Cureus
Part of SPRINGER NATURE

Open Access Original Article

Retrospective Comparison of Epidural and Intrathecal Hydromorphone Analgesia for Hysterectomy and Cytoreductive Surgery

Review began 04/01/2026
Review ended 10/11/2026
Published 10/26/2026

© **Copyright** 2026
Kirk et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

DOI: 10.7759/cureus.118631

Laura Kirk [1], Dili Dhanani [2], Madison Blake [1], Johnpaul Pozek [1]

1. Department of Anesthesiology, The University of Kansas Medical Center, Kansas City, USA 2. Pain and Perioperative Medicine, University of Kansas Medical Center Department of Anesthesiology, Kansas City, USA

Corresponding author: Laura Kirk, lkirk2@kumc.edu

Abstract

Introduction

Epidural analgesia is widely used for postoperative analgesia in patients undergoing gynecologic surgeries, but the use of intrathecal hydromorphone has been largely unexplored in this patient population. This retrospective comparative effectiveness study evaluated intrathecal hydromorphone versus thoracic epidural analgesia (TEA) in patients undergoing open gynecologic surgery. The primary endpoints were length of hospital stay, ability to participate in physical therapy, and requirement of fluid boluses to maintain normotension. Secondary endpoints included postoperative pain scores at 12, 24, 48, and 72 hours; opioid consumption (reported in morphine milligram equivalents, or MME) at 24, 48, and 72 hours; and postoperative nausea and vomiting (PONV).

Methods

We analyzed retrospective data after implementing the use of intrathecal hydromorphone in females > 18 years old undergoing hysterectomy and cytoreductive surgery at our institution. We compared these data to a similar cohort that received epidural analgesia.

Results

The intrathecal hydromorphone group had significantly lower pain scores at 12 hours post-surgery compared to the epidural group (mean 3.57 ± 2.43 vs. 5.35 ± 2.92; $p = 0.029$) and a significantly shorter length of hospital stay (mean 60.65 ± 26.83 hours vs. 86.26 ± 39.26 hours; $p = 0.013$). Physical therapy participation and fluid bolus requirements were comparable between groups. Pain scores at 24, 48, and 72 hours, overall opioid consumption, and rates of PONV did not differ significantly between the groups.

Conclusion

Literature on intrathecal opioid use in gynecologic oncologic surgery remains limited, particularly regarding intrathecal hydromorphone. This study demonstrates the feasibility of intrathecal hydromorphone as an analgesic strategy in this population, with associated reductions in length of hospital stay and comparable pain control relative to epidural analgesia. These findings support intrathecal hydromorphone as a promising and feasible alternative to epidural analgesia, warranting further investigation in prospective, randomized controlled trials.

Categories: Obstetrics/Gynecology, Quality Improvement, Anesthesiology
Keywords: epidural, intrathecal hydromorphone, neuraxial anesthesia, postoperative pain control, regional anesthesia

Introduction

Enhanced recovery after surgery (ERAS) pathways are developed by a multidisciplinary team aiming to reduce the patient's surgical stress response, optimize physiologic function, and facilitate recovery. Epidural analgesia is often used as part of a multimodal approach to analgesia in many types of operations, including gynecologic oncology surgeries [1,2]. Epidural analgesia has been associated with delayed mobilization, incomplete achievement of pain control, and increased risk of hypotension leading to iatrogenic hypervolemia or overuse of inotropic agents [3].

Intrathecal opioids have been shown to have similar efficacy to epidural analgesia for multiple types of surgical procedures and conditions. Morphine has been a well-studied opioid for intrathecal use, but the use of intrathecal hydromorphone is growing [4-6]. Given the decreased hydrophilicity and more limited rostral spread of hydromorphone in the cerebrospinal fluid (CSF) compared to morphine, there is a theoretical basis for fewer opioid-related adverse drug events (ORADEs) such as nausea and pruritus, which motivated our

selection of hydromorphone as the intrathecal agent of choice over morphine. Intrathecal hydromorphone has been used successfully in both acute and chronic pain regimens for colorectal, urologic, orthopedic, and obstetric surgeries [7]. It has not been studied extensively in gynecological surgeries [8,9].

