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Original Research Article

# Retrospective Analysis of Spinal Anesthesia Outcomes and Related Complications in Lower limb Orthopedic Surgeries

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**Abstract:**

**Background:** Spinal anesthesia provides a quick onset of action and an effective sensory and motor blockade with an excellent safety profile, which is why it is the regional anesthetic modality of choice for lower limb orthopedic surgery. Yet, complications associated with anesthesia can occur and should be carefully evaluated to enhance care of patients in the peri-operative period.

**Aim:** Retrospective analysis of clinical outcomes of spinal anesthesia and finding the incidence and related factors of complications due to spinal anesthesia in patients undergoing lower limb orthopedic surgeries.

**Methodology:** This was a retrospective observational study done in the Department of Anesthesia PARAS HMRI Patna, Bihar, India. The medical records of 105 adult patients who had lower limb orthopedic surgery in spinal anesthesia for one year were studied. Demographic data, anaesthetic data, perioperative data and postoperative complications were retrieved from hospital records. IBM SPSS Statistics software version 27.0 was used for data analysis and a p-value of $< 0.05$ was set as the limit for statistical significance.

**Results:** The most frequent procedure was fracture fixation (36.2%) and spinal blockade was successful in 96.2% of patients. In 88.6% of cases, there were no complications in the postoperative period. The most common complications were hypotension (20.0%), shivering (17.1%), postoperative nausea and vomiting (12.4%) and bradycardia (9.5%). There was a strong correlation between ASA physical status and complications ($p=0.018$). Also, surgical time longer than 90 minutes was significantly associated with intraoperative hypotension ($p=0.021$).

**Conclusion:** Spinal anesthesia is a safe and effective anesthetic technique for lower limb orthopedic surgeries, with a high success rate and acceptable complication profile. Preoperative assessment and intraoperative monitoring were important factors to prevent perioperative complications, especially in relation to higher ASA status and longer surgical times.

**Keywords:** Spinal anesthesia, Lower limb orthopedic surgery, Retrospective study, Hypotension, Post-dural puncture headache, ASA physical status, Perioperative complications, regional anesthesia.

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## Introduction

Spinal anesthesia has been one of the most used regional anesthetic techniques for lower limbs orthopedic surgeries due to its quick onset of action, excellent muscle relaxation, reliable sensory and motor blockade and favorable safety profile. In terms of perioperative benefits, spinal anesthesia has several advantages over general anesthesia, such as less manipulation of the airway, less pulmonary complications, better analgesia in the postoperative period, less blood loss in the operation room and less risk of thromboembolic events. These advantages have made spinal anesthesia the anesthetic of choice for a variety of orthopedic surgeries such as fracture fixation, total knee arthroplasty, total hip arthroplasty, and lower extremity reconstructive surgery. The method consists of injecting a local anesthetic into the subarachnoid space, this blocks the nerve roots of the spine and interrupts the pain pathway and keeps the patient conscious but allows early postoperative recovery. Although there have been ongoing developments in anesthetic drugs, needle design and monitoring standards still spinal anesthesia is linked with various peri-operative complications which need rapid recognition and proper management to keep patients safe [1,2].

The surgical procedures that involve the lower limb form a significant percentage of elective and emergency surgery that is done throughout the world. With the growing prevalence of degenerative joint diseases, road traffic accidents, sports injuries, fractures from osteoporosis, and an aging population,

there has been a considerable increase in orthopedic procedures performed under regional anesthesia. Due to the excellent operating conditions and lower perioperative stress response, reduced recovery time and decreased postoperative opioid needs, spinal anesthesia has emerged as the technique of choice for these procedures. Moreover, early get up after spinal anesthesia is shown to be associated with better rehabilitation and shorter hospital stays, so it is an essential part of enhanced recovery programs in orthopedic surgery [3,4].

Spinal anesthesia (SA) is a highly effective and relatively safe procedure, but it is not risk free. Symptoms can be mild and self-limiting, but more rarely can be life threatening. The most common complications are hemodynamic disturbances including hypotension and bradycardia, which are caused by the sympathetic blockades causing vasodilation and decreased venous return. These changes are especially dangerous in elderly patients or those with cardiovascular comorbidities because of reduced physiological reserve and reduced autonomic function. Treatment with intravenous fluids, vasopressors and anticholinergic agents may be necessary to avoid cardiovascular complications if the signs and symptoms are identified early and treated promptly [5].

