Retrospective Review

Comparison of Different Spinal Level Approaches in Splanchnic Sympathetic Neurolysis for Intractable Upper Abdominal Cancer Pain: A Retrospective Review

Dhanalakshmi Koyyalagunta, MD, Steven Mach, MD, and Matthew Chung, MD

From: Department of Pain Medicine, University of Texas, MD Anderson Cancer Center, Houston, TX

Address Correspondence: Dhanalakshmi Koyyalagunta, MD Department of Pain Medicine, University of Texas, MD Anderson Cancer Center 1400 Holcombe Blvd, Unit 409 Houston, TX 77030 E-mail: desidock@gmail.com; dkoyyala@mdanderson.org

Author Contributions: SM and MC helped write the manuscript. DK helped write the manuscript and perform the procedures.

Disclaimer: There was no external funding in the preparation of this article.

Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

Article received: 02-12-2024
Revised article received: 12-03-2024
Accepted for publication: 12-13-2024

Free full article: www.painphysicianjournal.com

Background: Celiac plexus or splanchnic nerve neurolysis is a treatment modality commonly offered for cancer-related upper abdominal pain. The optimal spinal level for performing celiac/splanchnic sympathetic neurolysis remains unclear.

Objective: We aimed to assess the outcome, effectiveness, and complications associated with undergoing splanchnic sympathetic neurolysis at various spinal levels for treating intractable upper abdominal cancer pain.

Study Design: This is an analysis of a retrospective cohort.

Setting: Pain management clinic at a large quaternary comprehensive cancer center.

Methods: A retrospective chart review of patients with unremitting cancer-related upper abdominal pain refractory to medical management was performed. Data were collected on pertinent demographic, clinical characteristics, cancer diagnosis and staging, location of abdominal pain, pain Numeric Rating Scale (NRS-11) scores, prior cancer treatments, level/laterality of splanchnic neurolysis, agents and volumes used for neurolysis, adverse events, pre- and postprocedure daily morphine milligram equivalents (MME), and symptom burden/quality-of-life outcomes.

Results: A total of 254 patients treated with splanchnic sympathetic neurolysis for intractable upper abdominal cancer pain from July 2014 through June 2017 were included. Of the splanchnic sympathetic neurolysis procedures performed, most were done at T12 (44%) and L1 (54%)., The vast majority were bilateral (96%) using absolute alcohol (98%). There was no significant difference in MME requirements at postprocedure 6-months. Additionally, while NRS-11 scores improved at postprocedure one month and 6 months compared to baseline, there was no significant difference in NRS-11 scores based on the level at which the procedure was performed. A subgroup analysis of patients (n = 201 observations) with cancer pain related to intraabdominal viscera innervated by the splanchnic nerves (i.e., pancreatic, hepatobiliary, renal/adrenal, and gastrointestinal tract) also revealed that block level was not significantly associated with pain score. Time was a significant factor associated with NRS-11 score; patients had a significantly decreased pain score at postprocedure one month and 6 months. For patients with abdominal cancers of predominately splanchnic innervation, splanchnic sympathetic neurolysis also improved quality of life measures such as nausea, feeling of wellbeing, and mental clarity.

Limitations: One-third of the patients in our study were lost to follow-up at 3 months, likely due to the patient population with end-stage cancer, the natural history of cancer disease progression, or death.

Conclusion: The majority of splanchnic sympathetic neurolysis were performed at L1 and T12. Improved pain scores were comparable between block levels and provided sustained pain relief for at least 6 months. Significant changes in daily MMEs were demonstrated with neurolysis in association with the one month follow-up. While we found that splanchnic sympathetic neurolysis was effective in reducing opioid requirements, larger randomized studies are needed to look for any meaningful difference in long-term efficacy for pain control and side effects for splanchnic nerve sympathetic neurolysis.

Key words: Splanchnic, celiac plexus, neurolysis, abdominal pain, cancer pain, spinal level

Pain Physician 2025: 28:E403-E410

Pain is a common and distressing symptom experienced among patients with cancer. A systematic review (1) showed an overall decrease in the incidence of cancer pain, with an overall prevalence of 44.5%. Despite a historical decline in the number of patients with cancer experiencing moderate to severe pain (around 30.6%), the prevalence of overall pain remains high, especially in patients with advanced, metastatic, and terminal cancer (54.6%) (1). Patients with pancreatic cancer continue to report a relatively higher incidence of pain; 93% reported having pain related to the diagnosis of pancreatic cancer and 83% reported moderate to severe pain intensity levels (2).

