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REVIEW ARTICLE

Complications and Risks of General Versus Regional Anesthesia in Orthopedic Surgeries: A Narrative Review

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Abstract

Orthopedic surgeries, whether major or minor, often require anesthesia to ensure patient comfort, safety, and optimal surgical conditions. The choice between general anesthesia and regional anesthesia remains a critical decision, influenced by the type of surgery, patient characteristics, and surgeon preferences. Both approaches carry unique risks and complications, and a careful understanding of these factors is essential for optimizing patient outcomes. This narrative review aims to compare the complications and risks associated with general anesthesia and regional anesthesia in orthopedic surgeries, with a focus on perioperative management, potential side effects, and long-term recovery outcomes. The anesthetic management of orthopedic surgery is a dynamic and evolving field. There is no one-size-fits-all solution. The choice between general anesthesia and regional anesthesia, or more commonly their combination, must be individualized based on the type of surgery, patient comorbidities, and institutional expertise. Regional anesthesia may be the preferred anesthetic technique in patients at high risk with general anesthesia, such as those with reactions to general anesthesia in the past or with significant cardiopulmonary risk factors.

Keywords Complications, General anesthesia, Orthopedic Surgeries, Regional anesthesia, Risk, Spinal anesthesia

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1 Introduction

Orthopedic surgery is one of the most rapidly growing surgical specialties in the world. The number of orthopedic procedures is projected to increase by 4.9% per year, reaching 28.3 million surgeries by 2022.[1] Orthopedic procedures present unique challenges to the anesthesiologist, including patient factors (extremes of age, high prevalence of cardiopulmonary disease), surgical requirements (patient positioning, tourniquet use, bone cement implantation), and the significant burden of post-operative pain.[2,3] The choice of anesthetic technique is a critical decision that influences not only the intraoperative course but also postoperative recovery, patient satisfaction, and functional outcomes.[4-7]

Anesthesia represents a cornerstone of modern medicine, enabling the performance of complex and life-saving surgical procedures that would otherwise be intolerable. The fundamental goal of any anesthetic technique is to provide a state of controlled, reversible loss of sensation, ensuring patient safety, comfort, and optimal surgical conditions. The two primary modalities for achieving this are general anesthesia (GA) and regional anesthesia (RA).[8] GA induces a reversible state of unconsciousness, analgesia, and muscle relaxation through systemic administration of anesthetic agents. In contrast, RA refers to techniques that provide analgesia and anesthesia to a specific region of the body by targeting peripheral nerves or nerve plexuses, without necessarily affecting consciousness. Common forms of RA include peripheral nerve blocks such as brachial plexus, femoral, and sciatic nerve blocks. Neuraxial anesthesia represents a distinct category of regional techniques that involve the administration of local anesthetics in proximity to the spinal cord. This category includes spinal anesthesia, which involves intrathecal injection into the subarachnoid space, and epidural anesthesia, in which anesthetic agents are delivered into the epidural space.[9,10]

GA and RA are both widely used techniques, but each carries distinct complications and risk profiles. GA leads to a reversible loss of consciousness and sensation, while RA involves injecting local anesthetic into the spinal canal to numb the lower part of the body.[11,12] The choice between GA and RA is a critical perioperative decision, influenced by multiple factors, including the type and duration of surgery, patient comorbidities, institutional resources, and clinician and patient preferences. While both GA and RA are highly effective, they are associated with distinct pathophysiological effects and, consequently, unique spectra of potential complications and risks.[13,14]

GA is commonly employed in orthopedic surgeries, particularly when patient immobility, airway control, or rapid procedural completion is required. In short orthopedic procedures such as pin fixation, closed reduction of fractures, superficial tendon repair, and minor arthroscopic interventions, GA is often induced using short-acting intravenous agents (e.g., propofol) alone or in combination with inhalational anesthetics such as sevoflurane.[4] GA carries systemic implications, including the risk of postoperative nausea and vomiting (PONV), pulmonary complications such as atelectasis and pneumonia, cardiovascular instability, delayed emergence, and rare but serious events like malignant hyperthermia or intraoperative awareness. RA, including techniques such as spinal, epidural, and peripheral nerve blocks, offers a targeted approach to pain management while maintaining patient consciousness.[15] These techniques are particularly beneficial for lower-limb surgeries, such as hip and knee replacements, as well as for upper-extremity procedures. RA blocks nerve conduction in a specific region of the body, providing analgesia and motor blockade while the patient may remain conscious (with sedation) or under a light GA.[16,17] Conversely, RA offers advantages such as superior postoperative analgesia, reduced opioid consumption, and earlier mobilization. Nevertheless, it introduces its own set of potential complications, ranging from common but benign issues like post-dural puncture headache to more serious, albeit rare, neurological injuries, local anesthetic systemic toxicity (LAST), and hematoma formation.[18-20]

