

Retrograde Intrathecal Catheter Placement at L5/S1 for Sacropelvic Cancer Pain: A Pilot Feasibility Study

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Background: Intrathecal drug delivery systems have a role in treating cancer pain. For patients with predominant sacropelvic pain, caudally directed retrograde catheter placement targeting L5/S1 represents an alternative strategy that has been less well described.

Objective: This pilot study evaluated outcomes associated with retrograde intrathecal catheter placement in patients with refractory sacropelvic cancer pain, with a primary focus on systemic opioid reduction and discharge facilitation.

Methods: This pilot retrospective, pre-post cohort study was conducted at two academic medical centers between January 2021 and September 2024. Seven patients with cancer-related sacropelvic pain who received a caudally directed (retrograde) intrathecal catheter with tip positioning at L5/S1 were included. Pre-intervention data, including pain scores and daily oral plus intravenous opioid requirement, were collected and compared (two-tailed paired *t*-test) with post-intervention data. Patients were followed for up to six months.

Results: Systemic (oral plus intravenous) opioid use decreased substantially from a pre-intervention mean of 731.8 ± 515.8 mg oral morphine equivalents (OME) in the 24 hours prior to intrathecal delivery system placement to 195.9 ± 93.4 mg in the 24 hours prior to discharge ($t = 3.112$, $df = 6$, $p = 0.02$), a mean reduction of 535.9 OME (95% CI: 114.46 to 957.25). Mean pain scores showed a modest reduction from 5.94 ± 1.64 to 4.55 ± 1.62 , which, while statistically significant, should be interpreted cautiously given the small sample and absence of a comparator group. All five hospitalized patients were discharged within one week of implantation.

Conclusion: In this small retrospective pilot cohort, retrograde L5/S1 intrathecal catheter placement was associated with substantial systemic opioid reduction and discharge facilitation. Findings are exploratory and hypothesis-generating; prospective comparative studies are needed.

Keywords: cancer pain, intrathecal drug delivery, opioid reduction, pain management, palliative care

Introduction

Background

Adequate control of cancer-related pain remains a persistent challenge, particularly in advanced stages of disease. Over 66% of patients with advanced, metastatic, or terminal disease report experiencing pain.¹ Current guidelines from the World Health Organization and the National Comprehensive Cancer Network recommend a stepwise progression to analgesia, culminating in strong opioids for moderate to severe cancer pain.^{2,3} However, systemic opioid therapy is frequently associated with intolerable side effects, often necessitating changes in treatment.⁴ In the inpatient setting, escalating systemic opioid requirements frequently prolong hospitalization due to inadequate analgesia, opioid-related adverse effects, or difficulty transitioning patients to a sustainable outpatient regimen. The ability to rapidly convert patients from high-dose systemic opioid to intrathecal therapy during an acute admission, thereby facilitating discharge, represents a clinically meaningful systems-level outcome, and one that informed the primary focus of the present study.

Over the past several decades, intrathecal drug delivery systems (IDDSs) have emerged as an effective modality for managing refractory cancer pain.⁵ These systems consist of a subcutaneously implanted pump that stores medication and a catheter that delivers drugs directly into the intrathecal space, typically inserted at the lumbar level and advanced cranially.⁶ This form of drug delivery bypasses the blood-brain barrier and hepatic first-pass metabolism, allowing for lower systemic doses and fewer side effects.⁵ Clinical studies have demonstrated that intrathecal drug delivery can reduce pain scores, systemic opioid use, and cancer-related symptom severity with a favorable safety profile, with the IDDS serving as the conduit that enables this therapy.⁶

Despite their growing use, optimal catheter tip positioning remains debated, and the Polyanalgesic Consensus Conference recommends the use of “clinical judgment” to determine the appropriate position.⁶ Citing the limited longitudinal spread of intrathecal infusions, some advocate for catheter placement at vertebral levels corresponding to the pain distribution.^{6,7} Within this paradigm, the conus medullaris is the traditional target for sacropelvic pain.^{6,7} Placement targeting the lumbosacral region via retrograde, craniocaudal advancement of the catheter is infrequently described in the primary literature as an alternative strategy.⁸

