



Intrathecal Fentanyl with Hyperbaric Bupivacaine for Spinal Anesthesia in Abdominal Hysterectomy: A Literature Review

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Abstract

Background: Abdominal hysterectomy performed under spinal anesthesia may be accompanied by visceral discomfort when the uterus, broad ligaments, peritoneum, and adjacent pelvic structures are manipulated. Hyperbaric bupivacaine provides reliable somatic anesthesia, but visceral traction can still provoke deep pain, nausea, vomiting, restlessness, and autonomic responses. Intrathecal fentanyl is commonly added to bupivacaine because its high lipid solubility allows rapid spinal opioid action with limited prolongation of motor block. **Aim:** To review the mechanisms, clinical effects, and safety of intrathecal fentanyl added to hyperbaric bupivacaine during abdominal hysterectomy, with particular attention to visceral traction pain, block quality, intraoperative supplementation, postoperative analgesia, and adverse effects. **Methods:** Evidence from randomized clinical trials, systematic reviews, meta-analyses, and relevant mechanistic studies on neuraxial fentanyl, bupivacaine, visceral pain, and gynecological surgery was critically summarized. Greater weight was given to studies involving abdominal hysterectomy or comparable uterine manipulation under neuraxial anesthesia. **Results:** Fentanyl acts mainly at spinal mu-opioid receptors in the substantia gelatinosa, reducing release of excitatory transmitters and dampening nociceptive transmission without intensifying sympathetic or motor blockade to the same degree as increasing the local-anesthetic dose. Added to hyperbaric bupivacaine, it improves intraoperative analgesia, reduces visceral discomfort and rescue analgesic use, and modestly prolongs early postoperative analgesia. Its rapid onset and relatively short neuraxial duration are useful during surgery, while pruritus, nausea, vomiting, and early respiratory depression remain the principal opioid-related concerns. **Conclusion:** Intrathecal fentanyl is a practical and effective adjuvant to hyperbaric bupivacaine for abdominal hysterectomy when improved visceral analgesia is required without marked prolongation of motor recovery. Careful dosing and respiratory observation remain essential.

Keywords: fentanyl, hyperbaric bupivacaine, abdominal hysterectomy, visceral traction reaction, spinal anesthesia



1. Introduction

Abdominal hysterectomy remains an important approach for women in whom vaginal or minimally invasive surgery is not appropriate, particularly when the uterus is markedly enlarged, pelvic adhesions are extensive, or wide exposure is needed. The operation combines an abdominal wall incision with deep pelvic manipulation, traction on the uterus and supporting ligaments, peritoneal handling, and sometimes adhesiolysis around bowel or bladder. This mixture of somatic and visceral stimulation is relevant to anesthetic planning because a spinal block that is fully adequate for the incision may not always suppress discomfort produced by traction on pelvic viscera.^{1,2}

Spinal anesthesia with hyperbaric bupivacaine is attractive for lower abdominal and gynecological surgery because it gives rapid sensory and motor blockade, avoids airway instrumentation, and provides good operating conditions with relatively simple equipment. Its limitation in hysterectomy is not usually failure of cutaneous anesthesia, but incomplete control of visceral nociception as the uterus, broad ligaments, cervix, and peritoneum are pulled or stretched. This may appear as poorly localized lower abdominal pain, pressure, nausea, vomiting, diaphoresis, or restlessness, sometimes with changes in heart rate and arterial pressure.^{3,4}

A common response is to deepen the spinal block by increasing the bupivacaine dose, but this can also increase sympathetic blockade, hypotension, and the duration of motor block. Another approach is to add a small dose of an intrathecal opioid. Fentanyl is especially suited to this role because it is highly lipophilic, reaches spinal opioid receptors quickly, and improves analgesia without materially strengthening motor blockade. The aim of this review is to examine how intrathecal fentanyl complements hyperbaric bupivacaine during abdominal hysterectomy, with focus on visceral traction pain, block quality, analgesic duration, dose selection, adverse effects, and clinical use.^{9,10}