Historically, patients undergoing open gynecologic oncologic procedures at our institution received IV opioids and/or thoracic epidural for intraoperative and postoperative analgesia. In performing this study, we hope to add to the evidence supporting the use of intrathecal hydromorphone as an alternative to intrathecal morphine while also demonstrating the utility of intrathecal opioids as an alternative to epidural analgesia. The results of our study may alter how we manage the analgesic regimens of patients undergoing gynecologic oncologic surgeries. The objective of this retrospective comparative effectiveness study was to compare intrathecal hydromorphone with thoracic epidural analgesia in patients undergoing open hysterectomy and cytoreductive surgery. The primary endpoints were length of hospital stay, ability to participate in physical therapy, and requirement of fluid boluses to maintain normotension. Secondary endpoints included postoperative pain scores at 12, 24, 48, and 72 hours; postoperative opioid consumption (converted to morphine milligram equivalents, or MME) at 24, 48, and 72 hours; and postoperative nausea and vomiting (PONV). We hypothesized that intrathecal hydromorphone would result in comparable hospital length of stay and physical therapy participation, with fewer fluid boluses required to maintain normotension postoperatively, compared to epidural analgesia.

Materials And Methods

Acute Pain Service (APS) at our institution manages inpatient epidurals, peripheral nerve catheters, and a variety of other specific acute pain-related modalities. Members of this team observed that many of the epidurals placed for hysterectomies and cytoreductive surgeries were being removed on postoperative day (POD) 1 as patients quickly met criteria for removal or were planning to be discharged. While the specific criteria for epidural removal can vary by patient and anesthesiologist rounding on the APS service, our group's consensus centered around oral intake. We agreed that patients who were tolerating a regular diet and whose pain was controlled by oral pain medications were good candidates for epidural catheter removal. In addition to only having had the epidural in place until POD 1, there were also practical limitations of the effects of the epidural. For example, persistent hypotension or the need to restart home anticoagulation regimens. The idea was brought forth to transition to the use of a pre-operative single-shot intrathecal opioid in lieu of epidural placement. This idea was discussed with our Gynecology Oncology (Gyn/Onc) surgery team by our APS staff, and the new workflow in the ERAS protocol was implemented at our institution beginning January 2021.

At our institution, three standard epidural infusions are available for postoperative analgesia: bupivacaine 0.0625%, bupivacaine 0.125%, and bupivacaine 0.1% with hydromorphone 10 mcg/mL. The choice of solution is determined by the attending anesthesiologist, with most patients initiated on 0.0625% bupivacaine infusion and adjusted as needed based on analgesic response. Epidurals are typically needed for one to two days for these surgeries, so major titrations are uncommon. Patient-controlled epidural analgesia (PCEA) settings can be modified to optimize comfort. Standard parameters are 6 mL/h basal rate, 4 mL demand dose with a 15-minute lockout interval, allowing a maximum delivery of 22 mL/h depending on patient demand. Postoperatively, epidural infusions were monitored by the APS team with assessments at least once daily. Adjustments to the infusion rate, PCEA settings, or solution concentration were made based on patient-reported pain scores and adverse effects, including hypotension and motor blockade.

Patient selection

Patients undergoing open hysterectomy and cytoreductive surgery were included in the study. The intrathecal hydromorphone group included patients who underwent surgeries from January 2021 to June 2021, while the epidural analgesia group included patients from October 2020 to December 2020, just prior to the change in ERAS workflow. Inclusion was limited to female patients >18 years old. Surgeries likely requiring bowel resection and/or the assistance of a second intraoperative service were excluded. Based on this clinical judgment by the Gyn/Onc team, the APS then reviewed the patients' histories with our own criteria for appropriateness of pre-operative neuraxial analgesia. Further exclusion criteria included contraindication to neuraxial intervention, pre-existing chronic pain syndrome, preoperative use of extended-release opioids, preoperative opioid requirement of >50 morphine milliequivalents, diagnosed obstructive sleep apnea (OSA), use of home oxygen, and a STOP-Bang score >5.

Opioid selection and administration

Based on the available data surrounding the efficacy of hydromorphone in the gynecologic oncology population and potential for decreased ORADEs due to its decreased hydrophilicity, our group decided to use hydromorphone as the intrathecal opioid of choice. To implement a uniform approach with our chosen population, the APS team agreed to provide real-time, bedside education to our other anesthesiologist colleagues and patients in the pre-operative setting. Based on the generally accepted morphine-to-hydromorphone potency conversion factor of approximately 10:1.5 and guided by published dosing of intrathecal hydromorphone in the obstetric analgesia literature (which commonly employs doses of 40-80 mcg), we selected 40 mcg as a conservative and appropriate starting dose for intrathecal administration in this population [10,11].