The comparative safety of these two anesthetic pillars remains a subject of ongoing research and debate. Some studies have shown that RA may be associated with reduced major morbidity, particularly in specific patient populations like those with significant cardiopulmonary disease or undergoing orthopedic procedures.[21] However, the evidence is not universally conclusive, and the absolute risks are often low and highly dependent on the clinical context and operator skill. Spinal anesthesia is a commonly used anesthetic technique. It is a quick, inexpensive, and effective method for completely impairing sensory and motor function and delivering postoperative analgesia.[22,23]

Therefore, the objective of this narrative review is to synthesize and critically appraise the current body of literature comparing the complications and risks associated with GA and RA. We will provide a comprehensive overview of common and serious adverse events associated with each technique, discuss patient- and surgery-specific factors that modify these risks, and highlight areas where the evidence supports a clear advantage of one modality over the other. By elucidating the comparative risk profiles, this review aims to equip anesthesiologists and surgeons with the knowledge necessary to engage in informed shared decision-making, ultimately optimizing patient outcomes and safety in the perioperative period.

2 Methods

This article is a narrative integrative review designed to synthesize and interpret existing evidence regarding "Complications and risks of GA versus RA in orthopedic surgeries". The integrative narrative approach was selected to accommodate diverse study designs and to provide a comprehensive conceptual understanding of the topic, rather than a quantitative synthesis.

To enhance reproducibility and methodological transparency, explicit inclusion and exclusion criteria were defined as follows. Eligible studies were peer-reviewed articles published in English between 2008 and 2025, including observational studies, clinical trials, and relevant review articles. Studies involving adult patients that compared the risks and complications of GA versus RA in any type of orthopedic surgery were included. We excluded studies conducted in pediatric populations, obstetric or trauma settings, animal studies, case reports, and conference abstracts.

To identify and retrieve published literature that directly or indirectly compares the postoperative complications, side effects, and overall risks associated with GA versus RA, which includes neuraxial (spinal, epidural) and peripheral nerve block techniques. The databases, including PubMed/MEDLINE, Embase (via Ovid), Web of Science, Scopus, and Google, were used for the search of published articles in the English language and the last 10-20 years (2008-2025). The search terms are built around core concepts (including "general anesthesia", "regional anesthesia", "spinal anesthesia", "complications", and "orthopedic surgery") and combined with the Boolean operator "AND". Within each concept, terms are combined with "OR". All retrieved records will be imported into a reference manager (EndNote), and duplicates will be removed.

3 Results and Discussion

GA Complications

GA in orthopedic surgery is linked to a high rate of postoperative complications such as vomiting, shivering, pain, nausea, and changes in vital signs. Vomiting is the most frequent complication after GA in orthopedic surgeries, with rates reported up to 91.8% in some studies.[24] GA is the most commonly used anesthetic technique for major orthopedic surgeries, particularly those involving the spine, pelvis, and large joint replacements. Other common issues include shivering, pain, nausea, tachycardia, and tachypnea, often associated with longer surgeries. Blood pressure changes, though less common (5%), and hypertension are also noted.[4]

RA Complications

RA carries risks like nerve injury, toxicity, infection, hematoma, and cardiovascular disturbances, but generally leads to fewer cardiac and pulmonary complications and shorter hospital stays. Complications can include LAST, infection, hematoma, cardiovascular disturbances, allergies, and, notably, nerve injury.[16,17,20] Serious but rare complications include dural puncture, cardiorespiratory arrest, permanent neurological injury, and even death in extreme cases. Minor complications include failed blocks, paresthesia, and vascular punctures.[25] The incidence of nerve injury is a significant concern, although overall morbidity and mortality are typically lower than with GA.[26,27]

The complications of GA vs. RA

The optimal anesthesia technique for older patients undergoing orthopedic surgery remains controversial. RA has long been associated with better analgesic outcomes than general GA with systemic opioids, but the evidence that RA generates further outcome benefits is less certain.[28-30] Studies that have compared the main complications and outcomes between the two anesthesia techniques are listed below:

- **Airway and Respiratory Complications**

Helwani et al.[31] reported that pulmonary complications were lower in RA than in GA. The results of another study by Chen et al. showed no significant differences between the two techniques in patients undergoing hip fracture surgery for pulmonary embolism or pneumonia.[32] Zhang et al. demonstrated that the older adults undergoing hip fracture surgery in the GA group have a higher rate of pulmonary complications, while the RA group has a higher rate of cardiac complications.[33]