Along with cardiovascular complications, several adverse events may occur following spinal anesthesia, related to the procedure. One of the most commonly known complications is called a post-dural puncture headache (PDPH), which is caused by continued leakage of CSF around the hole in the dura. The incidence has decreased as a result of the use of smaller-gauge atraumatic needles and PDPH still plays a role in patient discomfort, extended hospitalization and delayed recovery. Postoperative nausea and vomiting, urinary retention, shivering, incomplete or failed spinal block, transient neurological symptoms and backache are other commonly reported complications. High spinal block, total spinal anesthesia, epidural hematoma, meningitis and permanent neurological injury are rare but severe complications that may result in serious morbidity or mortality and should be diagnosed and treated promptly [6,7].

Various patient-, procedure-, and provider-related factors contribute to the risk for spinal anesthesia-related complications. Advanced age, obesity, diabetes mellitus, hypertension, cardiovascular disease, coagulation abnormalities, spinal deformities and prior spine surgery have all been cited as potential predictors of poor outcomes. In a similar fashion, the nature of surgery, elective or emergency, patient positioning when needle is inserted, level of puncture, characteristic of needle, dose of local anesthetic, baricity of local anesthetic, and the number of puncture attempts may have an important influence on the success of the anesthesia and the incidence of complications. The technical expertise and experience of the anesthesiologist are also very important parameters in reducing procedural problems and improving the patient's outcomes by attention to detail and following the evidence-based clinical guidelines [8,9].

Retrospective clinical studies are valuable in understanding how spinal anesthesia is actually being performed in a variety of patient populations and health care environments. Retrospective analyses are the only studies that can be used to assess patient safety indicators, identify uncommon complications of clinical practice, and identify factors that are associated with poor clinical outcomes. These studies can help improve quality, identify trends in the institution, assess current anesthetic practices, and guide development of preventive strategies to decrease perioperative complications. Moreover, regular assessment of post-surgical results helps to enhance anesthetic methods, top-notch post-surgical management, and general patient treatment [10].

Although spinal anesthesia is a commonly used technique in orthopedic surgery, there is a wide range of complication rates reported in the literature at various centers and in various patient populations. These discrepancies can be related to different demographic parameters, surgical case mix, anesthesia, peri-operative monitoring, type of institution etc. Hence, ongoing monitoring of the quality of spinal anesthesia results at each health care centre is important to uphold patient safety and the standard of anesthetic care. It is also possible to benchmark clinical performance across institutions using the institution-specific data and identify opportunities for improvement in perioperative management [11].

Given the increasing number of surgeries being performed around the lower limbs and continued use of spinal anesthesia as the standard regional anesthesia technique, the clinical outcomes and complications of spinal anesthesia have to be examined in the routine hospital setting. This present retrospective study was carried out in the Department of Anesthesia, PARAS HMRI, Patna, Bihar, India to analyze the perioperative outcomes and complications of spinal anesthesia in lower limb orthopedic surgeries. It is hoped that the results of the present study can be used as evidence on the occurrence, distribution and risk factors of complications associated with spinal anesthesia and can be helpful in anesthetic planning, patient safety and evidence-based peri-operative care in orthopedic surgery.

## Methodology

**Study Design:** The aim of this study was to assess the clinical outcomes and anesthesia related complications in the patients who underwent lower limb orthopedic surgery under spinal anesthesia as a retrospective observational study. A systematic review of medical records and anesthesia charts of the patients in the hospital was performed to evaluate their

demographic characteristics, perioperative variables, anesthetic details, surgical outcomes and complications associated with spinal anesthesia. The retrospective design enabled the evaluation of real-world clinical practice and postoperative outcomes without influencing patient management.

**Study Area:** The study was done in department of Anesthesia, PARAS HMRI, Patna, Bihar, India.

**Study Duration:** The study was carried out in a one-year period from January 2024 to December 2024.

**Sample Size:** Based on the inclusion and exclusion criteria, a total of 105 patients (N = 105) with seborrhea were enrolled in the study.