Why Visceral Traction Can Break Through an Apparently Adequate Spinal Block

Visceral pain has a different clinical character from somatic pain. It is commonly diffuse, deep, and difficult to localize, and it is often accompanied by autonomic symptoms rather than a sharply defined painful area. Visceral afferent input is carried largely by small myelinated A δ fibers and unmyelinated C fibers that travel with autonomic pathways. Within the dorsal horn, visceral afferents converge with somatic input, which helps explain referred pain and the poor relationship between the dermatome tested on the skin and the patient's response to traction on an internal organ.^{3,11}

The uterus and adjacent pelvic structures receive complex sympathetic and parasympathetic innervation. Pain from the uterine body and fundus is transmitted mainly with sympathetic pathways toward thoracolumbar segments, while the cervix and lower pelvic structures also communicate through sacral pathways. The visceral peritoneum is relatively insensitive to cutting but responds to distension and traction, while parietal peritoneal stimulation has a stronger somatic component. During hysterectomy, these inputs may occur together, particularly during elevation of the uterus, clamping of supporting ligaments, manipulation of the cervix, and bowel or bladder retraction.^{2,12}

Clinical evidence from neuraxial anesthesia for cesarean delivery shows the same problem in a closely related setting. Visceral pain can occur despite a satisfactory sensory level with bupivacaine, and its incidence changes with local-anesthetic dose and the intensity of uterine manipulation. These observations support the practical point that the height of the cutaneous block should not be treated as the only marker of surgical comfort when the main stimulus is visceral traction.^{5,6}

Uterine exteriorization provides another useful model because it increases stretching of the uterine supports and peritoneum. A systematic review found that exteriorization during cesarean delivery was associated with more intraoperative nausea and vomiting than in situ repair. Although abdominal hysterectomy differs from cesarean delivery, the mechanism is comparable: more traction produces more visceral afferent input and a greater chance of unpleasant autonomic symptoms during neuraxial anesthesia.⁸

Hyperbaric Bupivacaine and the Need for an Adjuvant

Bupivacaine produces spinal anesthesia by blocking voltage-gated sodium channels in spinal nerve roots and preventing propagation of action potentials. In its hyperbaric form, glucose increases solution density relative to cerebrospinal fluid, allowing patient position and spinal anatomy to influence spread. For abdominal hysterectomy, an adequate cephalad sensory level and dense bilateral block are required because both the abdominal incision and pelvic manipulation must be tolerated for the duration of surgery.¹³

Increasing the dose of bupivacaine can improve the density and duration of anesthesia, but the gain is accompanied by greater sympathetic and motor blockade. This is important in middle-aged and older women, in whom a high spinal level may produce marked hypotension. A useful adjuvant should therefore improve nociceptive control without simply reproducing the effects of more local anesthetic. Lipophilic intrathecal opioids meet this requirement because analgesia is enhanced through spinal opioid receptors while motor function and the distribution of local-anesthetic sympathetic block are affected much less.^{9,14}



Meta-analytic evidence supports the general value of this combination. In randomized trials of single-shot spinal anesthesia for non-obstetric surgery, adding an opioid to a local anesthetic improved the duration and quality of analgesia. Fentanyl produced a clinically useful extension of postoperative pain relief and reduced the need for additional analgesia, although pruritus became more frequent. The benefit is therefore not simply a longer spinal block; it is improved sensory analgesia through a second pharmacological pathway.¹⁰

Pharmacology of Intrathecal Fentanyl

Fentanyl is a potent synthetic phenylpiperidine opioid with high affinity for the mu-opioid receptor. Its marked lipid solubility is central to its neuraxial behavior. After intrathecal injection, fentanyl rapidly leaves cerebrospinal fluid and enters the spinal cord and surrounding epidural tissues, while part of the dose is absorbed systemically. This produces a rapid onset and a relatively short spinal residence time compared with hydrophilic morphine, making fentanyl particularly useful when the main target is intraoperative analgesia rather than analgesia lasting well into the following day.^{9,15}

