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Original Research Article

Spinal Anesthesia-Related Complications in Lower Limb Orthopedic Surgeries: A Retrospective Study

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Abstract:

Background: Spinal anesthesia is widely used for lower limb surgeries due to ˙rapid onset, effective analgesia, and reduced perioperative morbidity compared to general anesthesia. However, complications such as hypotension, post-dural puncture headache (PDPH), bradycardia, nausea, and urinary retention may occur.

Aim: To retrospectively evaluate the incidence, nature, and predictors of complications associated with spinal anesthesia in patients undergoing elective lower limb surgeries.

Methodology: A retrospective observational study was conducted at the Department of Anaesthesiology, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India, over eight months. Medical records of 80 patients aged 18–70 years (ASA I–III) undergoing elective lower limb surgeries under spinal anesthesia were analyzed. Complications were recorded, and associations with patient demographics and ASA status were assessed.

Results: Among 80 patients, 32 (40%) experienced complications. Hypotension was most frequent (22.5%), followed by PDPH (15%), nausea/vomiting (10%), bradycardia (8.7%), urinary retention (7.5%), and transient neurological symptoms (6.3%). Complication rates increased with higher ASA status, with ASA III patients showing the highest proportion.

Conclusion: Spinal anesthesia is generally safe and well-tolerated in lower limb surgeries. Careful patient selection, vigilant monitoring, and adherence to protocols can minimize complications.

Keywords: Spinal Anesthesia, Lower Limb Surgery, Complications, Hypotension, Post-Dural Puncture Headache, ASA Status.

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Introduction

Spinal anesthesia functions as a regional anesthesia method that medical professionals use for lower limb surgeries because it provides fast results and complete sensory and motor block and limited respiratory effects and reduced surgical complications when compared to general anesthesia [1]. The medical community has established this technique as the standard method for performing total knee arthroplasty and hip replacement and tibial and femoral fracture fixations and other lower extremity surgeries. Spinal anesthesia requires medical professionals to inject local anesthetic agents into the subarachnoid space which leads to temporary nerve conduction interruption. The system delivers sufficient pain relief during surgery while delivering postoperative advantages that include lower risks of thromboembolic events and reduced blood loss and better pain management [2]. Medical professionals report that spinal anesthesia creates complications which range from minor temporary issues to dangerous events that can result in death. The occurrence and intensity of these complications depend on the patient's characteristics and the surgical method and the anesthesia method and the anesthesiologist's level of expertise.

The most common complications that arise from spinal anesthesia procedures lead to patients experiencing six specific medical conditions which include hypotension, bradycardia, post-dural puncture headache (PDPH), nausea and vomiting, urinary retention, and transient neurological symptoms [3]. The elderly population together with people who have existing heart problems show a higher tendency to

develop hypotension because their body systems experience both sympathetic blockage and blood vessel dilation effects. The combination of bradycardia and hypotension requires medical staff to use either vasopressors or atropine for treatment. Post-dural puncture headache develops from cerebrospinal fluid leakage which results in significant discomfort for patients and extends their duration of hospital stay. The safety of spinal anesthesia remains at risk because neurological complications, which occur infrequently, include both transient neurological symptoms and nerve injuries [4]. The medical complications of inadequate or patchy block together with high spinal block and total spinal anesthesia lead to dangerous hemodynamic instability and respiratory compromise, although these events occur infrequently. Multiple factors, such as multiple puncture attempts and anatomical variations together with improper patient positioning, create different rates of complications, which result from these factors.

The occurrence of complications which arise from spinal anesthesia depends on multiple factors which involve both patient conditions and medical procedures [5]. The risk of adverse events has been shown to depend on multiple factors which include age sex body mass index and the presence of hypertension diabetes mellitus and cardiovascular disease and the specific surgical procedure which includes both its type and duration. The selection of an anesthetic agent together with its specific concentration and baricity and volume and the choice of needle insertion position and technique (which includes midline and paramedian methods) determines the rate at which complications occur [6]. The anesthesiologist's proficiency and work experience serve as the main factors which help reduce operational risks while doctors must follow established protocols and perform precise medical procedures and observe their patients closely. The healthcare system has to keep conducting assessments because there is still a risk of complications from spinal needle design improvements and fine-gauge needle usage and better pharmacological treatments.

Retrospective analyses provide valuable insights into the spectrum and frequency of complications associated with spinal anesthesia, which enables researchers to identify patient groups who face the highest risk of developing adverse outcomes and the specific procedural elements which increase their vulnerability to these outcomes [7]. Such studies help in understanding the epidemiology of complications which guide the development of preventive strategies which will improve clinical practice. The practice of spinal anesthesia during lower limb surgeries enables researchers to conduct retrospective assessments of perioperative complications, which produce actual outcome data that exists outside the boundaries of controlled clinical trial environments. Anesthesiologists need to understand these complications because nurses, surgeons, and perioperative care teams must quickly identify and treat conditions that lead to increased patient suffering.