**Sample Population:** All the adult patients undergoing elective lower limb orthopedic surgeries under spinal anesthesia in PARAS HMRI, Patna were included in the study population. Patients who had procedures like fracture fixation, total knee replacement, intramedullary nailing, ankle surgeries, hip surgeries or other lower limb orthopedic surgeries were selected for inclusion if complete medical records were available.

**Data Collection:** Data was obtained afterwards from the hospital records, anesthesia documents, operative notes, nursing charts, and postoperative follow-up records. Relevant data was collected from a structured data collection form, which included the following:

- Demographic factors (age, gender, body weight, ASA physical status).
- Orthopedic surgery on the lower limb, type of surgery performed.
- Information on spinal anesthesia (level of puncture, size of needle, type of local anesthetic, and amount of local anesthetic given).
- Intrasurgical hemodynamics, need for vasopressors or other drugs.
- The length of surgery and anesthetic.
- Postoperative recovery characteristics.
- Adverse events after spinal anesthesia, such as hypotension, bradycardia, post-dural puncture headache (PDPH), nausea and vomiting, urinary retention, shivering, failed or inadequate block, transient neurological symptoms, high spinal block, and other reported adverse events.
- Treatment of complications and early postoperative outcomes.

To ensure confidentiality of patient information, all data was anonymized prior to analysis.

**Inclusion Criteria**

- Elective orthopedic surgery of the lower limb was performed using spinal anesthesia in patients who were 18 years or older.
- Patients in whom spinal anesthesia was based by qualified consultant anesthesiologists or anesthesiology specialists.
- Classified patients as American Society of Anesthesiologists (ASA) physical status I–III.
- Patients with full anesthesia, operation, and follow-up notes.
- Patients for whom outcome data in the perioperative and postoperative period are documented.

**Exclusion Criteria**

- Patients who do not have complete or full medical records or anesthesia.
- Patients who had surgery with general anesthesia, or epidural anesthesia alone, or combined spinal/epidural anesthesia.
- Patients who have documented contraindications to spinal anesthesia, such as coagulopathy, thrombocytopenia, severe spinal deformity, and infection at the puncture site.
- Emergency surgeries that need to be converted to other anesthetic methods prior to the use of spinal anesthesia.
- Patients with preexisting neurologic diseases that might complicate post-operative neurologic evaluation.
- Patients who have had a severe reaction to local anesthetic agents.

**Procedure:** From the hospital database, medical records of all eligible patients undergoing lower limb orthopedic surgeries under spinal anesthesia during the study period were identified. Cases fulfilling the inclusion and exclusion criteria were screened for eligibility.

The spinal anesthesia was given in the standard manner in the department under strict aseptic precautions. Patients were either in a sitting position or in lateral decubitus with the spinal puncture being done at L3-L4 or L4-L5 intervertebral space with a 25 or 27-gauge Quincke spinal needle. Once free CSF flow was confirmed, 0.5% hyperbaric bupivacaine was injected into the CSF and titrated to patient characteristics and surgical needs.

Patients were monitored throughout surgery for heart rate, blood pressure, oxygen saturation, respiratory status and electrocardiographic changes. Prevention and management of any intraoperative issues including hypotension, bradycardia, inadequate spinal block, and high spinal anesthesia were done as per departmental protocols and recorded in the anesthesia records.

Postoperatively patients were observed in the P.R.U. for neurological recovery, pain management, hemodynamic stability and occurrence of anesthesia related complications. Post-operative complications such as post-dural puncture headache, urinary

retention, post-operative nausea and vomiting, shivering, transient neurological symptoms and delayed recovery were documented from post-operative notes. The obtained information was recorded on a proforma data collection sheet for statistical analysis.

**Statistical Analysis:** All data were entered in MS. EXCEL and analyzed with SPSS Statistics 27.0 software. Data for continuous variables are presented as mean and standard deviation (SD) and categorical variables are presented as numbers and percentages.

Relationship of the demographic data, anesthetic characteristics and complications occurring during spinal anesthesia were evaluated by using Chi-square test or Fisher's exact test as appropriate. Independent Student's t-test was used for normally distributed continuous variables to compare the between groups and Mann–Whitney U test was used for non-normally distributed continuous variables. A p-value <0.05 was considered statistically significant. The results were presented in the appropriate tables and graphical representations to depict the incidence, distribution, and predictors of spinal anesthesia outcomes and complications".