The theoretical advantage of retrograde placement with the tip positioned at L5/S1 lies in permitting higher concentrations of medications near the sacral nerve roots innervating the pelvis and perineum. This concept is supported by a case report by McRoberts et al, in which L5/S1 was targeted with a retrograde intrathecal catheter.⁹ Importantly, the pharmacologic response in that report suggested a differential effect across intrathecal agents: morphine provided little analgesic benefit, whereas clonidine produced substantial analgesia (albeit limited by systemic side effects) and bupivacaine resulted in “100% pain relief” with only localized motor and bladder symptoms.⁹ These observations are consistent with known receptor and target distributions within the cauda equina, which is composed predominantly of nerve roots and contains relatively sparse dorsal horn gray matter where μ -opioid receptors are concentrated. These observations are consistent with known anatomic differences in receptor distribution within the cauda equina, though the mechanistic basis for any differential pharmacologic response at this level remains speculative and cannot be inferred from the available clinical data. A separate correspondence by Urits et al also described using this retrograde low-lumbar technique in a patient with pelvic cancer pain, positioning the catheter at L5–S1 to concentrate hydromorphone and bupivacaine delivery at the symptomatic level.⁸

Although both reports support the feasibility of this approach, no comparative data exist evaluating retrograde L5/S1 placement against conventional conus-level positioning; therefore, based on our clinical experience, we sought to characterize our outcomes with retrograde placement to provide initial groundwork for future comparative studies. From a systems-of-care perspective, the ability to transition patients from high-dose oral and intravenous opioids to intrathecal therapy during an acute hospitalization represents a clinically meaningful outcome, particularly when downstream pain trajectories are confounded by disease progression, hospice transition, or end-of-life care.

Objectives

This study aimed to describe our clinical experience and observed outcomes with retrograde intrathecal catheter placement in patients treated for sacropelvic cancer pain.

Study Design

This pilot retrospective, pre-post cohort study was conducted at two academic medical centers between January 2021 and September 2024. Data collection of predefined outcomes (Subsection 2.3) concluded in May 2025. The Mass General Brigham Institutional Review Board determined the study met criteria for exemption from review.

Methods

Patient Selection

Patients were eligible for inclusion if they had a diagnosis of cancer and underwent retrograde intrathecal catheter placement due to inadequate response to systemic opioids or dose-limiting side effects (Figure 1). Seven patients met these criteria and were included in the analysis. Of the seven patients included, five underwent catheter placement during

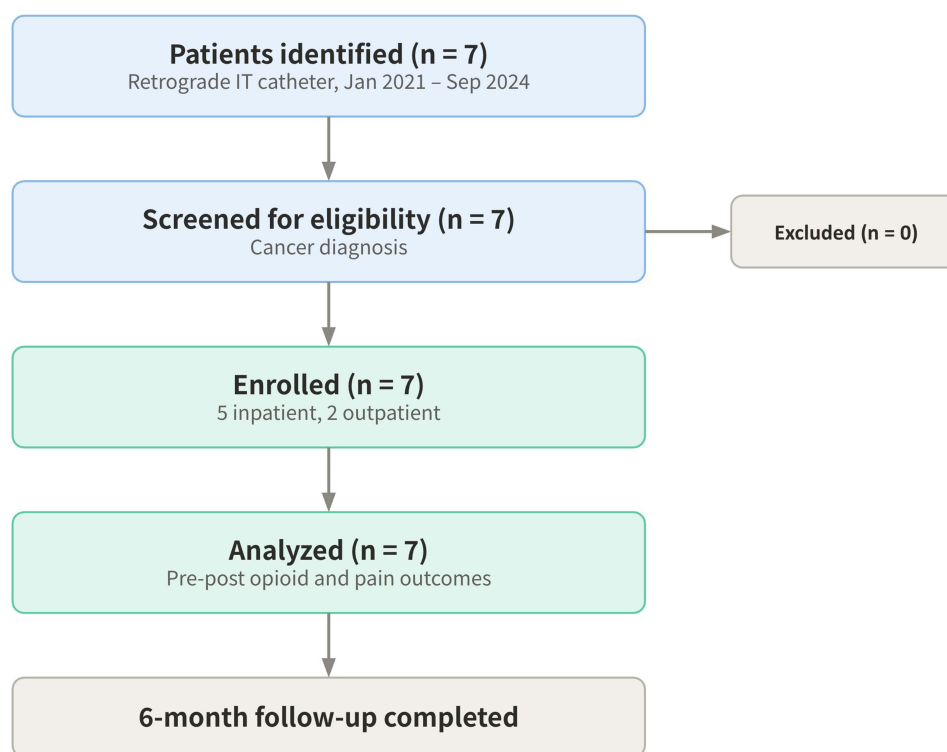


Figure 1 Patient Enrollment and Study Flow Diagram.

an inpatient admission for refractory pain, whereas two patients were referred electively from the outpatient setting and admitted following implantation for observation and intrathecal titration.