At the dorsal horn, mu-opioid receptor activation reduces nociceptive transmission at both presynaptic and postsynaptic sites. Presynaptic inhibition decreases calcium entry and limits release of excitatory transmitters such as substance P and glutamate. Postsynaptic effects increase potassium conductance and reduce neuronal excitability. These actions are concentrated in regions such as the substantia gelatinosa, where primary nociceptive afferents terminate and where modulation of C-fiber input can directly influence visceral pain transmission.^{15,16}

The pharmacology of fentanyl complements bupivacaine rather than duplicating it. Bupivacaine prevents conduction along nerve roots, whereas fentanyl reduces synaptic processing of nociceptive input after it enters the spinal cord. The combination can therefore improve the quality of anesthesia without requiring a proportional increase in local-anesthetic dose. Because fentanyl does not produce a meaningful motor block by itself, it is also less likely than some non-opioid adjuvants to delay recovery of lower-limb movement.^{9,17}

Clinical Evidence for Fentanyl with Bupivacaine

One of the clearest demonstrations of opioid–local anesthetic synergy came from work in cesarean delivery. Hunt and colleagues showed that small doses of subarachnoid fentanyl added to bupivacaine improved perioperative analgesia, establishing a clinical basis for using a lipophilic opioid to strengthen spinal anesthesia during uterine surgery. Later studies confirmed that fentanyl can reduce intraoperative discomfort and the need for supplemental analgesics without requiring a major increase in bupivacaine dose.¹⁸

Belzarena evaluated intrathecal fentanyl in women undergoing cesarean section and reported dose-related improvement in intraoperative analgesia. The study also showed the trade-off that continues to guide dose selection: larger fentanyl doses improve analgesic conditions but increase opioid-related adverse effects, particularly pruritus. This is relevant to hysterectomy because the ideal intrathecal dose is not the dose that gives the longest possible analgesia, but the dose that controls visceral stimulation while preserving an acceptable recovery profile.¹⁹

Dahlgren and colleagues compared lipophilic intrathecal opioids added to bupivacaine for cesarean section and found that fentanyl improved the quality of spinal anesthesia and early analgesia. The rapid effect of fentanyl is especially useful during procedures in which visceral manipulation starts soon after the spinal injection. Its short cerebrospinal fluid residence also means that late respiratory depression is less typical than with hydrophilic opioids, although early respiratory effects and sedation remain possible and require routine observation.²⁰

Bogra and colleagues demonstrated a synergistic effect between intrathecal fentanyl and bupivacaine in spinal anesthesia for cesarean delivery. Lower doses of bupivacaine combined with fentanyl were able to maintain satisfactory surgical anesthesia while improving hemodynamic stability compared with larger local-anesthetic doses. Although the obstetric population differs from women undergoing hysterectomy, the pharmacological lesson is useful: fentanyl can allow analgesic quality to be improved without depending only on increasing the dose of bupivacaine.²¹

Evidence Specific to Abdominal Hysterectomy

Procedure-specific evidence is more limited than the broader spinal-anesthesia literature, but the available studies are clinically informative. Gautam and colleagues directly compared intrathecal fentanyl 25 µg with dexmedetomidine 10 µg, each added to 15 mg hyperbaric bupivacaine, in women undergoing abdominal hysterectomy. The fentanyl regimen provided effective spinal anesthesia and no patient required conversion to general anesthesia. Visceral pain requiring additional treatment occurred more often with fentanyl than with dexmedetomidine, showing that fentanyl is effective but may provide less prolonged or dense visceral analgesia than an α_2 -adrenergic adjuvant in this setting.²²