Cancer pain is largely secondary to the mass effect of the cancer itself, or invasion into nearby tissue/nerves, though it often results from the side effects of treatments such as chemotherapy, radiation, and surgery (3). Upper abdominal pain is the most common manifestation of visceral cancer pain and is strongly associated with significant morbidity. Pharmacologic management with oral medications such as opioids may not be sufficient to address upper abdominal pain and is frequently fraught with significant side effects. In search of effective treatment options, interventional therapies in the form of diagnostic, therapeutic, and neurolytic blocks are included in the pain physician's armamentarium to optimize pain control for abdominal pain in patients with cancer.

The celiac plexus is the largest visceral plexus that is composed of a dense network of nerve fibers from the celiac, superior mesenteric, and aorticorenal ganglia. It originates from the preganglionic sympathetic fibers of the greater (T5–T9), lesser (T10,T11), and least

(T12) splanchnic nerves (SNs) (4). Visceral afferent fibers follow sympathetic efferent pathways that supply the liver, pancreas, gall bladder, stomach, spleen, kidneys, adrenal glands, and parts of the intestine. Visceral pain arising from tumors related to these organs can be alleviated by a celiac plexus or splanchnic nerve neurolytic block (5-7).

Celiac plexus or splanchnic nerve neurolysis is a treatment commonly offered for cancer-related supraumbilical abdominal pain. Yang, et al (8) reported the contribution of thoracic sympathetic ganglia nerve branches toward divisions of the SN: over 80% from T8 and T9 toward the greater SN, approximately 80% from T10 and T11 toward the lesser SN, and over 60% from T11 and T12 toward the least SN (8). Anatomical variations previously described for the greater, lesser, and least splanchnic nerves have 77% of all 3 passing through the common hiatus of the diaphragm (9,10). The current practice within our pain management center is an unconventional way of blocking the splanchnic sympathetic nerves for the upper abdomen. It involves a posterior approach to splanchnic neurolysis under fluoroscopic guidance in order to target these nerves bilaterally at a single spinal level, between T11, T12, or L1. Based on anatomy, we assume it is retrocrural or antecrural at T12; and antecrural at L1 (Fig. 1, blue arrows). The injectate volume blocks the sympathetic nerves at the anterolateral border of the vertebral border before they join the celiac plexus.

In our study, we aimed to assess the outcome, effectiveness, and complications associated with undergoing splanchnic sympathetic neurolysis at various spinal levels for treating intractable upper abdominal cancer pain.

Methods

This was an institutional review board-approved analysis of a retrospective cohort of patients at the University of Texas, MD Anderson Cancer Center, approved with a waiver of informed consent. The patients included in this retrospective review presented to the MD Anderson's pain management center with unremitting cancer-related upper abdominal pain that was refractory to medical management (i.e., on an opioid regimen greater than 100 morphine milligram equivalents [MME] daily).

Each patient was offered fluoroscopically guided splanchnic sympathetic neurolysis and informed consent was waived for the retrospective protocol. A retrospective chart review was performed to collect data on pertinent demographic/clinical characteristics, cancer diagnosis and staging, location of abdominal pain, pain level using the Brief Pain Inventory (11), prior cancer treatments, level/laterality of splanchnic sympathetic neurolysis, agents and volumes used for neurolysis, adverse events, pre- and postprocedure daily opioid MME, and symptom burden/quality-of-life outcomes based on the Edmonton Symptom Assessment Scale (ESAS, a 10-item symptom-based numeric rating scale questionnaire validated in the palliative care and cancer populations) (12).

Procedure

Fluoroscopically guided, posterior approach splanchnic sympathetic neurolysis was performed in the clinic or operating room setting as dictated by the patient's medical comorbidities. The patient was hydrated

with 500 mL–1000 mL of intravenous fluids. Standard monitoring was applied, and the patient was positioned prone on the procedure table. After sterile preparation and draping, the vertebral bodies were identified using fluoroscopy. The fluoroscopy beam was stationed oblique to 20° to 30° until the transverse process of the target level (T11, T12 or L1) was seen superimposed on the vertebral body. Note: at T11, given the concern for potential pneumothorax, the fluoroscopy beam should be obliqued no greater than 15°, with a distance not more than 4 cm from the midline.