Our institution supplies hydromorphone in aliquots of 2 mg/mL. Therefore, to achieve a volume amenable to intrathecal injection at a dose of 40 mcg, we needed to first dilute 1 mg (1 mL) of hydromorphone in 10 mL normal saline in a sterile fashion. Normal saline was seen as the diluent of choice given its safety profile and comparable osmolarity to CSF [12]. After the first dilution to a 100 mcg/mL concentration, a 1 mL syringe was used to obtain 0.4 mL (40 mcg). Because of this small volume, the 40 mcg was then further diluted in normal saline to a total volume of 1-2 mL in a 3 mL Luer-lock syringe.

Intrathecal injection was performed in the pre-operative area by an anesthesiology resident or attending anesthesiologist. The patient was prepped and draped in a sterile fashion, and after identifying anatomic landmarks, up to 5 mL of 1% lidocaine was used to anesthetize the identified area of insertion. A 3.2 cm introducer needle was used to allow placement of a 25-gauge Pencan® spinal needle (B. Braun Melsungen AG, Melsungen, Germany). Once backflow of CSF was observed, the diluted intrathecal hydromorphone was injected. The introducer and spinal needles were then removed, and the patient underwent general anesthesia.

Data collection

Postoperatively, all patients were admitted to the Med-surg unit and were prescribed respiratory monitoring for 24 hours as well as additional analgesics, antiemetics, and opioid-reversal agents on an as-needed basis. The patients were evaluated on POD 1 to determine adequacy of pain control, requirements of additional pain medications, and ORADEs. Pain scores were recorded by nursing staff using a 0-10 numeric rating scale at four-hour intervals as part of routine clinical care; pain scores at 12, 24, 48, and 72 hours postoperatively were extracted for analysis. Opioid consumption within 24, 48, and 72 hours was collected from the electronic medical record and standardized to MME for comparison between groups. Participation in physical therapy was defined as completion of at least one physical therapy session per POD, as documented in nursing and physical therapy records. Administration of a fluid bolus for hypotension was defined as the administration of 250 mL or more of intravenous crystalloid in response to a systolic blood pressure below 90 mmHg or a decrease greater than 20% from baseline, as documented in the input/output section of the electronic medical record. Adverse effects including nausea, vomiting, and pruritus were extracted from nursing and physician documentation.

The University of Kansas Medical Center Institutional Review Board approved the study (approval no.: STUDY00147167). The requirement for patient informed consent was waived due to the retrospective nature of the study. A waiver is allowed due to consent already given during the study participant's clinical care. This is in alignment with citation 45 CFR 46.104(d)(4)(iii) in the Health and Human Services, as well as in compliance with the Declaration of Helsinki on patient safety and confidentiality. Patient data were collected over a nine-month period from October 2020 to June 2021. The primary endpoints were time to discharge in hours, ability to participate in physical therapy, and requirement of fluid boluses to maintain normotension. Our secondary endpoints were postoperative pain scores at 12, 24, 48, and 72 hours; postoperative opioid use at 24, 48, and 72 hours (Figure *1*); and evidence of nausea/vomiting and/or pruritus.

