Retrospective Study

Computed Tomography-Guided Celiac Plexus Block and Neurolysis: Technical Outcomes and Complications

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Background: Celiac plexus block (CPB) and celiac plexus neurolysis (CPN) are interventions used to treat chronic abdominal pain, particularly in cancer patients with pancreatic malignancy and patients who have chronic pancreatitis. Both CPB and CPN have been shown to significantly improve pain in patients with abdominal cancers while decreasing opioid consumption and side effects. Existing data on the technical variations and complications associated with both CPB and CPN are limited.

Objectives: We sought to examine the technical factors, patient demographic data, and intra- and post-operative complications and side effects of CBP and CPN.

Study Design: We conducted a retrospective analysis of all patients at our institution who underwent CPB and/or CPN between September 2017 and February 2023. The study primarily included a chart review of patient data followed by statistical analysis.

Methods: Computed tomography-guided imaging was used for all patients' CPB and/or CPN procedures, which included injections of either lidocaine or ethanol, respectively. Data were collected on patient demographics and baseline disease status, procedural indications, procedural technique, and intra- and post-procedural complications. Patients were stratified based on malignant and nonmalignant pain indications.

Results: Of the 141 patients included in the study, 70.2% of were found to have undergone treatment for malignancy-related pain. When assessing needle position, there were no significant differences in technical data between groups. Rates of side effects, including hypotension, diarrhea, and localized pain, were overall low and similar to those reported in meta-analyses. There was a subjective improvement in pain in 67.4% of all patients.

Limitations: This study is limited by its retrospective observational nature and the inability to perform standardized pain scoring pre- and post-procedurally. Data on opioid use and consumption was inferred from prescribing data, which might not have accurately reflected real-world use. Despite these issues, this study provides insight into key patient data around CPB and/or CPN.

Conclusions: This study bridges a gap in the literature to address both technical variables and procedural complications of the CPB for patients with malignant and nonmalignant pain.

Key words: Celiac plexus block, celiac plexus neurolysis, chronic abdominal pain, pancreatic cancer pain, visceral pain, sympathetic blockade, alcohol neurolysis, CT-guided injection, cancer pain management, chronic pancreatitis pain, quality of life, regional anesthesia

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Chronic abdominal pain affects nearly 25% of the U.S. population and includes a broad spectrum of etiologies commonly encountered in pain medicine (1-3). Targeting the celiac plexus is an established technique for managing chronic visceral abdominal pain, particularly in the setting

of malignancy (4,5). Celiac plexus neurolysis (CPN) is generally well tolerated, with common post-procedural side effects including orthostatic hypotension, diarrhea, and back pain (6,7). This procedure is distinct from a celiac plexus block (CPB), which typically uses local anesthetics and corticosteroids, whereas CPN involves neurolytic agents such as ethanol or phenol (6,8,9). The choice of agent reflects differing therapeutic goals and expected durations of effect. Interventions targeting the celiac plexus may be performed for both benign and malignant indications (6).

Malignant indications for CPN include cancers involving any abdominal organ innervated by the celiac plexus, with pancreatic cancer being the most common indication (10,11). The pathophysiology of pancreatic cancer pain is complex and is thought to not only be due to the mass effect from the neoplasm but also to local alterations in pain perception and neural excitability (10,11). The interplay of local neural modulatory changes and direct neoplastic effects, such as invasion and structural compression, may limit the efficacy of opioid analgesics, thereby necessitating interventional pain management strategies (12,13). Benign indications for CPB are more heterogeneous. For example, median arcuate syndrome is a poorly understood condition associated with chronic abdominal pain and limited response to conventional therapies, but this syndrome has shown favorable outcomes when treated with CPB (14). Chronic pancreatitis-related abdominal pain is another well-recognized indication for CPN. Given the typically indolent nature of nonmalignant conditions, CPB is often preferred over neurolysis due to the risks associated with permanent neural disruption.