A 22G spinal needle (5–7 cm) was advanced to the anterolateral margin of the vertebral body with frequent image guidance. Once the needle position was confirmed at the anterolateral margin, the needle tip was advanced to the anterior border of the vertebral body in the lateral view. Similar needle placement was performed on the contralateral side.

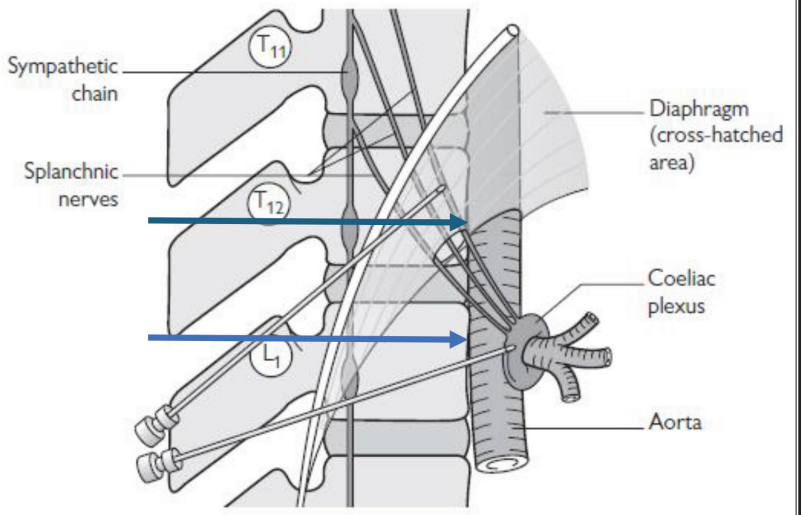

Fig. 1. *Diagram showing neural connections and various needle positions for coeliac plexus and splanchnic block. Blue arrows show needle placement for the procedure described by us. Image courtesy of Dr SG Tordoff, FRCA, FFPMRCA.*

After negative aspiration for blood (avoiding inadvertent intravascular access), contrast medium was injected to confirm the spread over the anterior vertebral body and to assure no posterior tracking towards the spinal nerve roots. An initial diagnostic block was performed using 5 mL of 2% chloroprocaine or 3 mL–4 mL of 0.25% bupivacaine. After confirmation of a positive diagnostic block (both pain relief and no new neurologic symptoms), the neurolysis was performed by incrementally injecting 6 mL–10 mL of the neurolytic agent (10% phenol or absolute alcohol).

If the patient did not receive pain relief from the diagnostic block or a new neurologic symptom arose (e.g., motor block), the neurolysis was not performed. Finally, to prevent posterior tracking of the neurolytic agent into the subcutaneous tissue, 2 mL of a local anesthetic (with or without steroid) was injected to flush the neurolytic agent, the inner stylette was replaced, and the needle was removed.

Statistical Analysis

Frequencies and percentages are reported for categorical variables. Summary statistics such as number of nonmissing observations (N), mean (SD), median, minimum, and maximum were provided for continuous data. The χ^2 test and Fisher's exact test were used to evaluate the association between categorical variables. Wilcoxon's rank-sum test or the Kruskal-Wallis test was used to compare the distributions of continuous variables among study groups (L1, T12, and T11) and different time points. A repeated measures model was fitted to assess the association between the pain score and the block level over different time points. Multiple times when the pain scores were measured they were treated as a categorical variable in the model. A repeated measures model was based on auto-regressive covariance structure, since Akaike Information Criterion and Bayesian Information Criterion values using auto-regressive were smaller than those using unstructured covariance structure and compound symmetry covariance structures. Other ESAS data were not normally distributed and could not be fitted with the repeated measures model. All tests were 2-sided. *P* values less than 0.05 were considered statistically significant for the overall comparison. Pairwise comparisons were performed to compare the pain score and ESAS scores at postprocedure one month and 6 months vs baseline; Bonferroni correction was used to control the overall Type I error rate while a 0.025 *P* value was used as the cut-off. *P* values less than 0.025 were considered statistically significant in the pairwise comparison. All analyses were conducted using SAS 9.3 software (SAS Institute, Inc.).

Results

A total of 254 patients were treated with splanchnic sympathetic neurolysis for intractable upper abdominal cancer pain at MD Anderson Cancer Center from July 2014 through June 2017.