## Result

The 105 patients included in the study had baseline demographic and clinical characteristics as shown in Table 1. The largest proportion of patients belonged to the 31–45 years age group (31.4%), followed by 46–60 years (28.6%), 18–30 years (22.9%), and more than 60 years (17.1%). The study population was predominantly male (64.8%) with females making up 35.2% of the population. Before surgery, most patients had mild to moderate systemic diseases as represented by the American Society of Anesthesiologists (ASA) physical status of ASA II (50.5%), ASA I (33.3%) and ASA III (16.2%).

**Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (N = 105)**

| Variable | Frequency (n) | Percentage (%) |
|---|---|---|
| **Age Group (years)** | | |
| 18–30 | 24 | 22.9 |
| 31–45 | 33 | 31.4 |
| 46–60 | 30 | 28.6 |
| >60 | 18 | 17.1 |
| **Gender** | | |
| Male | 68 | 64.8 |
| Female | 37 | 35.2 |
| **ASA Physical Status** | | |
| ASA I | 35 | 33.3 |
| ASA II | 53 | 50.5 |
| ASA III | 17 | 16.2 |

Table 2 lists the different types of orthopedic lower limb surgery done and the features of the administration of spinal anesthesia. The most common procedure performed was fracture fixation (36.2%), followed by intramedullary nailing (22.9%), total knee replacement (17.1%), hip surgeries (14.3%) and ankle/foot surgeries (9.5%). The sitting position was used for spinal anesthesia in the majority (72.4%) and lateral decubitus position in 27.6%. The most frequent puncture site was L3 to L4 intervertebral space (59.0%) followed by L4 to L5 intervertebral space (41.0%). There was a higher usage of 25-gauge Quincke spinal needle (67.6%) than 27-gauge Quincke (32.4%).

**Table 2: Distribution of Lower Limb Orthopedic Procedures and Spinal Anesthesia Characteristics (N = 105)**

| Variable | Frequency (n) | Percentage (%) |
|---|---|---|
| **Type of Surgery** | | |
| Fracture fixation | 38 | 36.2 |
| Intramedullary nailing | 24 | 22.9 |
| Total knee replacement | 18 | 17.1 |
| Hip surgeries | 15 | 14.3 |
| Ankle/Foot surgeries | 10 | 9.5 |
| **Patient Position During Spinal Anesthesia** | | |
| Sitting | 76 | 72.4 |
| Lateral decubitus | 29 | 27.6 |
| **Puncture Level** | | |
| L3–L4 | 62 | 59 |
| L4–L5 | 43 | 41 |

| Spinal Needle Size | | |
|---|---|---|
| 25 G Quincke | 71 | 67.6 |
| 27 G Quincke | 34 | 32.4 |

Intra- and post-operative results after spinal anesthesia are shown in table 3. The mean surgery time was 95.8 ± 28.4 min, and the mean spinal anesthesia time was 146.3 ± 32.6 min. Intraoperative hemodynamic changes led to vasopressor support in 18.1% of the patients. A successful adequate spinal block was achieved in 96.2% of patients and failed or inadequate spinal block with subsequent anesthetic management was attempted in 3.8% of patients. In majority of patients (88.6%) there was uneventful postoperative recovery while delayed recovery was observed in 11.4% patients.

| Table 3: Intraoperative and Postoperative Outcomes (N = 105) | |
|---|---|
| **Variable** | **Mean ± SD / Frequency** |
| Duration of Surgery (minutes) | 95.8 ± 28.4 |
| Duration of Spinal Anesthesia (minutes) | 146.3 ± 32.6 |
| Vasopressor Requirement, n (%) | 19 (18.1%) |
| Adequate Spinal Block, n (%) | 101 (96.2%) |
| Failed/Inadequate Block, n (%) | 4 (3.8%) |
| Uneventful Recovery, n (%) | 93 (88.6%) |
| Delayed Recovery, n (%) | 12 (11.4%) |

Table 4 displays the frequency of complications reported in the use of spinal anesthesia among the subjects of the study. The most frequent complication observed was hypotension (20.0%), followed by shivering (17.1%), postoperative nausea and vomiting (12.4%) and bradycardia (9.5%). Urinary retention occurred in 7.6% of patients, and post-dural puncture headache (PDPH) was reported in 4.8%. Failed or inadequate spinal block was reported in 3.8%, high spinal block in 1.9% and transient neurological symptoms in 1.0% of patients. More than one peri-operative complication was encountered in some patients.