This study was reviewed by the Mass General Brigham Institutional Review Board and determined to be exempt human subjects research (protocol number: 2024P002643). The requirement for informed consent was waived due to the retrospective use of de-identified clinical data, and the study was conducted in accordance with the Declaration of Helsinki.

All seven patients were identified from institutional records at Mass General Brigham and are distinct from any previously published case reports or series describing retrograde intrathecal catheter placement, including those by Urits et al^{8,10} and McRoberts et al.⁹

Data Collection

Data was extracted from the electronic medical record. Pre-intervention variables included demographics, cancer diagnosis, prior pain interventions, opioid consumption (in oral morphine equivalents [10], OME) and pain scores measured using the numeric rating scale (NRS). OME and pain scores were averaged in the 24 hours preceding IDDS placement.

Opioid consumption was converted to OME using the standardized equianalgesic calculator published by the UCSF Pain Management Education program.¹⁰ Conversions were performed by James S. Cho and reviewed for consistency by David Hao as part of the data verification process.

Post-intervention (IDDS placement) variables included opioid consumption and NRS pain scores in the 24 hours prior to discharge. For these two variables, this specific post-intervention time point was chosen as data was most consistently collected during this period. Additional data included time from IDDS placement to discharge for all patients, and time from admission to IDDS placement for inpatients. Patients were followed for up to 180 days post-procedure to assess the pain-related hospital readmission across three intervals: 0–30 days, 31–90 days, and 91–180 days.

The primary outcome was the magnitude of oral plus intravenous opioid reduction achieved through conversion to intrathecal therapy. Secondary outcomes included time to discharge, short-term pain score changes, and adverse events. Data collection was performed by James S. Cho and verified by David Hao.

Post-intervention opioid consumption and pain scores were assessed in the 24 hours prior to discharge, as this time point most directly reflects successful conversion from systemic opioids to intrathecal therapy and readiness for transition out of the hospital. For outpatients, these measures reflect early post-implant outcomes during the immediate post-procedure admission.

Statistical Analysis

Paired two-tailed *t*-tests were used to assess whether systemic (oral plus intravenous) opioid consumption and pain scores changed following intervention, with patients serving as their own controls. The alternative hypothesis was that both measures would change post-intervention. Descriptive statistics were used for all other variables. Analyses were conducted using R version 4.4.2, with a statistical significance set at $p < 0.05$.

Results

Patient Characteristics

Seven patients were included (Table 1) with a mean age of 54 years (range 39 to 67, standard deviation = 8.3). Cancer diagnoses included metastatic rectal cancer ($n = 3$), anal cancer ($n = 3$), and cervical cancer ($n = 1$). All seven patients had received prior chemoradiation. Five had undergone prior nerve blocks or neurolytic procedures (eg. ganglion impar block). At the time of the IDDS placement, five patients were hospitalized for refractory pain; two underwent elective procedures and were admitted post-implantation.

Procedural Details

In all patients, catheter insertion was performed via a paramedian approach under fluoroscopic guidance using anteroposterior, contralateral oblique, and lateral views. The needle was directed caudally at an angle targeting a level below the termination of the conus medullaris, and the catheter was threaded in a retrograde (caudad) direction to achieve tip positioning at the L5/S1 interspace (Figures 2 and 3). Implanted pumps were Medtronic SynchroMed II or SynchroMed III devices. Each patient was initiated on an intrathecal admixture of hydromorphone (5 mg/mL), bupivacaine (15 mg/mL), and clonidine (50 mcg/mL), delivered via a basal infusion supplemented by patient-triggered boluses. Titration followed a structured strategy in which patient-triggered bolus utilization over each 24-hour period informed subsequent programming adjustments; a proportion of the total daily patient-triggered bolus consumption was incorporated into the