Table 1 summarizes demographic variables and clinical characteristics. The majority (72%) of our patients had oncologic staging consistent with advanced or metastatic cancer, with 29% having received radiation, 90% with a history of receiving chemotherapy, and 72% having undergone surgery for their cancer treatment. The daily opioid MME mean was 186.79 (SD, 384.77) and median was 105.80. Cancer subtypes consisted of mostly pancreatic (including adenocarcinoma and neuroendocrine), gastrointestinal tract (esophagus, gastric, small bowel, colon, rectum), and hepatobiliary (liver, gallbladder, cholangiocarcinoma), with the remaining number subtypes related to renal/adrenal, gynecologic (ovarian and cervical), hematologic (lymphoma and myeloma), breast, lung, sarcoma, and other non-thoracoabdominal primary malignancies (mesothelioma, melanoma, hemangioendothelioma). Of note, the described cancers pertain to the patients' primary cancers; while some of these cancer subtypes are in regions not innervated by the splanchnic nerves, many patients had metastatic disease causing pain in the abdominal viscera targeted by the splanchnic neurolysis. Characteristics of the sympathetic neurolysis procedure are described in Table 2; of the neurolyses performed, most were done at T12 (44%) and L1 (54%), with the vast majority of the procedures placed bilaterally (96%) using absolute alcohol (98%).

Tables 3 and 4 outline a comparative primary analysis of the various levels (T11, T12, and L1) in relation to daily opioid MME and Numeric Rating Scale (NRS-11) pain scores, respectively. The large majority of neurolyses were performed at the L1 and T12 levels. Among the 3 levels assessed during our primary analysis, there was a significant difference in age, total volume used for the block, and postprocedure one-month MME requirements. There was no significant difference in MME requirements at postprocedure 6 months. Additionally, while NRS-11 pain scores improved at postprocedure one month and 6 months compared to baseline, there was no significant difference in NRS-11 scores based on the level at which the procedure was performed.

A subgroup analysis of patients (n = 201 observations) with cancer pain related to intraabdominal viscera innervated by the splanchnic nerves (i.e., pancreatic, hepatobiliary, renal/adrenal, and gastrointestinal tract) also revealed that block level was not significantly associated with pain score. Time was a significant factor that was associated with NRS-11 scores; patients had a

Table 1. *Clinical characteristics of patients who underwent splanchnic neurolysis (n = 254).*

Clinical Characteristic	n (%)
Gender (women)	121 (48%)
Pain Location	
Abdomen only	131 (52%)
Abdomen and back	107 (42%)
Abdomen and other location	16 (6%)
Cancer history	
Primary cancer type	
Pancreatic	139 (55%)
Gastrointestinal tract	42 (17%)
Hepatobiliary	25 (10%)
Ovarian/Cervical	9 (3.5%)
Hematologic	6 (2.3%)
Renal/Adrenal	5 (1.9%)
Breast	5 (1.9%)
Lung	4 (1.5%)
Sarcoma	5 (1.9%)
Other nonabdominal	11 (4%)
Unknown	3 (1%)
Metastasis present	182 (72%)
Prior chemotherapy	229 (90%)
Prior radiation therapy	74 (29%)
Prior cancer-related surgery	183 (72%)
Social History	
Current smoker	23 (9%)
Prior smoker	97 (38%)
History of alcohol use	249 (98%)

Table 2. *Splanchnic neurolysis characteristics.*

Anatomical Level	n (%)
T11	5 (2%)
T12	112 (44%)
L1	137 (54%)
Laterality	
Unilateral	4 (4%)
Bilateral	243 (96%)
Type of Neurolytic Agent	
Alcohol	249 (98%)
Phenol	5 (2%)

Table 3. *Comparative analysis of various levels of splanchnic neurolysis and effect on daily morphine milligram equivalent (MME) requirements.*

Variable	Level of Block	n	Mean (SD); Median (min–max)	*P* Value
Baseline MME	T11	5	136.5 (91.61); 120 (37.5 – 270)	0.641
	T12	137	200.94 (254.22); 125 (0 – 1,560)	
	L1	112	171.44 (509.4); 90 (0 – 5,310)	
Postprocedure One Month MME	T11	5	100 (77.78); 90 (0 – 200)	0.0097
	T12	133	164.09 (143.69); 135 (0 – 784.6)	
	L1	108	138.57 (285.77); 90 (0 – 2,880)	
Postprocedure 6 Months MME	T11	3	113.33 (95.44); 150 (5 – 185)	0.8907
	T12	99	167.22 (225); 100 (0 – 1,460)	
	L1	68	135.3 (139.61); 82.5 (0 – 680)	