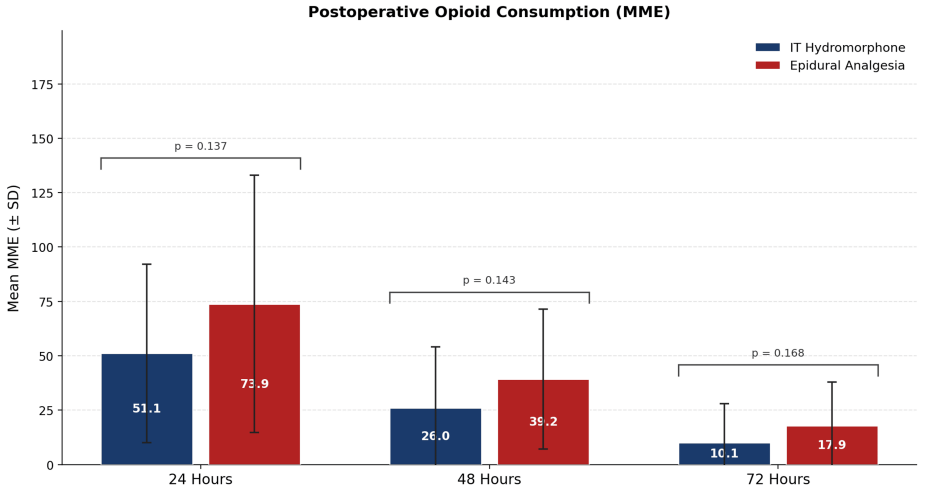


FIGURE 1: Postoperative Opioid Consumption (MME)

Total postoperative opioid consumption, converted to morphine milligram equivalents (MME) using the following factors: fentanyl (mcg) × 0.3, IV hydromorphone (mg) × 20, IV morphine (mg) × 3, and PO oxycodone (mg) × 1.5. Mean MME was lower in the intrathecal hydromorphone group at 24 hours (51.1 ± 41.0 vs. 73.9).

PO: oral; IT: intrathecal

Data analysis

Group means for continuous dependent measures were compared using independent-samples t-tests (two-tailed, unequal variance, $p < 0.05$) between the two groups. MME was calculated using the following conversion factors applied to postoperative opioid administration: fentanyl (mcg) × 0.3, IV hydromorphone (mg) × 20, IV morphine (mg) × 3, and PO oxycodone (mg) × 1.5. Given the exploratory and retrospective nature of this study, formal sample size justification was not performed, and no multivariable adjustment for baseline confounders was conducted; these limitations are addressed in the Strengths and Limitations section. All analyses were conducted using IBM SPSS Statistics for Windows, Version 29 (Released 2022; IBM Corp., Armonk, New York, United States). Data are presented as mean ± SD.

Results

Over the study's course, 23 patients who received intrathecal hydromorphone were compared to 23 patients who received epidural analgesia. Time to discharge was significantly shorter for patients receiving intrathecal hydromorphone (mean = 60.65 ± 26.83 hours) compared to the epidural group (mean = 86.26 ± 39.26 hours) ($t = -2.583$, $p = 0.013$) (Figure 2).

