

A Review of the Intrathecal Opioids' Effect on Hemodynamic Changes and Spinal Anesthesia Quality in Femoral Surgeries (Review Article)

Abstract

Intrathecal opioids, such as morphine and fentanyl, are increasingly being used as adjuncts to spinal anesthesia and improve the quality of pain relief during and after surgery. This review investigates the mechanisms, benefits, and side effects of using these opioids, particularly in the context of femoral surgeries. The pharmacokinetics of these agents, including their rapid distribution in cerebrospinal fluid and binding to spinal receptors, contribute to effective pain management but also carry risks such as respiratory depression and urinary retention. Additionally, the impact of hemodynamic changes in femoral surgery is reviewed, emphasizing the importance of carefully adjusting anesthetic regimens and close postoperative monitoring to minimize complications. Evidence suggests that intrathecal opioids may reduce the incidence of postoperative delirium and opioid consumption in elderly patients, although further research is needed to confirm their efficacy in various surgical settings. This review underscores the need for more research into multimodal pain control using intrathecal opioids.

Keywords: Intrathecal opioids, Spinal anesthesia quality, Hemodynamic changes, Femoral surgery.

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Introduction

Since the introduction of intrathecal opioids into clinical practice in the 1970s⁽¹⁾, these drugs have become a popular option for acute pain management in various surgical conditions such as cesarean section or lower limb joint arthroplasty. Intrathecal opioids can be used either in combination with general anesthesia or as an adjunct to spinal anesthetics. Their use is associated with postoperative advantages, including improved spinal anesthesia quality, reduced postoperative analgesic requirements, and facilitated early ambulation after abdominal surgeries⁽²⁾. Intrathecal morphine can maintain analgesic effects for up to 24 hours after administration⁽²⁾. Quick and easy administration method and a low risk of treatment failure are other advantages⁽³⁾. However, there are also side effects⁽⁴⁾.

Two major categories of opioids have been identified: lipophilic molecules (such as fentanyl and sufentanil) and hydrophilic molecules (such as morphine, diamorphine, and hydromorphone)⁽⁵⁾. Opioids like fentanyl and morphine are widely added to intrathecal local anesthetics to enhance and prolong analgesic effects during and after surgery. This combination, by providing deep and sustained analgesia, is recognized as a valuable adjunct in the management of both acute and chronic pain⁽⁶⁾.

In spinal anesthesia, the addition of fentanyl to the local anesthetic bupivacaine significantly increases the duration and quality of analgesia while reducing the required dose of the local anesthetic and improving patient comfort during surgeries such as cesarean sections⁽⁷⁾. Studies have shown that the combination of intrathecal fentanyl with local anesthetics for spinal anesthesia improves intraoperative analgesic quality and extends postoperative analgesia duration without increasing side effects⁽⁸⁾. The use of intrathecal opioids in spinal anesthesia is well-documented in providing effective analgesia, and pain in surgical and non-surgical cases⁽⁹⁾.

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Intrathecal opioids penetrate the spinal cord and bind to specific receptors in the dorsal horn. This process provides targeted analgesia by modulating pain transmission pathways⁽¹⁰⁾. They are absorbed into the plasma via venous uptake, resulting in systemic effects and potential side effects⁽¹¹⁾. The rapid distribution of intrathecal opioids in the cerebrospinal fluid (CSF) is one of the key factors in their analgesic efficacy.

However, administration of these drugs may be associated with side effects that, in some patients and clinical conditions, can hinder the use of this otherwise effective method⁽⁴⁾. They carry the risk of respiratory depression, particularly immediately after administration, due to their spread in the CSF and effect on central respiratory centers⁽¹²⁾. Therefore, close monitoring after injection is mandatory⁽¹³⁾. The pharmacokinetic properties of lipophilic opioids result in their rapid clearance from the intrathecal space. This reduces the incidence of urinary retention, making this category of opioids ideal for outpatient surgeries^(10,14). The risk of nausea and vomiting increases with higher doses of intrathecal opioids, as shown in a study indicating that the occurrence of these side effects is dose-dependent and observed with intrathecal morphine used in cesarean sections⁽¹⁵⁾.

Hemodynamic changes during femoral surgery may be influenced by stabilization of endothelial cells and regulation of platelet aggregation, which are critical in evaluating thromboembolic events and ensuring adequate blood flow⁽¹⁶⁾. Moreover, postoperative complications such as pulmonary issues⁽¹⁷⁾, gastrointestinal disorders⁽¹⁸⁾, and urinary tract problems⁽¹⁹⁾ can affect recovery and treatment outcomes⁽²⁰⁾. It has been shown that the addition of intrathecal opioids to spinal anesthesia increases the duration of anesthesia⁽⁸⁾ and improves analgesia quality during and after surgery. Adding opioids such as fentanyl or sufentanil to local anesthetics like bupivacaine has been shown to enhance both the quality and duration of analgesia. Studies report that intrathecal fentanyl can significantly reduce the required dose of bupivacaine and minimize its side effects⁽²¹⁾.

Additionally, the synergy of low-dose local anesthetics with opioids is associated with improved hemodynamic stability and a reduced incidence of intraoperative hypotension^(22,23). Specifically, the synergistic effect of opioids and local anesthetics not only enhances intraoperative analgesia but also

prolongs postoperative pain relief, resulting in overall improved patient outcomes.