Table 4. *Comparative analysis of various levels of splanchnic neurolysis on pain Numeric Rating Scale (NRS-11) scores.*

Variable	Level of Block	n	Mean (SD); Median (min–max)	*P* Value
Baseline Pain Score	T11	5	6.2 (1.3); 6 (5 – 8)	0.0586
	T12	137	6.74 (1.8); 6 (4 – 10)	
	L1	112	6.21 (1.71), 6 (4 – 10)	
Postprocedure One Month Change in Pain Score	T11	5	2.4 (2.07); 3 (-1 – 4)	0.3582
	T12	137	2.73 (2.96); 3 (-5 – 10)	
	L1	112	2.27 (2.86); 2.5 (-4 – 10)	
Postprocedure 6 Months Change in Pain Score	T11	3	3.33 (2.08); 4 (1 – 5)	0.8242
	T12	100	3.11 (3.06); 3 (-3 – 10)	
	L1	69	2.62 (2.81); 3 (-4 – 7)	

significantly decreased pain score at postprocedure one month and 6 months.

The subgroup analysis was also stratified based on block level (L1 vs T12). Among patients with their block performed at L1, pain, nausea, and ESAS "feeling of wellbeing" were factors that were statistically different over time. Pain scores were significantly reduced at one month and 6 months follow-ups compared to the baseline. The nausea score was significantly decreased at the one month follow-up and quality-of-life "feeling of wellbeing" had a marginally significant decrease at the 6 months follow-up.

Among patients who had neurolysis at T12, pain score, nausea, insomnia, and ESAS mental clarity were statistically different over time. In a pairwise comparison, pain and mental clarity were significantly reduced (improved) at postprocedure one month and 6 months compared to baseline ($P < 0.025$). Nausea and insomnia scores were significantly reduced at postprocedure one month ($P < 0.025$) compared to baseline.

Adverse effects were seen in 4% (10/249) of patients, irrespective of the level at which the procedure was performed. Adverse effects included hypotension, loose stools, nausea, vomiting, high fever, worsened dyspnea from baseline, and mechanical fall. There was no noted difference in complication rate by level.

Discussion

This was a study conducted with a retrospective cohort at a large quaternary cancer center, evaluating the effectiveness of visceral sympathetic neurolysis at various vertebral levels to treat chronic upper abdominal pain refractory to conservative medication management in patients with abdominal cancer.

The most common neurolytic approach in our study was a retrocrural trajectory at the T12 and L1 levels, with a smaller proportion at T11. In conjunction with previously reported studies (6,13), the majority of neurolysis were performed around the thoracolumbar junction. Within our pain medicine department, the procedure is commonly performed bilaterally under fluoroscopic guidance, with the final needle position along the anterolateral border of the targeted vertebral body. It is an unconventional way of blocking the splanchnic sympathetic nerves for the upper abdomen. It involves a posterior approach for splanchnic sympa-

thetic nerve neurolysis under fluoroscopic guidance to target these nerves bilaterally at a single spinal level, between T11, T12, or L1. The use of imaging modalities for splanchnic and celiac plexus neurolysis can vary by provider and institution. While fluoroscopic guidance is widely reported, alternative imaging modalities include the use of computed tomography, endoscopy, and ultrasound guidance (14).

In our study, no significant difference in preprocedure MME levels between the patients receiving neurolysis at T11, T12, or L1 suggests that the baseline opioid usage was similar among groups. Upon the one-month follow-up, the statistically significant differences in daily MME dosing indicates variation in opioid requirements for each level compared to one another, as well as a noted reduction from baseline. Although the 6-month postprocedure MME showed no significant difference, there was substantial loss to follow-up in chart review for this timepoint.

Compared to baseline scores, the NRS-11 pain score was the lowest at postprocedure one month; there was a slight increase at 6 months. While no significant difference in pain relief or quality-of-life was seen among treated levels during the follow-up period, this similarity indicates that the effect of splanchnic sympathetic neurolysis on these outcomes is comparable regardless of the level at which the procedure was performed.