- **Cardiovascular Complications**

Pugely et al. reported that the spinal anesthesia group had a lower rate of superficial wound infections, blood transfusions, and overall complications than the GA group.[34] Another study showed that rates of postoperative cardiovascular events were lower in the RA group after total hip arthroplasty.[31] In a study by Basques et al., stroke and cardiac arrest were greater in GA compared to RA.[35] In Li et al.'s study, GA was associated with higher risks of intraoperative cardiovascular events, respiratory depression, and postoperative complications such as cognitive dysfunction and delirium.[36] The inconsistent results in cardiac events between the two anesthesia methods may be due to the type of surgery, as fractures carry a higher risk of cardiac complications than total hip arthroplasty. Hip fracture surgeries often are done in elderly, frail, multiple comorbidities, acute trauma patients, and are associated with higher

overall cardiovascular risk due to sympathetic activation, inflammation, and fluid shifts. While total hip arthroplasties are often done electively in younger patients, preoperative optimization is better.[37,38]

- **Neurological Complications**

GA carries higher risks for diffuse brain complications like delirium and perioperative stroke, largely due to systemic physiological effects and drug actions.[39] RA carries higher risks for focal neurological complications related to needle placement and local anesthetic pharmacology, such as nerve injury, post-dural puncture headache, and spinal hematoma.[27,40] Seraji et al. reported that spinal anaesthesia provides better operating conditions, better postoperative pain control, and faster postoperative recovery than GA.[41] In a study by Bhushan et al., no significant difference in the incidence of cognitive dysfunction was observed between elderly patients undergoing general or regional anesthesia.[42]

- **Other Complications**

A study by Helwani et al. reported that compared with GA, the RA for total hip arthroplasty was associated with a reduction in deep surgical site infection rates and hospital length of stay.[31] In a study by Matharu et al., RA was associated with shorter length of stay, fewer readmissions, and fewer complications following total hip and total knee replacement compared with GA.[43] The results of another study indicated that GA may be associated with slightly increased preoperative and postoperative room times, postoperative hospital stay, transfusion requirements, and surgical site infection rates in primary unilateral total knee arthroplasty (TKA).[44] In Warren et al.'s study, patients who underwent GA had a greater risk for any complication, major complications, and minor complications compared to RA after total knee and hip arthroplasty.[45] Basques et al. showed that, compared with spinal anesthesia, GA was associated with any adverse event, prolonged postoperative ventilator use, unplanned intubation, any minor adverse event, and blood transfusion in total hip arthroplasty.[35] In a study by Wei et al., it was shown that RA was associated with decreased risk of any complication, perioperative blood transfusion, and extended length of stay compared to GA in Patients Undergoing Revision TKA.[46] Another study reported there was no difference in 30-day minor complications (surgical site infection, pneumonia, urinary tract infection) between neuraxial anesthesia and GA in patients who underwent total joint arthroplasty.[47]

4 Conclusion

Both GA and RA have specific advantages and limitations. GA is generally preferred for more invasive orthopedic procedures or surgeries requiring complete muscle relaxation, whereas RA offers notable benefits such as reduced postoperative pain and faster recovery. Evidence suggests that, compared with GA, RA in orthopedic surgery is associated with lower rates of thromboembolism, reduced blood loss and transfusion requirements, shorter operative time, and fewer superficial wound infections.[34,48,49] In addition, RA has been shown to decrease the incidence of postoperative nausea and delirium.[50,51]

Despite these benefits, the overall complication profiles of GA and RA remain controversial. While GA is more commonly associated with PONV, RA—although generally safer in terms of cardiopulmonary outcomes—carries risks such as nerve injury and LAST. Some studies report no significant difference in complication rates between the two techniques,[52-60] whereas others indicate a higher incidence of complications with RA.[61] Therefore, the risk profile of each anesthetic approach should be carefully evaluated in the context of the patient's medical history and the type of surgery.

In summary, anesthetic management in orthopedic surgery is complex and continually evolving, with no universal approach suitable for all patients. The choice between GA, RA, or their combination should be individualized, taking into account surgical complexity, patient comorbidities, anticipated recovery, and institutional expertise. RA may be preferable in patients at high risk for GA, such as those with prior adverse reactions or significant cardiopulmonary disease, while GA remains essential for certain complex procedures or when regional techniques are contraindicated. A patient-centered, balanced approach to anesthesia selection is crucial for optimizing outcomes and minimizing perioperative risks in orthopedic surgery.

Declarations

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Artificial Intelligence Disclosure

The author confirms that artificial intelligence (AI) tools were used in some sections of this study.

Authors' Contributions

Nazli Karami is the sole author of this article.

Availability of Data and Materials

No data were used in this study.

Conflict of Interest
There is no conflict of inertest.

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