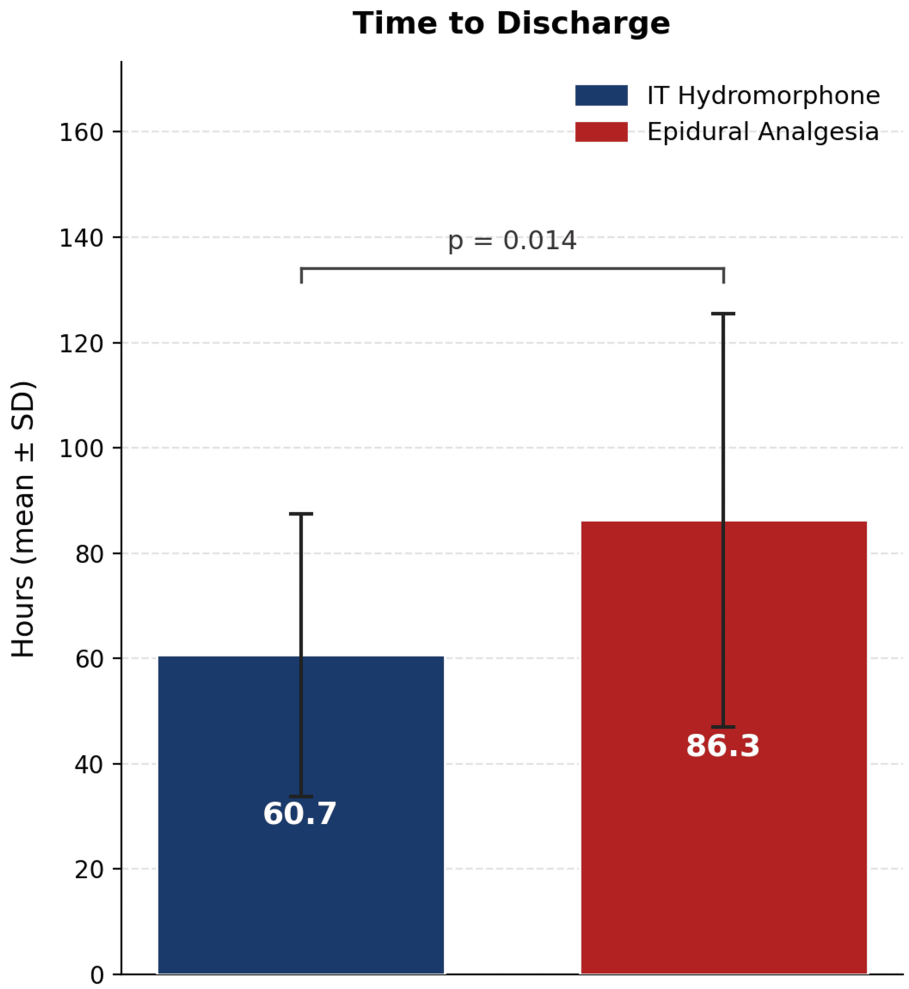


FIGURE 2: Time to Discharge

The length of hospital stay between the two groups was compared. Patients receiving intrathecal hydromorphone were found to have a statistically significantly shorter length of stay than those receiving epidural analgesia ($t = -2.583$, $p = 0.013$).

IT: intrathecal

There was no statistically significant difference in the number of fluid boluses administered for hypotension or in the ability to participate in physical therapy between groups.

Patients receiving intrathecal hydromorphone had significantly lower pain scores at 12 hours post-surgery

(mean = 3.57 ± 2.43) compared to the epidural analgesia group (mean = 5.35 ± 2.92) (t = -2.253, p = 0.029). When comparing the mean pain scores at 24, 48, and 72 hours, the intrathecal hydromorphone group consistently had lower pain scores at each time interval, but it did not reach statistical significance, with p-values of 0.068, 0.47, and 0.21, respectively (Figure *3*).

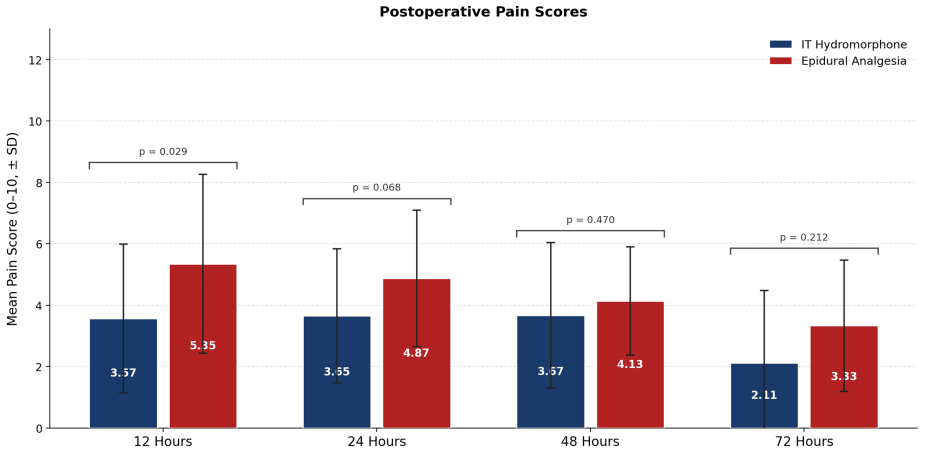


FIGURE 3: Postoperative Pain Scores

Postoperative pain scores at 12, 24, 48, and 72 hours were compared. No significant difference was found between the two groups except at the 12-hour time point.

IT: intrathecal

Postoperative opioid consumption, expressed as MME, was lower in the intrathecal hydromorphone group at all timepoints: 24 hours (mean = 51.1 ± 41.0 vs. 73.9 ± 59.1, t = -1.516, p = 0.138), 48 hours (mean = 26.0 ± 28.1 vs. 39.2 ± 32.1, t = -1.492, p = 0.143), and 72 hours (mean = 10.1 ± 17.9 vs. 17.9 ± 19.9, t = -1.401, p = 0.168); though none of these differences reached statistical significance (Figure *1*). Only two patients in the intrathecal hydromorphone group reported PONV, compared with only one patient in the epidural analgesia group.