When analyzing the patients with abdominal cancers that are strictly innervated by the splanchnic nerves, block level was again not significantly associated with pain scores, which may indicate an equivalent analgesic effect for splanchnic neurolysis no matter at which level the procedure is performed, with sustained pain relief up to 6 months, or potentially longer. For patients who had neurolysis at L1 and T12, both subgroups had reduced pain and nausea at postprocedure one month and 6 months. Nausea was significantly reduced at one month for both groups, but not at 6 months, which may suggest a shorter duration of antiemetic effect in comparison to analgesia. While patients with L1 block had an improvement in "feeling of wellbeing" and patients with T12 block had an improvement in insomnia and "mental clarity," this variability in ESAS factors suggest that different block levels may differentially influence quality-of-life based on pain or other associated symptoms. Additional research into the effect of splanchnic neurolysis on quality-of-life measures is needed to determine variance based on block level.

Neurolysis using alcohol or phenol has previously been described with no difference in efficacy (5). While we used both alcohol and phenol during our procedures without any report of neuritis, inadvertent nerve injury or neuritis is more commonly associated with alcohol-based neurolysis (5). Other noteworthy adverse events previously described include numbness and weakness if nearby nerve roots or vasculature are unintentionally involved in the neurolysis (15), as well as pneumothorax given the neighboring parietal pleura (16). Most commonly, up to 30% of patients will experience transient hypotension and diarrhea (14), as reflected in our study. In comparison to celiac plexus neurolysis, our department primarily utilizes an unconventional splanchnic neurolysis (though primarily at T12 and L1) to lower the risk of vascular (e.g., aorta) puncture and to avoid complications from distorted anatomy from intrabdominal tumor burden (17).

At our department, we identified a diagnostic block's efficacy variability with local anesthetic as a predictor of a successful splanchnic neurolysis. While some diagnostic blocks provided effective short-term pain relief, the subsequent neurolysis that immediately followed were inconsistent in controlling pain for longer periods of time. The majority of patients in our study presented to our pain medicine clinic with end-stage disease (i.e., stage IV cancer). Prior studies report that neurolysis is more effective if performed earlier in the disease's course (18,19), with some proponents suggesting performing the procedure as early as the time a cancer diagnosis is made (20).

Splanchnic neurolysis is often performed as a "last-resort" therapy when many other treatment options have been exhausted. It is unclear from available evidence whether involvement of the lymph nodes will decrease the spread of injectate and efficacy of celiac plexus neurolysis (21,22). Some retrospective data support that splanchnic neurolysis may be a better option in these patients (5). Furthermore, prior literature suggests that splanchnic neurolysis may influence survival outcomes depending on a patient's cancer stage; a decreased survival time was previously demonstrated in patients with stage II/III (23) or stage IV disease (13,24). Conversely, for patients with pancreatic cancer, neurolysis has been shown to improve survival time (18), especially for patients with unresectable tumors (25), as well as improve quality of life (26), though other literature suggests no effect on survival or quality of life (27-29). While our current study did not explore the effect of neurolysis based on oncologic staging, predictors of a successful local anesthetic block or chemical

ablation and effects on survival and quality of life are areas for further research.

Additional directions for future investigations include identifying the characteristics of patients who would most likely benefit from splanchnic neurolysis. Visceral abdominal pain is often poorly localized and can result from varying primary complaints. A history of the source of primary abdominal malignancy, versus metastasis to the abdomen, may provide clues into linking pain patterns to an oncologic diagnosis. Pain from primary cancers of the abdomen can have variable clinical presentations; in addition to abdominal pain, patients may report pain in the back, pelvis, or epigastrium, among others. These referred pain patterns from an abdominal cancer can potentially be misinterpreted as independent of the primary malignancy, and not treated accordingly, which could potentially delay targeted pain control via splanchnic neurolysis. Furthermore, as with numerous other oncologic pathologies, treating the source of the cancer can often alleviate pain. For abdominal cancers, the treatments are highly variable, consisting of chemotherapy, radiation, surgery, or a combination of these treatment modalitites. With the cancer treatments alone being another potential cause of abdominal pain for these patients, continued exploration into the efficacy of splanchnic neurolysis for cancer-related versus treatment-related pain is an avenue for future studies.

Limitations

Our study has several limitations. A notable number of patients (around one-third) were lost to follow-up after 3 months, which may have been related to the severity of these patients' cancer stage (e.g., end-of-life or palliative measures requiring more advanced interventions such as intrathecal pump management). The drop-out in recorded patient data is most likely multifactorial. Since most patients in this study had end-stage cancer with metastases, the natural history of their disease progression, or death, is a possible explanation for the missing data. In contrast, patients who may have experienced considerable pain relief may have decided to forgo subsequent clinic visits.