Background on the Use of Intrathecal Opioids and Spinal Anesthesia

Intrathecal opioids are medications administered directly into the spinal canal to provide localized pain relief. Their mechanism of action involves cephalad movement through the cerebrospinal fluid, penetration into the spinal cord, binding to specific opioid receptors, and occasionally diffusion across the dura into the epidural space^(10,24). Different opioids vary in terms of onset time, duration of action, and spread of effect. For instance, lipophilic opioids such as fentanyl and sufentanil have a rapid onset but a shorter duration of action, whereas hydrophilic opioids like morphine have a slower onset and longer duration of effect^(13,14,25).

Patients receiving spinal anesthesia generally experience significantly fewer postoperative complications, including reduced nausea and vomiting, as well as a lower need for antiemetic and analgesic medications^(26,27). Studies have shown that spinal anesthesia may shorten surgical time and improve procedural efficiency⁽²⁸⁾. Additionally, patients typically report lower postoperative pain scores and reduced requirements for analgesics⁽³²⁾. From an economic standpoint, spinal anesthesia is often more cost-effective than general anesthesia, contributing to reduced overall healthcare expenditures^(29,30). Most importantly, spinal anesthesia generally provides better hemodynamic stability, which is especially beneficial for patients with specific cardiovascular conditions⁽³¹⁾.

Previous research has shown that intrathecal morphine use in patients undergoing proximal femoral fracture surgery may be associated with a lower incidence of postoperative delirium. This is likely due to reduced postoperative pain and decreased systemic opioid administration, both of which are recognized contributors to delirium⁽³²⁾.

Hemodynamic Changes During Femoral Surgery

Hemodynamic changes—including hypotension and arrhythmias—are common during surgeries such as cement implantation in total hip arthroplasty, especially in elderly patients with underlying comorbidities. The release of histamine during cementation is one contributing factor to these

changes⁽³³⁾. In procedures such as hemiarthroplasty for pathological femoral fractures, significant intraoperative bleeding can result in hypovolemic shock. Effective management of this complication includes fluid resuscitation and the use of vasopressors⁽³⁴⁾. Additionally, the risk of fat embolism during femoral surgeries—particularly when intramedullary manipulation is involved—can lead to intraoperative cardiovascular instability⁽³⁵⁾. Postoperatively, orthostatic hypotension is common, with marked reductions in blood pressure and cardiac output, observed during the patient's initial mobilization. These hemodynamic changes require close monitoring and management to ensure patient safety during and after femoral surgeries⁽³⁶⁾.

Hemodynamic alterations during femoral surgery can be also influenced by the choice of anesthesia technique, as different anesthetic agents may affect baseline hemodynamics and responses to nociceptive stimuli. Understanding these factors can aid in improving surgical outcome^(37,38).

Maintaining hemodynamic stability throughout surgery is critical for minimizing complications, shortening hospital stays, and improving patient outcomes. Preoperative status, the type of surgical intervention, and postoperative care all play pivotal roles in achieving hemodynamic stability. Special attention should be given to existing comorbidities, the nature and duration of the surgical procedure, hemodynamic and fluid management, nutrition, pain control, and early patient mobilization to ensure stable perioperative hemodynamics⁽³⁹⁻⁴¹⁾.

The Impact of Adding Opioids to Spinal Anesthesia

Intrathecal opioids—particularly morphine—are associated with adverse effects such as urinary retention, which occurs in approximately 20–40% of patients shortly after administration and tends to diminish over time⁽⁴²⁾. The incidence of this complication is higher with intrathecal opioid administration compared to intravenous (IV) or intramuscular (IM) routes⁽⁴³⁾. The mechanism underlying opioid-induced urinary retention involves alterations in parasympathetic nervous system function and central analgesic effects, both of which interfere with normal bladder activity⁽⁴⁴⁾.

The combination of intrathecal opioids with local anesthetics enhances both intraoperative and postoperative analgesia, demonstrating synergistic effects in spinal anesthesia. This combination also

allows for the use of lower doses of local anesthetics, potentially improving hemodynamic stability and reducing the risk of complications such as hypotension⁽²²⁾. However, studies have shown that the addition of intrathecal fentanyl to spinal anesthesia does not significantly improve hemodynamic stability in elderly patients. One study found that combined spinal-epidural anesthesia (CSEA) with intrathecal fentanyl reduced the incidence of hypotension compared to spinal anesthesia alone, but overall hemodynamic outcomes were not significantly improved⁽⁴⁵⁾. Another study reported that intrathecal fentanyl alone does not offer distinct hemodynamic advantages compared to other techniques, such as its combination with bupivacaine⁽⁴⁶⁾.

Nonetheless, the addition of intrathecal opioids to spinal anesthesia provides notable benefits for elderly patients undergoing femoral surgeries, particularly hip fracture procedures. Research indicates that combining low doses of local anesthetics with intrathecal opioids—such as fentanyl or morphine—reduces the need for postoperative systemic opioids. This reduction is attributed to the superior analgesic efficacy of intrathecal opioids, enabling decreased use of systemic medications⁽⁴⁷⁾.

Conclusion

The addition of intrathecal opioids to spinal anesthesia represents a significant advancement in pain management during surgery, particularly in femoral procedures. This review highlights several key findings regarding the use of intrathecal opioids and underscores their role in enhancing the efficacy of analgesia, while also pointing to potential complications—such as respiratory depression and urinary retention—that warrant careful consideration.

Studies have also shown that the addition of intrathecal fentanyl to local anesthetics decreases the intraoperative requirement for supplemental intravenous analgesics and minimizes postoperative opioid consumption. However, they carry significant risks, for respiratory depression and urinary retention. Postoperative respiratory depression is a major concern, as it may lead to serious complications. This risk necessitates close monitoring of patients receiving these agents to ensure timely intervention should adverse effects arise.

Continued investigation in this area will deepen our understanding and application of intrathecal opioids, ultimately improving patient care in surgical settings.

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