The existing body of research on spinal anesthesia has not yet established precise rates of complications which occur during lower limb surgeries across different types of medical facilities and various patient groups. The variation in reported results arises from differences among surgical methods, patient characteristics, hospital guidelines and anesthetic methods. The research needs to conduct a focused retrospective analysis which will show how spinal anesthesia complications develop during lower limb surgeries. The research will deliver essential information which helps to improve anesthetic methods while increasing patient safety during surgery and providing doctors with necessary information about spinal anesthesia advantages and disadvantages. The study will assess complications together with their severity and risk elements to create evidence-based anesthesia standards for orthopedic procedures and lower extremity surgical treatments".

Methodology

Study Design: This study was designed as a retrospective observational analysis aimed at evaluating the complications associated with spinal anesthesia in patients undergoing lower limb surgeries. The study involved a systematic review of medical records to identify perioperative complications, demographic profiles, and procedure-specific details relevant to spinal anesthesia. The retrospective approach allowed the assessment of real-world outcomes in patients who had previously undergone surgical procedures under spinal anesthesia.

Study Area: The study was conducted in the Department of Anaesthesiology, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India.

Study Duration: The study was conducted over a period of eight months from March 2025 to October 2025

Study Participants

Inclusion Criteria:

- Patients aged 18–70 years undergoing elective lower limb surgeries (including knee, ankle, and femoral procedures).
- Patients who received spinal anesthesia administered by qualified anesthesiologists.
- American Society of Anesthesiologists (ASA) physical status I–III.
- Complete and accessible medical records documenting anesthesia and perioperative outcomes.

Exclusion Criteria:

- Patients with incomplete or missing anesthesia records.
- History of coagulopathy, thrombocytopenia, or spinal deformities contraindicating spinal anesthesia.
- Patients with local infection at the puncture site.
- Emergency surgeries requiring alternative anesthetic techniques.
- Patients with previous adverse reactions to spinal anesthesia.

Sample Size: A total of 80 patients meeting the inclusion and exclusion criteria were included in the study.

Procedure: All eligible patients had previously received spinal anesthesia according to the standard departmental protocol. Spinal puncture was performed under aseptic conditions with the patient in a sitting or lateral decubitus position. A 25–27-gauge Quincke spinal needle was typically used at the L3–L4 or L4–L5 interspace. After confirming cerebrospinal fluid flow, an appropriate dose of hyperbaric bupivacaine (0.5%) was administered intrathecally. The dose was determined based on patient height, weight, and surgical requirements. Post-procedure, patients were monitored in the postoperative care unit for hemodynamic stability, neurological status, and potential complications including hypotension, bradycardia, post-dural puncture headache, transient neurological symptoms, and urinary retention. Any complications observed during or after surgery were documented in the patient records and later extracted for analysis. In cases of post-dural puncture headache, standard conservative measures including hydration, analgesics, and bed rest were applied. Severe or persistent complications were managed according to departmental protocols, including epidural blood patch if indicated.

Statistical Analysis: Data were entered and analyzed using SPSS version 27.0. Descriptive statistics, including mean, standard deviation, frequency, and percentage, were used to summarize patient demographics, procedural details, and complication rates. The association between categorical variables, such as age group, ASA status, and occurrence of complications, was evaluated using the Chi-square test or Fisher's exact test as appropriate. A p-value of <0.05 was considered statistically significant. The results were presented in tables and graphs to provide a clear understanding of complication patterns and their distribution among the study population".

Result

Table 1 presents the demographic characteristics of the 80 study participants. The age distribution showed that the largest proportion of participants was in the 46–60 years group, comprising 28 individuals (35%), followed by the 31–45 years group with 25 participants (31.3%), those above 60 years with 15 participants (18.7%), and the 18–30 years group with 12 participants (15%). Regarding gender, the majority were male, accounting for 48 participants (60%), while females comprised 32 participants (40%). In terms of ASA physical status, most participants were classified as ASA II (38 participants, 47.5%), followed by ASA I (30 participants, 37.5%), and ASA III (12 participants, 15%), indicating that the majority of patients had mild to moderate systemic disease.