Another notable confounding factor is the multidimensional nature of quality-of-life questionnaires. The ESAS tool utilized in our study is comprised of an amalgam of biopsychosocial factors including pain, fatigue, drowsiness, shortness of breath, appetite, nausea, sleep, depression, anxiety, feeling of wellbeing, and mental clarity. While these endpoints are broad, the collection of these surveys at follow-up clinic visits pertain to a variety of concurrent pain factors; patients with cancer often have multiple simultaneous life stressors at the same time. Furthermore, routine pain questionnaires included in our analysis referred to "overall pain" rather than "abdominal pain." Future surveys pertaining directly to the effect of splanchnic neurolysis on abdominal pain would add specificity to the patient-reported pain and quality-of-life outcomes.

Conclusion

This study is a retrospective chart review comparing efficacy, duration, and complications of splanchnic nerve neurolysis among 254 patients with cancer-related upper abdominal pain at a large comprehensive cancer center. Most cases studied were related to pancreatic cancer, with abdominal metastases and gastric cancer accounting for the remainder.

We describe an unconventional way of blocking the splanchnic sympathetic nerves for the upper abdomen. It involves a posterior approach to splanchnic sympathetic nerve neurolysis under fluoroscopic guidance to target these nerves bilaterally at a single spinal level, between T11, T12, or L1. Among various levels injected, the majority of splanchnic neurolyses were performed at L1 and T12. Improved pain scores were comparable between block levels and provided sustained pain relief of at least 6 months. For patients with abdominal cancers of predominately splanchnic innervation, in addition to improved pain, splanchnic neurolysis improved quality-of-life measures such as nausea, feeling of wellbeing, and mental clarity. Significant changes in daily MME requirements were demonstrated with neurolysis in association with one month follow-up. While we found that splanchnic neurolysis was effective in reducing opioid requirements, larger randomized studies are needed to look for any meaningful difference in long-term efficacy for pain control and side effects of splanchnic nerve neurolysis.

References

1. Snijders RAH, Brom L, Theunissen M, van den Beuken-van Everdingen MHJ. Update on prevalence of pain in patients with cancer 2022: A systematic literature review and meta-analysis. *Cancers (Basel)* 2023; 15:591.
2. Coveler AL, Mizrahi J, Eastman B, et al. Pancreas cancer-associated pain management. *Oncologist* 2021;

26:e971-e982.