Table 1 Pre-Intervention Patient Demographics

Patient	Age at Implant	Patient Sex	Prior Radiation	Prior Chemotherapy	Primary Cancer Diagnosis	Previous Nerve Block or Neurolytic Procedure
A	67	Male	Yes	Yes	Rectal cancer, metastatic	No
B	39	Female	Yes	Yes	Cervical cancer, stage IIIB, squamous cell carcinoma	Ganglion impar
C	58	Female	Yes	Yes	Rectal cancer, metastatic	Ganglion impar
D	51	Female	Yes	Yes	Anal cancer, metastatic, squamous cell carcinoma	No
E	60	Female	Yes	Yes	Anal cancer, stage IIIA, squamous cell carcinoma	Ganglion impar
F	49	Male	Yes	Yes	Rectal cancer, metastatic	Ganglion impar
G	53	Male	Yes	Yes	Anal cancer, metastatic	No



Figure 2 Lateral View Demonstrating Intrathecal Catheter Tip at L5/S1 Interspace.

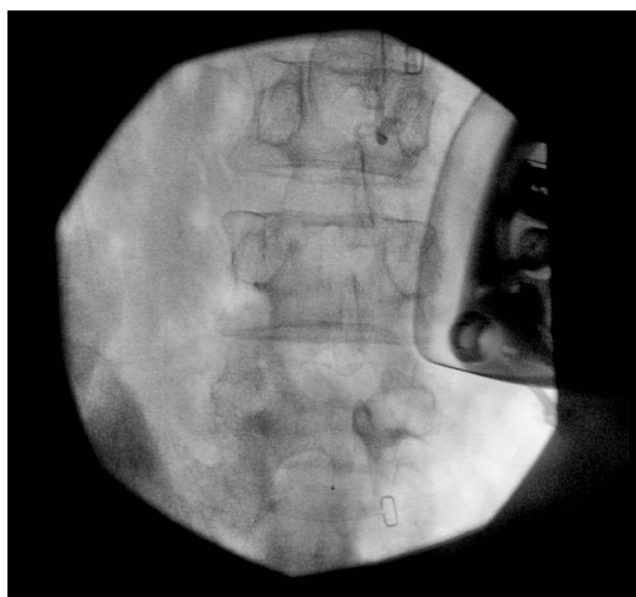


Figure 3 Anteroposterior View Showing Intrathecal Pump and Catheter Tip at L5/S1 Interspace.

basal infusion rate at the next programming visit, allowing for iterative individualization of therapy while preserving patient-directed rescue dosing capacity.

The intrathecal admixture reflects routine institutional practice and was not modified for the purposes of this study. Maintaining a consistent drug regimen across patients allowed the analysis to focus on catheter positioning and observed clinical outcomes rather than pharmacologic comparisons.

Variability in starting and discharge infusion rates across patients (Table 2) reflects individualized clinical decision-making: starting rates were determined by clinician preference, and discharge rates were the result of iterative titration guided by each patient's clinical response to therapy, including patient-triggered bolus utilization patterns and reported pain relief. No standardized dosing protocol was applied.

Table 2 Pre-and-Post Intervention Pain Scores (Numeric Rating Scale) and Oral Morphine Equivalents (OME)