That comparison is useful because it places fentanyl in a realistic clinical context rather than against placebo alone. Fentanyl offers a rapid onset, established spinal opioid action, and limited prolongation of motor block, whereas dexmedetomidine tends to produce longer sensory and motor blockade. For abdominal hysterectomy, the choice depends on the expected duration of surgery and the priority given to rapid recovery. Fentanyl may be attractive when good intraoperative analgesia is required but a very prolonged motor block is undesirable.^{22,23}



Recent work in abdominal hysterectomy has also used fentanyl 25 µg with 15 mg hyperbaric bupivacaine as an active spinal regimen. In a randomized study evaluating the addition of intrathecal magnesium sulfate, the fentanyl–bupivacaine control combination produced rapid sensory and motor onset and provided several hours of postoperative analgesia. Addition of magnesium prolonged analgesia further but delayed onset. The findings reinforce the role of fentanyl plus bupivacaine as a practical reference regimen against which newer adjuvant strategies are compared.²⁴

Effect on Visceral Traction Reaction

The value of fentanyl during abdominal hysterectomy is closely related to the way visceral pain is generated. Traction on the uterus and peritoneal structures activates C-fiber and Aδ input that reaches dorsal horn neurons involved in visceral processing. Fentanyl acts at mu-opioid receptors in this same region and reduces synaptic transfer of nociceptive signals. The effect is therefore not simply sedation or reduced anxiety; the drug directly modifies spinal pain transmission at a point where visceral afferent input is processed.^{3,16}

Clinical findings from uterine surgery support this mechanism. Adding intrathecal opioids to bupivacaine during cesarean delivery markedly reduces the need for intraoperative supplemental analgesia, and fentanyl is particularly useful for discomfort generated by uterine manipulation. In hysterectomy, where manipulation may be longer and more forceful, fentanyl cannot be expected to abolish every episode of traction pain, but it provides a rational way to decrease the intensity and frequency of these reactions without increasing the local-anesthetic dose.^{10,18}

Nausea and vomiting during pelvic surgery under spinal anesthesia may arise from several causes, including hypotension, vagal activation, visceral traction, and opioid exposure. This creates an important clinical balance. By reducing painful visceral input, intrathecal fentanyl may decrease traction-related nausea in some patients, but fentanyl itself can also produce nausea and vomiting through opioid mechanisms. Good hemodynamic control and avoidance of excessive systemic opioid supplementation therefore remain important even when fentanyl is included in the spinal mixture.^{6,25}

Dose Selection and Block Characteristics

Intrathecal fentanyl doses between about 10 and 25 µg are commonly used with bupivacaine for surgical spinal anesthesia. Lower doses may be sufficient when the main goal is to improve analgesic quality, while 20–25 µg has often been used when more intense intraoperative stimulation is expected. The dose should be considered together with the amount of bupivacaine, patient age, expected duration of surgery, and the likelihood of difficult pelvic dissection rather than chosen in isolation.^{19,20} Fentanyl generally has little influence on the duration of motor block compared with adjuvants such as dexmedetomidine or clonidine. This can be helpful in recovery pathways where early movement is desired. Sensory analgesia may last longer than motor blockade, which is clinically useful after hysterectomy because pain control can continue while lower-limb motor function begins to recover. The main limitation is that the postoperative analgesic extension is modest compared with hydrophilic intrathecal opioids.^{23,26}

A dose of 25 µg has been used in several lower abdominal and gynecological studies and offers a familiar reference point for abdominal hysterectomy. In the direct hysterectomy comparison by Gautam et al, 25 µg fentanyl was combined with 15 mg hyperbaric bupivacaine. This regimen provided effective anesthesia but shorter analgesia and more frequent need for treatment of visceral pain than 10 µg dexmedetomidine. These findings do not make fentanyl ineffective; they define its clinical profile as a shorter-acting adjuvant with less motor prolongation.²²