Discussion

Principle findings

Dedicated literature on intrathecal hydromorphone for postoperative analgesia in gynecologic oncology remains limited, though the broader landscape of neuraxial opioid analgesia offers a useful framework. Intrathecal morphine is by far the most studied agent in this class and has consistently demonstrated reductions in postoperative pain scores, systemic opioid requirements, and time to recovery across abdominal, orthopedic, and obstetric surgeries [5,13,14]. Interest in intrathecal hydromorphone has grown in part because of its pharmacokinetic advantages: it is more lipophilic than morphine and therefore less prone to cephalad migration within the CSF, which may translate to a lower risk of respiratory depression - one of the most feared complications of intrathecal morphine [4,6,7]. In one of the more rigorous comparisons to date, Sharpe et al. randomized patients undergoing cesarean delivery to receive either intrathecal morphine or intrathecal hydromorphone and found the two drugs to be similar in terms of both pain control and side effect profiles [4]. Charnin et al. retrospectively reviewed a range of intrathecal hydromorphone doses (50-300 mcg) for patients undergoing abdominal surgery and reported acceptable efficacy with an improved safety profile at 50-100 mcg doses (similar to the 40 mcg used in our protocol) [11]. Among the small number of studies specifically in gynecologic patients, Gajarawala et al. found ERAS protocol with intrathecal hydromorphone shortened hospital length of stay, reduced opioid usage with acceptable pain management, in addition to reduced hospital-related costs, when compared to the traditional post-op pain management [8]. Taken together, this literature provides a reasonable evidence base to support further exploration of intrathecal hydromorphone in open gynecologic surgery, which is precisely the gap our study aimed to address.

Results in the context of what is known

The comparison between neuraxial opioids and epidural analgesia has been studied across a range of surgical populations, with results that vary depending on the patient cohort, the specific agents used, and the outcomes analyzed. In the gynecologic oncology setting, Kjølhede et al. conducted an open-label randomized trial and found that intrathecal morphine was associated with shorter hospital stay, reduced opioid consumption, and equally improved quality of life compared to epidural analgesia [15]. Ioffe et al. took a different approach, comparing intrathecal opioid to standard systemic analgesic regimens in

gynecologic oncology surgery, and found reduced intravenous opioid requirements in the first 12 hours postoperatively in the intrathecal opioid group [16]. Additionally, Bucklin et al. performed a meta-analysis comparing epidural analgesia with single-injection intrathecal opioids for labor analgesia and found comparable analgesia between the two groups [17]. Although the laboring patients are different from the post-surgical gynecology oncology cohort, the core principle translates: a single preoperative intrathecal opioid injection can provide analgesia comparable to that of epidural analgesia.

Our findings are congruent with the reported literature. The most striking result was the significantly shorter length of hospital stay in patients who received intrathecal hydromorphone compared to those who had epidural analgesia (60.65 ± 26.83 hours vs. 86.26 ± 39.26 hours; p = 0.013), a difference of more than 24 hours (Figure *2*). We interpret this as likely reflecting the avoidance of epidural-related complications, particularly delayed mobilization, rather than a direct analgesic superiority of intrathecal hydromorphone. Pain scores were lower in the intrathecal hydromorphone group across all measured time points, reaching statistical significance only at 12 hours (3.57 ± 2.43 vs. 5.35 ± 2.92; p = 0.029) (Figure *3*). Postoperative opioid consumption expressed as MME trended lower in the intrathecal group at all time points, though none reached statistical significance at our sample size (Figure *1*). Physical therapy participation, fluid bolus requirements, and rates of PONV were all comparable between groups.

These data suggest that intrathecal hydromorphone may be a feasible alternative to epidural analgesia in this population, with a similar overall analgesic profile, significantly shorter length of hospital stay, and comparable side effects profile. These findings are observational and should not be interpreted as establishing equivalence or superiority between the two analgesic strategies. Future prospective trials with a prespecified non-inferiority margin would be valuable to formally evaluate this question.

Clinical implications

Along with comparable analgesia and side-effect profiles, this study highlighted a statistically significant hospital length of stay of more than 24 hours. This difference has real implications for resource utilization, patient experience, and downstream care. Shorter hospitalizations are associated with lower rates of hospital-acquired complications, reduced cost, and greater patient satisfaction [18-20]. In gynecologic oncology patients specifically, the ability to discharge patients sooner can help them transition rapidly to adjuvant chemotherapy or radiation if needed. These patients can often be on chronic anticoagulation, and a single-injection intrathecal opioid offers the ability to restart patients' anticoagulation regimen relatively earlier without interruption [21].

