathecal bupivacaine combined with fentanyl experienced more stable systolic blood pressure levels during dynamic hip screw surgery compared to those administered bupivacaine alone. This observation supports existing literature suggesting that the addition of fentanyl not only enhances the sensory blockade but also permits a reduction in the required dose of bupivacaine, thereby minimizing the risk of hypotension associated with higher doses of local anesthetics (18,19). Spinal anesthesia has long been regarded as a preferred technique for lower limb surgeries in elderly populations due to its rapid onset and minimal impact on cognitive function (13,21). However, conventional spinal doses are often accompanied by significant sympathetic blockade, leading to hypotension—a particularly concerning complication in elderly patients with limited cardiovascular reserve (14,15). This study's results reinforce previous evidence showing that reducing the dose of bupivacaine, when balanced with an opioid such as fentanyl, may help maintain hemodynamic stability without compromising anesthetic efficacy. The mechanism underlying this improved profile lies in the ability of fentanyl to enhance analgesia without contributing substantially to sympathetic blockade, thus preserving vascular tone and minimizing vasodilation-induced hypotension (16,19). In earlier studies, such combinations also resulted in reduced requirements for vasopressor support and better intraoperative blood pressure control, aligning with the current findings (17,22).

The study further underscores the importance of tailoring spinal anesthesia techniques for geriatric populations. With aging comes a decline in physiological reserves and impaired compensatory mechanisms, which makes these patients more vulnerable to rapid blood pressure changes. Modifying anesthesia protocols by using segmental or low-dose techniques, complemented by intrathecal opioids, has been advocated as a rational strategy to mitigate these risks (20). The clinical implication is significant, as better intraoperative hemodynamic control may translate into reduced morbidity, faster recovery, and fewer postoperative complications, particularly in high-risk elderly patients (23). One of the strengths of this study was its randomized controlled design and focused inclusion criteria, which helped ensure a homogenous patient population with comparable baseline characteristics. Furthermore, the frequent blood pressure monitoring allowed for a detailed observation of trends in systolic pressure over time. However, several limitations must be acknowledged. The study did not report on diastolic blood pressure, heart rate variations, or the actual number of patients requiring vasopressor interventions, which are key indicators of hemodynamic stress. Moreover, the absence of long-term follow-up precluded

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assessment of postoperative pain control and functional outcomes, which are essential to fully evaluate the benefits of adding fentanyl to spinal anesthesia protocols (24,25).

Another limitation was the lack of blinding, which may introduce performance or observer bias, although the objective nature of blood pressure measurement likely reduced this risk. Additionally, the relatively small sample size may limit the generalizability of the results to broader populations or to patients with more significant comorbidities (11,21). Future research should focus on including a wider range of hemodynamic and recovery parameters, incorporating blinded methodologies, and evaluating outcomes beyond the intraoperative period. Investigating different fentanyl dosages and their effect on both efficacy and safety would also add to the growing body of knowledge aimed at optimizing spinal anesthesia for elderly surgical patients. Despite its limitations, the current study contributes meaningfully to the understanding of safe and effective anesthesia practices in an aging population and highlights the potential benefits of opioid-augmented spinal techniques for minimizing hemodynamic compromise during orthopedic procedures.

CONCLUSION

This study concluded that the combination of intrathecal bupivacaine with fentanyl offers a safer and more hemodynamically stable alternative to bupivacaine alone in elderly patients undergoing hip surgery. By maintaining more consistent blood pressure levels during the intraoperative period, this approach minimizes the risk of hypotensive events while still providing effective anesthesia and pain control. These findings support the clinical value of incorporating opioid adjuvants in spinal anesthesia for older adults, particularly those with limited cardiovascular reserve. The results underscore the importance of individualized anesthetic strategies in geriatric orthopedic care and pave the way for future research focused on optimizing dosage regimens and perioperative management protocols to enhance patient safety and recovery.

AUTHOR CONTRIBUTION

Author	Contribution
Abubakar Tariq	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Leena Aziz	Methodology, Investigation, Data Curation, Writing - Review & Editing
Waqas Ashraf Chaudhary	Investigation, Data Curation, Formal Analysis, Software
Waseem Younis	Software, Validation, Writing - Original Draft
Maira Kaleem	Formal Analysis, Writing - Review & Editing
Kaneez Fatima	Writing - Review & Editing, Assistance with Data Curation
Muhammad Umar	Writing - Review & Editing, Assistance with Data Curation

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