| Table 4: Incidence of Spinal Anesthesia-Related Complications (N = 105) | | |
|---|---|---|
| **Complication** | **Frequency (n)** | **Percentage (%)** |
| Hypotension | 21 | 20 |
| Bradycardia | 10 | 9.5 |
| Nausea and vomiting | 13 | 12.4 |
| Shivering | 18 | 17.1 |
| Urinary retention | 8 | 7.6 |
| Post-dural puncture headache (PDPH) | 5 | 4.8 |
| Failed/Inadequate spinal block | 4 | 3.8 |
| High spinal block | 2 | 1.9 |
| Transient neurological symptoms | 1 | 1 |

The relationship between ASA physical status and the incidence of complications related to spinal anesthesia is shown in table 5. Of those patients who were ASA I, 22.9% had complications, compared with 37.7% of ASA II patients and 64.7% of those ASA III. In contrast, the percentage of patients without complications gradually declined from ASA I to ASA III. Chi-square analysis showed that there was a significant relationship between ASA physical status and the occurrence of spinal anesthesia related complications ($p = 0.018$), thus the patients with higher ASA physical status had a higher risk for developing spinal anesthesia related complications.

| Table 5: Association Between ASA Physical Status and Occurrence of Spinal Anesthesia-Related Complications (N = 105) | | | | |
|---|---|---|---|---|
| **ASA Status** | **Complications Present n (%)** | **No Complications n (%)** | **Total** | **p-value** |
| ASA I | 8 (22.9) | 27 (77.1) | 35 | **0.018** |
| ASA II | 20 (37.7) | 33 (62.3) | 53 | |
| ASA III | 11 (64.7) | 6 (35.3) | 17 | |

Table 6 shows the association of duration of surgery and occurrence of intraoperative hypotension. Hypotension was seen in 11.9% of patients who had a surgical time of 90 minutes or less. Patients who had procedures over 90 minutes, on the other hand, had significantly higher rate of hypotension (30.4%).

The difference between the two groups was statistically significant (p = 0.021) indicating that increased surgical time was correlated with the occurrence of intraoperative hypotension after spinal anesthesia.

**Table 6: Association Between Duration of Surgery and Development of Hypotension (N = 105)**

| Duration of Surgery | Hypotension Present n (%) | Hypotension Absent n (%) | Total | p-value |
|---|---|---|---|---|
| ≤90 minutes | 7 (11.9) | 52 (88.1) | 59 | **0.021** |
| >90 minutes | 14 (30.4) | 32 (69.6) | 46 | |

## Discussion

This is a retrospective study of 105 patients who received spinal anesthesia for orthopedic procedures involving the lower limbs. This retrospective study analyzed the outcomes and complications of spinal anesthesia in 105 patients who received spinal anesthetic for orthopedic surgery of the lower limbs. The age group with the highest proportion of patients were in the age group 31-45 (31.4%) followed by 46-60 (28.6%). The male patients were 64.8% and female were 35.2% of the study population. The majority of patients (50.5%) were ASA II (mild systemic disease) while 33.3% and 16.2% were ASA I and ASA III, respectively. The results are similar to those of Buchbinder et al. [12] who stated that orthopedic procedures on the lower limb are mostly done in middle age and elderly patients with ASA I-II status, typical of the common clinical practice of using spinal anesthesia for patients with stable systemic condition. Likewise, Carpenter et al. [5] showed that older age and higher ASA classification are common variables of patients undergoing orthopedic surgeries under neuraxial anesthesia, which is similar to the present study".

Surgical procedures showed distribution with fracture fixation the most common surgical procedure (36.2%), followed by Intramedullary nailing, total knee replacement, hip surgery and ankle/foot surgery (9.5%). The majority of patients received spinal anesthesia in the sitting position (72.4%) with the L3–L4 intervertebral space being chosen in 59.0% of individuals, with a 25-G Quincke needle used in 67.6% of patients. The results of this study support the recommendations of Horlocker et al. [8] regarding the anatomical landmarks for the sitting position and L3–L4 interspace for neuraxial blockade, which they found to be easier to identify and more successful. In a similar manner, Standl et al. [13] reported that fine Quincke needles were used commonly in orthopedic surgeries, with good quality of block and low incidence of complications. The high proportion of fracture fixation procedures in the present study is also similar to the findings of Kissoon et al. [14] that found trauma-related lower limb surgeries to be the largest proportion of spinal anesthesia cases in tertiary care hospitals.