Research implications

Based on our findings and experiences of our Gyn/Onc surgical team, the Gyn/Onc department has continued to advocate for the use of intrathecal hydromorphone for postoperative pain control in this patient population. With that said, our results should be taken as a starting point, not a conclusion. This study establishes that intrathecal hydromorphone is a feasible alternative, appears safe, and is associated with outcomes at least comparable to epidural analgesia in this patient population. However, given its retrospective design, small sample, and lack of randomization, we cannot establish non-inferiority or causality. A prospective randomized controlled trial with sufficient power, objective measurements of recovery and a formal cost-effectiveness analysis would help establish the utility of using intrathecal hydromorphone for this patient population.

Strengths and limitations

This study has several strengths. It addresses a clinically relevant analgesic question in an understudied gynecologic oncology population and provides a feasible alternative to the more commonly studied postoperative analgesia options. The emphasis on ERAS-relevant outcomes, including length of stay, opioid consumption, physical therapy participation, and hemodynamic stability, further enhances its clinical applicability. Nevertheless, several important limitations must be acknowledged. First, the retrospective, single-center, non-randomized design introduces the possibility of selection bias and confounding. Because cohorts were separated by a protocol change rather than randomized assignment, patient and surgical characteristics not captured in this dataset may have systematically differed between groups and influenced outcomes. Second, the absence of baseline demographic and clinical comparability data and the lack of multivariable confounding adjustment limit the internal validity of the findings. Third, the small sample size (n = 23 per group), due in part to reduced surgical volume during the COVID-19 pandemic, limits statistical power and generalizability. Fourth, the single-institution context and specific exclusion criteria (e.g., OSA, chronic opioid use) further restrict applicability to other settings and patient populations. Finally, no formal sample size justification or non-inferiority framework was pre-specified. For these reasons, the results of this study should be considered hypothesis-generating rather than practice-defining, and a prospective randomized investigation is needed before broader implementation.

Conclusions

Intrathecal hydromorphone can be a viable alternative to epidural analgesia for patients undergoing open gynecologic oncologic surgeries. The interest in intrathecal opioids for postoperative pain control has

expanded in our institution's surgical specialties. Other areas of surgery have begun incorporating it into their multimodal analgesic regimen. We anticipate that with more research into intrathecal hydromorphone as an alternative to morphine or epidural analgesia, we will be better able to highlight the full spectrum of the benefits of intrathecal hydromorphone.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Laura Kirk, Madison Blake, Johnpaul Pozek

Acquisition, analysis, or interpretation of data: Laura Kirk, Johnpaul Pozek, Dili Dhanani

Drafting of the manuscript: Laura Kirk, Johnpaul Pozek

Critical review of the manuscript for important intellectual content: Laura Kirk, Madison Blake, Johnpaul Pozek, Dili Dhanani

Supervision: Laura Kirk

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. The University of Kansas Medical Center Institutional Review Board issued approval STUDY00147167. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

The authors would like to acknowledge Grace Giron, Dr. Angie Ballew, and Dr. Erin Young in the Department of Anesthesiology, the University of Kansas Medical Center, for writing assistance and manuscript preparation.