3. van den Beuken-van Everdingen MH, Hochstenbach LM, Joosten EA, Tjan-Heijnen VC, Janssen DJ. Update on prevalence of pain in patients with cancer: Systematic review and meta-analysis. *J Pain Symptom Manage* 2016; 51:1070-1090.
4. Sachdev AH, Gress FG. Celiac plexus block and neurolysis: A review. *Gastrointest Endosc Clin N Am* 2018; 28:579-586.
5. Koyyalagunta D, Engle MP, Yu J, Feng L, Novy DM. The effectiveness of alcohol versus phenol based splanchnic nerve neurolysis for the treatment of intra-abdominal cancer pain. *Pain Physician* 2016; 19:281-292.
6. Ahmed A, Arora D. Fluoroscopy-guided neurolytic splanchnic nerve block for intractable pain from upper abdominal malignancies in patients with distorted celiac axis anatomy: An effective alternative to celiac plexus neurolysis - A retrospective study. *Indian J Palliat Care* 2017; 23:274-281.
7. Shwita AH, Amr YM, Okab MI. Comparative study of the effects of the retrocrural celiac plexus block versus splanchnic nerve block, C-arm guided, for upper gastrointestinal tract tumors on pain relief and the quality of life at a six-month follow up. *Korean J Pain* 2015; 28:22-31.
8. Yang HJ, Gil YC, Lee WJ, Kim TJ, Lee HY. Anatomy of thoracic splanchnic nerves for surgical resection. *Clin Anat* 2008; 21:171-177.
9. Plancarte R, Guajardo-Rosas J, Reyes-Chiquete D, et al. Management of chronic upper abdominal pain in cancer: Transdiscal blockade of the splanchnic nerves. *Reg Anesth Pain Med* 2010; 35:500-506.
10. Gest TR, Hildebrandt S. The pattern of the thoracic splanchnic nerves as they pass through the diaphragm. *Clin Anat* 2009; 22:809-814.
11. Cleeland CS, Ryan KM. Pain assessment: Global use of the Brief Pain Inventory. *Ann Acad Med Singap* 1994; 23:129-138.
12. Chang VT, Hwang SS, Feuerman M. Validation of the Edmonton Symptom Assessment Scale. *Cancer* 2000; 88:2164-2171.
13. Dong D, Zhao M, Zhang J, et al. Neurolytic splanchnic nerve block and pain relief, survival, and quality of life in unresectable pancreatic cancer: A randomized controlled trial. *Anesthesiology* 2021; 135:686-698.
14. Comlek S. Pain control with splanchnic neurolysis in pancreatic cancer patients unresponsive to celiac plexus neurolysis. *J Pain Res* 2020; 13:2023-2031.
15. Cherry DA, Lamberty J. Paraplegia following coeliac plexus block. *Anaesth Intensive Care* 1984; 12:59-61.
16. Stafford B. More complications of coeliac plexus blockade. *Aust N Z J Med* 1991; 21:782-783.
17. Rathmell J. *Atlas of Image-Guided Intervention in Regional Anesthesia and Pain Medicine.* Wolters Kluwer/Lippincott Willliams & Williams, Philadelphia, PA, 2012, pp. 174-175.
18. Lillemoe KD, Cameron JL, Kaufman HS, Yeo CJ, Pitt HA, Sauter PK. Chemical splanchnicectomy in patients with unresectable pancreatic cancer. A prospective randomized trial. *Ann Surg* 1993; 217:447-455; discussion 456-457.
19. Ischia S, Ischia A, Polati E, Finco G. Three posterior percutaneous celiac plexus block techniques. A prospective, randomized study in 61 patients with pancreatic cancer pain. *Anesthesiology* 1992; 76:534-540.
20. Wyse JM, Chen YI, Sahai AV. Celiac plexus neurolysis in the management of unresectable pancreatic cancer: When and how? *World J Gastroenterol* 2014; 20:2186-2192.
21. De Cicco M, Matovic M, Bortolussi R, et al. Celiac plexus block: Injectate spread and pain relief in patients with regional anatomic distortions. *Anesthesiology* 2001; 94:561-565.
22. Neuwersch-Sommeregger S, Köstenberger M, Stettner H, et al. Computed tomography-guided coeliac plexus neurolysis in palliative in-patients with intra-abdominal malignancy: Retrospective evaluation of neurolytic solution spread as a predictive factor. *Pain Ther* 2022; 11:1229-1243.
23. Levy MJ, Gleeson FC, Topazian MD, et al. Combined celiac ganglia and plexus neurolysis shortens survival, without benefit, vs plexus neurolysis alone. *Clin Gastroenterol Hepatol* 2019; 17:728-738.
24. Fujii-Lau LL, Bamlet WR, Eldrige JS, et al. Impact of celiac neurolysis on survival in patients with pancreatic cancer. *Gastrointest Endosc* 2015; 82:46-56.e2.
25. Staats PS, Hekmat H, Sauter P, Lillemoe K. The effects of alcohol celiac plexus block, pain, and mood on longevity in patients with unresectable pancreatic cancer: A double-blind, randomized, placebo-controlled study. *Pain Med* 2001; 2:28-34.
26. Cai Z, Zhou X, Wang M, Kang J, Zhang M, Zhou H. Splanchnic nerve neurolysis via the transdiscal approach under fluoroscopic guidance: A retrospective study. *Korean J Pain* 2022; 35:202-208.
27. Wong GY, Schroeder DR, Carns PE, et al. Effect of neurolytic celiac plexus block on pain relief, quality of life, and survival in patients with unresectable pancreatic cancer: A randomized controlled trial. *JAMA* 2004; 291:1092-1099.
28. Wyse JM, Carone M, Paquin SC, Usatii M, Sahai AV. Randomized, double-blind, controlled trial of early endoscopic ultrasound-guided celiac plexus neurolysis to prevent pain progression in patients with newly diagnosed, painful, inoperable pancreatic cancer. *J Clin Oncol* 2011; 29:3541-3546.
29. Yan BM, Myers RP. Neurolytic celiac plexus block for pain control in unresectable pancreatic cancer. *Am J Gastroenterol* 2007; 102:430-438.