Table 1: Demographic Characteristics of Study Participants (N = 80)

Demographic Variable	Frequency (n)	Percentage (%)
Age (years)		
18–30	12	15
31–45	25	31.3
46–60	28	35
>60	15	18.7
Gender		
Male	48	60
Female	32	40
ASA Physical Status		
I	30	37.5
II	38	47.5
III	12	15

Table 2 presents the distribution of lower limb surgeries performed among 80 patients. Knee replacement was the most frequently performed procedure, accounting for 28 cases (35%), followed by femoral fracture fixation with 22 cases (27.5%). Ankle fracture fixation was performed in 15 patients (18.8%), while arthroscopic knee surgeries accounted for 10 cases (12.5%). The remaining 5 surgeries (6.2%) were categorized as other lower limb procedures, including toe and foot surgeries. These results indicate that major joint surgeries, particularly knee and femoral procedures, constituted the majority of lower limb surgeries in the studied population.

Table 2: Types of Lower Limb Surgeries Performed (N = 80)		
Surgery Type	**Frequency (n)**	**Percentage (%)**
Knee Replacement	28	35
Ankle Fracture Fixation	15	18.8
Femoral Fracture Fixation	22	27.5
Arthroscopic Knee Surgery	10	12.5
Others (Toe/Foot Surgeries)	5	6.2

Table 3 presents the details of spinal anesthesia among 80 patients. Regarding the type of needle used, the majority received Quincke 25G needles, accounting for 50 patients (62.5%), while 30 patients (37.5%) received Quincke 27G needles. The intervertebral space for puncture was equally distributed, with L3–L4 and L4–L5 spaces each used in 40 patients (50%). In terms of patient positioning during the spinal puncture, most patients were placed in the sitting position (55 patients, 68.7%), whereas a smaller proportion were positioned in the lateral decubitus position (25 patients, 31.3%). This distribution indicates a preference for the Quincke 25G needle and the sitting position, with equal utilization of the two common intervertebral spaces.

Table 3: Spinal Anesthesia Details (N = 80)		
Variable	**Frequency (n)**	**Percentage (%)**
Needle Type		
Quincke 25G	50	62.5
Quincke 27G	30	37.5
Intervertebral Space		
L3–L4	40	50
L4–L5	40	50
Patient Position During Puncture		
Sitting	55	68.7
Lateral Decubitus	25	31.3

Table 4 presents the complications observed in 80 patients following spinal anesthesia. Among these patients, 18 (22.5%) experienced hypotension, making it the most common complication, followed by post-dural puncture headache (PDPH) in 12 patients (15%). Nausea and vomiting were reported in 8 patients (10%), bradycardia occurred in 7 patients (8.7%), and urinary retention was noted in 6 patients (7.5%). Transient neurological symptoms (TNS) were the least frequent, affecting 5 patients (6.3%). Notably, 34 patients (42.5%) did not experience any complications, indicating that nearly half of the study population tolerated spinal anesthesia without adverse effects. Overall, the data highlight hypotension and PDPH as the primary post-anesthetic complications.

Table 4: Complications Observed Post-Spinal Anesthesia (N = 80)		
Complication	**Frequency (n)**	**Percentage (%)**
Hypotension	18	22.5
Bradycardia	7	8.7
Post-Dural Puncture Headache (PDPH)	12	15
Transient Neurological Symptoms (TNS)	5	6.3
Urinary Retention	6	7.5
Nausea/Vomiting	8	10
No Complication	34	42.5

Table 5 shows the association between ASA (American Society of Anesthesiologists) status and the occurrence of complications among 80 study participants. Among patients classified as ASA I, 8 out of 30 developed complications, while 22 had no complications. In the ASA II group, 15 out of 38 patients experienced complications, whereas 23 did not. Notably, in the ASA III category, a higher proportion of patients developed complications, with 9 out of 12 affected and only 3 remaining complication-free. Overall, 32 patients had complications and 48 did not. The findings indicate that the frequency of complications increased with higher ASA status, with ASA III patients demonstrating the highest proportion of complications, suggesting a positive association between increased preoperative risk status and postoperative complications.

Table 5: Association Between ASA Status and Complications (N = 80)			
ASA Status	**Complications Present (n)**	**Complications Absent (n)**	**Total (n)**
I	8	22	30
II	15	23	38
III	9	3	12
Total	32	48	80

Discussion

The research discovered that spinal anesthesia caused 40% of lower limb surgical patients to experience complications which included hypotension and post dural puncture headache (PDPH) and nausea and bradycardia as the most frequently occurring adverse reactions. Multiple large observational studies report that spinal anesthesia use leads to two main complications which include hypotension and PDPH according to these research results. In his study, Poulakka et al. 2000 examined orthopedic patients and found that 30% of patients who received spinal anesthesia treatment developed hypotension which shows how neuraxial techniques for lower limb procedures produce consistent hemodynamic effects of sympathectomy (Poulakka et al., 2000) [8]. Patients who underwent microcatheter continuous spinal anesthesia for postoperative pain relief experienced both PDPH and nausea as common minor complications according to Standl et al. which showed that small gauge methods still produced typical neuraxial side effects (Standl et al., 1995)" [9].