Postoperative Analgesia

Fentanyl's high lipid solubility gives rapid onset but also limits the duration of intrathecal analgesia. It is therefore best suited to improving the intraoperative period and the first postoperative hours rather than providing prolonged overnight analgesia. This distinction is important after abdominal hysterectomy because postoperative pain has both somatic and visceral components and may remain substantial after the spinal block regresses. Scheduled non-opioid analgesics and, where appropriate, regional or systemic adjuncts are still required.^{9,27}

Meta-analysis of intrathecal opioids added to local anesthetics found that fentanyl prolonged postoperative analgesia compared with local anesthetic alone, although the extension was much shorter than that produced by hydrophilic morphine. This makes fentanyl useful when rapid recovery and limited late opioid effect are priorities, but it should not be treated as a complete postoperative analgesic plan for open hysterectomy. A multimodal regimen remains necessary once the spinal opioid effect has faded.¹⁰

The short duration can also be viewed as an advantage. Long-lasting neuraxial opioid effects can interfere with respiratory monitoring and may prolong pruritus, urinary retention, or nausea. With fentanyl, these effects are generally concentrated in the early perioperative period. For patients in whom extended neuraxial opioid exposure is undesirable, a fentanyl–bupivacaine spinal followed by planned systemic multimodal analgesia may provide a balanced approach.^{15,27}

Adverse Effects and Safety

Pruritus is the most characteristic adverse effect of intrathecal fentanyl. It is usually facial or truncal, may occur without visible skin changes, and is related to central opioid receptor activation rather than histamine release. Its frequency rises with increasing neuraxial opioid dose. Most cases are mild, but troublesome pruritus can reduce patient satisfaction and occasionally requires treatment with low-dose opioid antagonists or agents such as ondansetron.^{19,28}



Nausea and vomiting require more careful interpretation because the operation itself can provoke these symptoms through traction, hypotension, and vagal responses. Fentanyl may reduce nausea when the main trigger is untreated visceral pain, yet opioid exposure can also promote nausea. The anesthesiologist should therefore correct hypotension, communicate with the surgeon when traction is intense, and avoid assuming that every episode of nausea is a direct drug adverse effect.^{8,25}

Respiratory depression is the adverse event of greatest concern with neuraxial opioids. Fentanyl's lipophilicity limits prolonged rostral cerebrospinal fluid spread, so delayed respiratory depression is less characteristic than with intrathecal morphine. Early hypoventilation or sedation can still occur, especially when intrathecal fentanyl is combined with intravenous opioids, sedatives, obesity, obstructive sleep apnea, or other factors that reduce respiratory reserve. Standard respiratory observation remains necessary even when small intrathecal doses are used.^{9,15}

Urinary retention and sedation may also occur, although urinary catheterization is usually part of abdominal hysterectomy care and may make early urinary effects less clinically visible. Hemodynamic instability is driven mainly by the local-anesthetic sympathetic block rather than fentanyl itself. Compared with $\alpha 2$ -adrenergic adjuvants, fentanyl is less likely to add a direct bradycardic or sympatholytic effect, which may be an advantage in patients with limited tolerance of hypotension.^{9,23}

Fentanyl Compared with Other Intrathecal Adjuvants

Fentanyl and dexmedetomidine improve spinal anesthesia through different mechanisms and produce different recovery patterns. Meta-analysis comparing the two agents has generally found longer sensory block, motor block, and analgesic duration with dexmedetomidine, while fentanyl is associated with a shorter recovery profile and more opioid-related pruritus. This difference matters during hysterectomy: dexmedetomidine may be preferred when prolonged dense blockade is useful, whereas fentanyl may fit better when the operation is expected to be shorter or rapid motor recovery is important.²³

Clonidine also prolongs spinal analgesia but produces more prolonged motor and sympathetic effects than fentanyl. Magnesium sulfate acts through NMDA-related mechanisms and may extend analgesia, but onset can be slower. These comparisons show why fentanyl remains clinically useful despite the availability of newer adjuvants. It has a rapid onset, decades of neuraxial experience, predictable opioid effects, and a limited impact on motor blockade.^{17,24}