Patient	Baseline Pain Mean	Post-Intervention Pain Mean	Baseline Systemic (Oral + Intravenous) OME	Post-Intervention Systemic OME	Starting Intrathecal Infusion Rate (per Day)	Discharge Intrathecal Infusion Rate (per Day)
A	2.88	2.27	303	84	1 mg Hydromorphone, 3 mg Bupivacaine, and 10 mcg Clonidine	1.2 mg Hydromorphone, 3.6 mg Bupivacaine, and 12 mcg Clonidine
B	7	4.42	1,040	301	1.5 mg Hydromorphone, 4.5 mg Bupivacaine, and 15 mcg Clonidine	2 mg Hydromorphone, 6 mg Bupivacaine, and 20 mcg Clonidine
C	5.38	3.6	322	67	0.5 mg Hydromorphone, 1.5 mg Bupivacaine, and 5 mcg Clonidine	1.4 mg Hydromorphone, 4.2 mg Bupivacaine, and 14 mcg Clonidine
D	5.47	3.3	726	276	0.5 mg Hydromorphone, 1.5 mg Bupivacaine, and 5 mcg Clonidine	0.5 mg Hydromorphone, 1.5 mg Bupivacaine, and 5 mcg Clonidine
E	5.93	6.5	392	209	0.5 mg Hydromorphone, 1.5 mg Bupivacaine, and 5 mcg Clonidine	1.5 mg Hydromorphone, 4.5 mg Bupivacaine, and 15 mcg Clonidine
F	8	6.47	600	170	0.5 mg Hydromorphone, 1.5 mg Bupivacaine, and 5 mcg Clonidine	0.5 mg Hydromorphone, 1.5 mg Bupivacaine, and 5 mcg Clonidine
G	6.91	5.29	1740	265	0.5 mg Hydromorphone, 1.5 mg Bupivacaine, and 5 mcg Clonidine	0.75 mg Hydromorphone, 2.25 mg Bupivacaine, and 7.5 mcg Clonidine
Mean	5.94	4.55	732	196	0.7 mg Hydromorphone, 2.1 mg Bupivacaine, and 7 mcg Clonidine	1.12 mg Hydromorphone, 3.36 mg Bupivacaine, and 11.2 mcg Clonidine

Opioid Consumption and Pain Scores

Oral plus intravenous opioid use significantly decreased following the procedure, from a pre-intervention mean of 731.8 ± 515.8 mg (OME) in the 24 hours prior to intrathecal delivery system placement to 195.9 ± 93.4 mg in the 24 hours prior to discharge ($t = 3.112$, $df = 6$, $p = 0.020$) (Table 2). The mean reduction in systemic opioid consumption was 535.9 OME (95% CI: 114.46 to 957.25).

The observed reduction of over 500 mg OME represents a clinically substantial transfer of analgesic burden from systemic (oral and intravenous) to intrathecal delivery. This degree of conversion occurred over a short inpatient interval and preceded discharge in all hospitalized patients.

Mean 24-hour pain scores also showed a significant reduction at the same time intervals, from 5.94 ± 1.64 to 4.55 ± 1.62 ($t = 3.477$, $df = 6$, $p = 0.01$), with a mean reduction of 1.39 points (95% CI: 0.41 to 2.37).

Time to Discharge

Among inpatients, the mean time from admission to IDDS placement was 13.6 days (range 6–32 days, standard deviation = 9.4), with a mean time to discharge post-implantation of 4.4 days (range 3–7 days, standard deviation = 1.4). The two outpatients were discharged on post-procedure days 1 and 5.

Safety Outcomes

Three adverse events were observed. One patient developed a post-dural puncture headache. Another experienced urinary retention and lower extremity weakness, which resolved with downtitration of bupivacaine. One pump site infection requiring explantation was observed, representing a proportion of 1 in 7 in this cohort. Given the small sample size, this figure should not be interpreted as a reliable estimate of incidence.

Follow-Up Outcomes

During the six-month follow-up period, two patients were readmitted for pain-related issues: one within the first 30 days and one between days 31 and 90. No readmissions occurred between days 91 and 180. Aside from the patient who required explantation due to infection, all patients remained on intrathecal therapy through the end of follow-up or the end of life.

Discussion

This retrospective study demonstrates that retrograde intrathecal catheter placement targeting the L5/S1 level can facilitate substantial conversion from high-dose oral and intravenous opioids to intrathecal therapy in patients with refractory sacropelvic cancer pain. The most clinically salient effect was observed among hospitalized patients, in whom intrathecal therapy enabled rapid oral and intravenous opioid offloading and discharge following prolonged admissions driven by uncontrolled pain and escalating systemic opioid requirements. Intrathecal catheter placement marked a clear inflection point in clinical trajectory for the inpatients: all were discharged within one week of implantation.

Although pain scores declined modestly, the magnitude of systemic opioid reduction and the temporal association with discharge suggest that symptom stabilization sufficient for safe transition out of the hospital may be a more meaningful endpoint than maximal numeric pain score improvement. For patients with advanced malignancy, whose post-discharge pain trajectories are frequently confounded by disease progression, hospice enrollment, or end-of-life care decisions, short-term stabilization and opioid de-escalation represent pragmatic and patient-centered outcomes.