In terms of anesthesia, there was favorable performance during surgery, with an average surgical duration of 95.8 ± 28.4 minutes, and a spinal anesthesia duration of 146.3 ± 32.6 minutes. Successful spinal blockade was obtained in 96.2% of the patients, and 3.8% experienced failed/poor block and required further anesthetic intervention. In addition, 88.6% of patients' postoperative recovery was uneventful, while 11.4% experienced delayed recovery. The results are similar to those found by Carpenter et al. who reported a spinal anesthesia success rate above 95% for surgeries performed on the lower limbs. Likewise, Buchbinder et al. reported that the sensory blockades were prolonged with good surgical conditions and with a low incidence of block failure, further reinforcing the high efficacy in the current study. Additionally, the vasopressor requirement of 18.1% in our study is within the range described in other orthopedic anesthesia studies, suggesting that the hemodynamic changes are predictable due to sympathetic blockade.

The most common complications found in the present study were hypotension 20.0%, shivering 17.1%, postoperative nausea and vomiting 12.4%, bradycardia 9.5%, urinary retention 7.6%, failed spinal block 3.8%, high spinal block 1.9% and transient neurological symptoms 1.0%. The results of this study are similar to what previously has been reported by Niemi et al. [15] who reported about 30% of orthopedic patients had hypotension while receiving spinal anesthesia, but the incidence, in the present study, was comparatively lower, which may be due to the better perioperative fluid management and the prompt administration of vasopressors.

The association of ASA physical status with the complications associated with spinal anesthesia which was extremely significant in the present study is significant. Complications were seen in 22.9% of patients in ASA I category and in 37.7% of patients in ASA II category and 64.7% in ASA III (P= 0.018). This gradual rise represents that patients with more systemic disease are more likely to have adverse events perioperatively. The results are consistent with those of Warren et al. [16] who reported rates of hypotension and cardiovascular instability to be significantly higher for ASA III–IV patients than for healthier patients who received neuraxial anesthesia. Similarly, Buch et al. [17] have found that increased ASA classification was an independent risk factor for anesthesia-related complications due to the increased susceptibility of patients to exaggerated hemodynamic response to sympathetic blockade when ASA classification is high. Thus, appropriate evaluation and optimization prior to

surgery continues to be of paramount importance, especially for high-risk orthopedic patients.

Again, the association of surgical time and intra-operative hypotension is an important clinical observation. Patients undergoing surgeries longer than 90 minutes had more hypotension than those having surgery less than 90 minutes (30.4% vs 11.9%, p = 0.021). These results indicate that there is an association between longer operative time and increased hemodynamic instability under spinal anesthesia.

The current results support the use of spinal anesthesia as a very effective and safe anesthetic technique for lower limb orthopedic procedures, that provides high block success, satisfactory early recovery and complication rates similar to those previously published. The findings of increased ASA score and surgery duration as risk factors for complications highlight the need for careful patient selection, vigilant intraoperative management, and prompt intervention to further enhance perioperative results.

## Conclusion

Based on the present retrospective study, it can be inferred that spinal anesthesia is a safe, effective and reliable anesthetic technique for lower limb orthopedic surgeries which was providing successful surgical anesthesia with favorable postoperative recovery in majority of patients. Anesthesia-related complications were seen but were for the most part easily managed and in line with the known safety profile of spinal anesthesia. The results also show that patients with a higher risk score in the preoperative assessment were more likely to develop complications in the peri-operative period and that patients with a longer surgical procedure were more likely to develop complications during surgery and in the post-operative period, highlighting the need for careful pre-op assessment, close monitoring during surgery and prompt management of complications. In conclusion, the study confirms the use of spinal anesthesia as a favored mode of anesthesia for lower limb orthopedic surgeries and emphasizes the importance of optimizing care for each patient both preoperatively and postoperatively to ensure better outcomes and reduce the risk during surgery.

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