Intrathecal morphine provides much longer postoperative analgesia than fentanyl and can be valuable after major abdominal surgery, but its hydrophilic nature causes longer cerebrospinal fluid residence and greater concern for delayed respiratory depression, nausea, pruritus, and urinary retention. Fentanyl therefore occupies a different position: it is primarily an intraoperative spinal adjunct with short early postoperative benefit rather than a long-duration postoperative analgesic.^{9,27}

Practical Perioperative Use

For elective abdominal hysterectomy, fentanyl should be integrated into a complete spinal-anesthetic plan rather than used as the sole answer to visceral pain. The patient should have an adequate bilateral sensory level before incision, and arterial pressure should be maintained close to baseline because hypotension itself contributes to nausea and discomfort. When marked traction begins, communication with the surgeon can be as important as drug therapy; temporary reduction in traction may rapidly improve symptoms while the anesthesiologist evaluates the block.^{4,8}

If visceral pain develops despite fentanyl-containing spinal anesthesia, small titrated doses of intravenous analgesic can be used while avoiding excessive sedation in an awake patient. Recurrent severe pain should prompt reassessment of block adequacy and the expected duration of surgery. Repeated systemic opioid administration simply to continue an inadequate spinal block may remove many of the respiratory and recovery advantages that motivated use of regional anesthesia in the first place.^{9,22}

Postoperative planning should begin before the spinal block regresses. Regular paracetamol and a nonsteroidal anti-inflammatory drug, when not contraindicated, can reduce systemic opioid requirements. Local or regional techniques may be added according to surgical approach and institutional practice. Because fentanyl's neuraxial effect is relatively short, rescue analgesia should be prescribed in advance rather than waiting for severe pain to appear in the recovery area.^{7,27}

Current Evidence Gaps

The major limitation of the evidence is that much of the detailed fentanyl literature comes from cesarean delivery, lower abdominal surgery, and mixed surgical populations rather than abdominal hysterectomy alone. These studies are pharmacologically relevant, especially where uterine manipulation is involved, but differences in age, pregnancy physiology, local-anesthetic dose, surgical duration, and postoperative pain prevent simple transfer of every numerical result to hysterectomy.^{5,18}

Another problem is variation in how visceral pain is measured. Some trials record a visual analog pain score, some use nausea or vomiting as a surrogate for traction intolerance, and others record supplemental opioid requirements. A standardized visceral traction score that separates mild awareness of manipulation from painful traction requiring treatment would make future studies easier to compare. Patient satisfaction and conversion to general anesthesia should also be included because they are clinically meaningful outcomes.²²



Future hysterectomy trials should compare several fentanyl doses with a fixed bupivacaine regimen and should report sensory level, motor recovery, visceral traction score, rescue analgesia, nausea and vomiting, pruritus, hemodynamics, respiratory events, and time to mobilization. Direct comparisons with dexmedetomidine or other adjuvants are useful, but the goal should be to define which patient and which operation benefit most from each regimen rather than searching for one universally superior additive.^{22,23}

Conclusion

Intrathecal fentanyl is a useful adjuvant to hyperbaric bupivacaine for abdominal hysterectomy because it strengthens spinal analgesia through mu-opioid receptor activity without markedly prolonging motor blockade. Its rapid onset is well matched to intraoperative visceral stimulation, and available evidence supports better analgesic quality and less need for supplemental medication than local anesthetic alone. The main limitations are its relatively short postoperative duration and opioid-related effects, particularly pruritus, nausea, and possible early respiratory depression. A dose selected according to bupivacaine amount, patient factors, and expected surgical duration, together with careful hemodynamic and respiratory monitoring, offers the most balanced use of fentanyl in this setting.

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