While rapid inpatient opioid conversion was the dominant pattern in this cohort, the inclusion of two outpatient cases demonstrates that retrograde intrathecal catheter placement may also provide early opioid reduction and pain stabilization when implemented electively. In these patients, outcomes reflect early post-implant response rather than rescue from prolonged hospitalization, suggesting a potential role for intrathecal therapy earlier in the disease course to mitigate future inpatient escalation.

Adverse events were observed but were generally transient or responsive to adjustment of intrathecal therapy. One patient developed urinary retention and lower extremity weakness following L5/S1 catheter placement, both of which resolved with downtitration of intrathecal bupivacaine. No persistent neurologic deficits, falls, or sustained bowel or bladder dysfunction were documented during the observation period. Given the small cohort and retrospective design, these findings are reported descriptively and should not be interpreted as a formal assessment of safety.

No comparative data currently exist evaluating retrograde L5/S1 positioning against conventional conus-level placement, and our findings should be viewed as preliminary evidence supporting feasibility rather than a comparative effectiveness claim. Future studies isolating individual drug effects and directly comparing catheter tip locations will be essential to determine the optimal pharmacologic and anatomic treatment strategy. CSF flow dynamics below the conus medullaris may also be relevant when considering caudal catheter placement.¹¹ Prior physiologic studies demonstrate attenuated pulsatile CSF flow in the caudal spine, which may, in theory, increase the risk of catheter tip granuloma formation. Catheter tip granulomas have been reported at sacral levels, including cases associated with permanent neurologic injury; however, comparative rates by catheter tip location have not been studied, and the clinical implications of caudal placement remain uncertain.¹²

Limitations

This study has several limitations. The retrospective design precludes causal inference, and neither patients nor clinicians were blinded to the intervention. Subjective outcomes such as pain scores may have been influenced by observer or documentation bias. Additionally, the absence of functional or patient-reported outcome measures hinders interpretation of broader clinical impact. Most notably, no current or historical comparator group receiving conventional conus-level catheter placement was available; accordingly, no conclusions can be drawn regarding the relative efficacy or safety of retrograde L5/S1 positioning versus standard technique. Taken together, these constraints, including the sample size of seven patients, mean this study is best characterized as a pilot study, and all findings should be interpreted as descriptive and hypothesis-generating, providing the preliminary data needed to justify future comparative studies.

Long-term pain outcomes were not emphasized, as post-discharge data were highly heterogeneous and confounded by factors such as disease progression, transition to hospice care, and variability in outpatient documentation. In this clinical context, inpatient opioid conversion and discharge facilitation were considered more interpretable and clinically relevant outcomes than longitudinal pain scores. The inclusion of both inpatient and outpatient cases introduces heterogeneity in clinical context; however, this reflects real-world utilization of intrathecal therapy, which may serve either as an inpatient de-escalation strategy or as an elective intervention aimed at early symptom control and opioid sparing.

The use of a three-agent admixture in this study reflects longstanding institutional practice, with drug ratios based on legacy protocols. We have not isolated the contribution of each agent nor evaluated alternative ratios in the retrograde setting, and this approach is intended to provide continuity with prior institutional standards rather than to suggest superiority of this specific combination.

Variability in intrathecal infusion rates across patients was not formally analyzed. Given the small sample size and the individualized nature of titration, statistical comparison of rates would be underpowered and difficult to interpret; this represents an analytical limitation that future larger studies should address with standardized dosing protocols or regression-based approaches to account for clinical covariates.

Conclusions

In this small, retrospective pilot cohort of seven patients with refractory sacropelvic cancer pain, retrograde intrathecal catheter placement targeting the L5/S1 level was associated with substantial reduction in systemic opioid requirements and facilitated timely discharge among hospitalized patients. Pain score improvement was modest, no comparator group was available, and causal inference is precluded by the study design. These findings should be interpreted as exploratory and hypothesis-generating. Prospective, adequately powered comparative studies directly evaluating retrograde L5/S1 versus conventional conus-level catheter positioning, with standardized outcome measures and longer follow-up, are needed before conclusions regarding efficacy, safety, or clinical superiority can be drawn.

Disclosure

The authors report no conflicts of interest in this work.

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