References

1. Huepenbecker SP, Cusworth SE, Kuroki LM, et al.: Continuous epidural infusion in gynecologic oncology patients undergoing exploratory laparotomy: the new standard for decreased postoperative pain and opioid use. Gynecol Oncol. 2019, 153:356-61. 10.1016/j.ygyno.2019.02.017
2. Helander EM, Webb MP, Bias M, Whang EE, Kaye AD, Urman RD: A comparison of multi-modal analgesic approaches in institutional enhanced recovery after surgery protocols for colorectal surgery: pharmacological agents. J Laparoendosc Adv Surg Tech A. 2017, 27:903-8. 10.1089/lap.2017.0338
3. Zorrilla-Vaca A, Lasala JD, Mena GE: Updates in enhanced recovery pathways for gynecologic surgery . Anesthesiol Clin. 2022, 40:157-74. 10.1016/j.anclin.2021.11.008
4. Sharpe EE, Molitor RJ, Arendt KW, et al.: Intrathecal morphine versus intrathecal hydromorphone for analgesia after cesarean delivery: a randomized clinical trial. Anesthesiology. 2020, 132:1382-91. 10.1097/ALN.0000000000003283
5. Meylan N, Elia N, Lysakowski C, Tramèr MR: Benefit and risk of intrathecal morphine without local anaesthetic in patients undergoing major surgery: meta-analysis of randomized trials. Br J Anaesth. 2009, 102:156-67. 10.1093/bja/aen368
6. Anderson VC, Cooke B, Burchiel KJ: Intrathecal hydromorphone for chronic nonmalignant pain: a retrospective study. Pain Med. 2001, 2:287-97. 10.1046/j.1526-4637.2001.01052.x
7. Felden L, Walter C, Harder S, et al.: Comparative clinical effects of hydromorphone and morphine: a meta-analysis. Br J Anaesth. 2011, 107:319-28. 10.1093/bja/aer232
8. Gajarawala S, Wells A, Watkins E, Rust B, Archambault M: Intrathecal hydromorphone as an analgesia option for gynecology patients. JAAPA. 2020, 33:33-7. 10.1097/01.JAA.0000684128.83801.e6
9. Virlos I, Clements D, Beynon J, Ratnalikar V, Khot U: Short-term outcomes with intrathecal versus epidural analgesia in laparoscopic colorectal surgery. Br J Surg. 2010, 97:1401-6. 10.1002/bjs.7127
10. Rauch E: Intrathecal hydromorphone for postoperative analgesia after cesarean delivery: a retrospective study. AANA J. 2012, 80:25-32.
11. Charnin JE, Weingarten TN, Schroeder DR, Sviggum HP, Portner ER, Nuttall GA: Retrospective review of intrathecal hydromorphone dose range and complications. Pain Physician. 2023, 26:557-65.
12. Shang Y: The pH test paper: a tool for distinguishing between the cerebrospinal fluid and saline . Br J

Anaesth. 2016, 117:
13. González-Santos S, Osorio-López A, Mugabure-Bujedo B, et al.: Intrathecal morphine in major abdominal and thoracic surgery: observational study. Healthcare (Basel). 2025, 13:761. 10.3390/healthcare13070761
14. Gehling M, Tryba M: Risks and side-effects of intrathecal morphine combined with spinal anaesthesia: a meta-analysis. Anaesthesia. 2009, 64:643-51. 10.1111/j.1365-2044.2008.05817.x
15. Kjølhede P, Bergdahl O, Borendal Wodlin N, Nilsson L: Effect of intrathecal morphine and epidural analgesia on postoperative recovery after abdominal surgery for gynecologic malignancy: an open-label randomised trial. BMJ Open. 2019, 9:e024484. 10.1136/bmjopen-2018-024484
16. Ioffe Y, Yao R, Hou E, Wheeler M, Nour M, Wang WY, Hong L: One shot to control pain: decreasing postoperative opioid use in gynecologic oncology patients with intrathecal opioid injection. Gynecol Oncol Rep. 2021, 38:100858. 10.1016/j.gore.2021.100858
17. Bucklin BA, Chestnut DH, Hawkins JL: Intrathecal opioids versus epidural local anesthetics for labor analgesia: a meta-analysis. Reg Anesth Pain Med. 2002, 27:23-30. 10.1053/rapm.2002.29111
18. Nelson G, Bakkum-Gamez J, Kalogera E, et al.: Guidelines for perioperative care in gynecologic/oncology: Enhanced Recovery After Surgery (ERAS) Society recommendations-2019 update. Int J Gynecol Cancer. 2019, 29:651-68. 10.1136/ijgc-2019-000356
19. Kalogera E, Bakkum-Gamez JN, Jankowski CJ, et al.: Enhanced recovery in gynecologic surgery. Obstet Gynecol. 2013, 122:319-28. 10.1097/AOG.0b013e31829aa780
20. Ljungqvist O, Scott M, Fearon KC: Enhanced recovery after surgery: a review. JAMA Surg. 2017, 152:292-8. 10.1001/jamasurg.2016.4952
21. Horlocker TT, Vandermeuelen E, Kopp SL, Gogarten W, Leffert LR, Benzon HT: Regional anesthesia in the patient receiving antithrombotic or thrombolytic therapy: American Society of Regional Anesthesia and Pain Medicine evidence-based guidelines (fourth edition). Reg Anesth Pain Med. 2018, 43:263-309. 10.1097/AAP.0000000000000763