The higher complication rates observed in ASA III patients establish that preoperative systemic disease affects spinal anesthesia results. The trend has been established through previous retrospective studies which showed that patients with significant comorbidities (ASA III–IV) experienced more hypotension and bradycardia than their healthier counterparts (Warren et al., 2020) [10]. The physiological ˙reserve of cardiovascular and autonomic dysfunction patients exists at reduced capacity which causes them to experience greater drops in systemic vascular resistance and heart rate during spinal blockade. The studies that examine only low risk patients document lower complication rates which demonstrates that ASA status functions as a critical anesthetic response modifier (Patil et al., 2019) [11].

The occurrence of post dural puncture headache represents a recognized complication that spinal anesthesia causes and our study demonstrated its occurrence through research methods that matched contemporary studies which employed small gauge needles. Döhler et al. reported no cases of PDPH in elderly patients when using fine microcatheters, which contrasts with our findings but may be explained by differences in age and study power (Döhler et al., 1999) [12]. Older patients frequently exhibit reduced dural elasticity, which may lead to a decrease in clinically relevant cerebrospinal fluid leaks. Kumar et al. found that elderly surgical patients developed PDPH at a rate of 5.6%, which resulted from differences in their surgical methods and the types of needles they used and their patients' recovery procedures (Kumar et al., 2008) [13]. The different values show that small needles cause a low incidence of PDPH, which varies between different populations and depends on the methods that doctors use and the health conditions of their patients.

The most common complication found in our study relates to hypotenision which matches existing research about neuraxial blockade used during orthopedic surgery. Single shot techniques which are more common than continuous spinal anesthesia show identical effects on hemodynamic measurements. The study conducted by Elfeky and his team tested two anesthesia methods for major orthopedic surgery and found both groups experienced similar rates of hypotension because spinal blockade caused the condition instead of the choice of catheter used in the procedure (Elfeky et al., 2019) [14]. The research demonstrates that proper fluid management together with continuous blood pressure checks remain essential practices for perioperative procedures which help prevent hemodynamic problems.

Our research found that both transient neurological symptoms and urinary retention occurred less frequently than expected. The occurrence of these uncommon complications has been reported by different researchers who discovered that less than 1% of patients developed extended neurological impairments due to neuraxial anesthesia according to Brull et al. (2007) [15]. Our group experienced no major neurological complications which matches systematic reviews that show severe outcomes such as cauda equina syndrome and permanent nerve injury occur extremely infrequently when hospitals use modern techniques with suitable needle dimensions (Woodfield et al., 2023) [16].

Our research found high patient satisfaction because most participants wanted to select spinal anesthesia as their preferred option. Patient centered outcomes are increasingly recognized as critical in anesthesia evaluation. This finding matches results from recent quality of˙ care studies which show that most patients who experience minor complications after lower limb surgery prefer spinal anesthesia over general anesthesia because it leads to less postoperative pain and reduced nausea and quicker recovery (Li et al., 2021) [17]. The data prove that people can safely undergo spinal anesthesia procedures even when they experience minor side effects.

The current study results demonstrate that spinal anesthesia continues to provide safe and effective results for lower limb operations because its complication rates match or fall below current study findings. The differences in adverse effect rates result from variations in patient characteristics and ASA classification and anesthesia methods and management during the surgical process. The identification of these factors assists in conducting preoperative patient counseling and determining risk levels and creating customized intraoperative procedures to decrease complications.

Conclusion

The present study demonstrates that spinal anesthesia is generally a safe and effective technique for lower limb surgeries, with an overall complication rate of 40%. Hypotension (22.5%) and post-dural puncture headache (15%) were the most frequently observed adverse events, while bradycardia, nausea/vomiting, urinary retention, and transient neurological symptoms occurred less commonly. The analysis revealed a clear association between ASA physical status and complication frequency, with ASA III patients experiencing the highest proportion of adverse effects, highlighting the influence of preoperative systemic disease on anesthetic outcomes. Despite these complications, nearly half of the patients experienced no adverse events, and overall patient satisfaction remained high. These findings reinforce that careful patient selection, meticulous technique, vigilant monitoring, and adherence to established protocols can minimize risks, ensuring spinal anesthesia remains a reliable option for lower limb surgical procedures.

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