Anatomical considerations are central to procedures targeting the celiac plexus, a large retroperitoneal structure located anterior to the aorta at the level of the celiac artery (8,15). The celiac plexus innervates many upper abdominal organs and resides in the antecrural space, while the splanchnic nerves are positioned in the retrocrural space, making the diaphragmatic crura a major anatomical landmark (8,15). Approaches to the celiac plexus vary based on imaging modality, such as computed tomography (CT), fluoroscopy, magnetic resonance imaging (MRI), or endoscopic ultrasound, and by patient-specific factors, including body habitus and tumor location in malignant cases (8). Percutaneous access can be achieved via anterior, posterior or oblique approaches. When access to the antecrural space is limited, a retrocrural approach may be preferred (8,15). Notably, at least one meta-analysis has shown no significant differences in pain outcomes between antecrural and retrocrural approaches (16). Technical variables in celiac plexus interventions include injectate volume, number of needles, and needle placement relative to midline. While one RCT showed no differences in outcomes between 40% and 70% ethanol for neurolysis, other data suggest that diagnostic blocks using less than 20 mL of local anesthetic are associated with improved outcomes in CPBs (17,18). Erdek et al assessed pain relief and procedurals variables in patients undergoing CPN for refractory cancer pain, including imaging modality, single- versus double-needle technique, block location, timing of neurolysis, injectate volume, and type of sedation (19). The researchers' findings highlight the heterogeneity in indications, techniques, and outcomes among situations in which CPBs have been administered. While there has been robust research comparing celiac plexus interventions to medical management for chronic abdominal pain, data on technical variables and procedural outcomes remain limited.

Objectives

Given the widespread use of these interventions, we sought to evaluate technical factors and peri-procedural complications associated with CT-guided procedures targeting the celiac plexus at our institution.

Study Design

This study was deemed exempt by the Massachusetts General Hospital Institutional Review Board. In a collaboration among the Departments of Interventional Radiology and Anesthesia, Critical Care, and Pain Medicine, we performed a retrospective analysis of all patients who underwent CPBs and/or CPN at Massachusetts General Hospital between September 2017 and February 2023. Patients were included if an operative note documenting CPN or CPB was present in the medical record. Individual charts were reviewed by the study team, and relevant data were extracted.

Methods

Patients in the study underwent CT-guided CPBs and/or CPN at our institution during the study period. Each of these procedures was performed under CT guidance by an interventional radiologist. The patient was brought into the procedural suite and placed in a prone or supine position on the CT table. Standard American Society of Anesthesiologists (ASA) monitors were applied, and procedural sedation was provided

by either a registered nurse or anesthesiology provider at the discretion of the booking provider based on patient co-morbidities. Scout images were obtained to direct the trajectory of needle placement. Once the celiac plexus was identified, the patient was prepped and draped in sterile fashion. The skin was anesthetized using 1% lidocaine. A 21-gauge Morrison needle or 20-gauge Chiba needle was then advanced to the celiac plexus under CT guidance. Once the celiac plexus was accessed by either retrocrural or antecrural technique, 1-2 mL of dilute iodinated contrast was injected to confirm appropriate needle positioning and the pattern of contrast spread around the celiac plexus. For the CPB, an anesthetic mixture of 0.25% bupivicaine mixed with a methylprednisolone was then injected via the needle(s). For CPN, 5 mL of 1% lidocaine is injected via the needle(s) prior to injection of the neurolytic solution (99% ethyl alcohol) to reduce the pain associated with the administration of the alcohol. A total treatment volume of approximately 10-20 mL was injected on each side. The selection of whether to use an antecrural or a retrocrural approach was made in real time based on plexus location, proximity of nearby visceral organs, involvement by malignant disease, and operator preference. Post-procedure images were obtained to evaluate for the presence of complications. Patients were transported to the post-procedural area for recovery. Demographic data collected on patients included age, gender, and survival status (alive or deceased/date of death). Comorbid conditions were recorded, including each patient's ASA Physical Status Classification and the presence or absence of hypertension, diabetes mellitus, chronic obstructive pulmonary disease, and chronic kidney disease in the individual. Home opioid regimens were documented by reviewing prescribed medications, including dose and frequency. Procedural indication was categorized as either malignancy- or non-malignancy-related pain. For patients treated for malignancy, the primary tumor type was recorded. Technical variables included sedation type, anterior vs. posterior approach, antecrural vs. retrocrural needle placement, approach variations, single- vs. double-needle technique, volume and concentration of local anesthetic and/or alcohol injectate, contrast volume and spread pattern, and needle position relative to midline, depth from skin, and angle of insertion (Figs. 1 and 2). Postoperative complications assessed included localized pain, hypotension, and diarrhea. Additional comments regarding postoperative side effects or complications were extracted from the chart and converted into binary outcomes. Any patient-reported improvement in pain after the procedure was also extracted and categorized as a binary outcome. Pain scores were not analyzed due to variability in documentation and

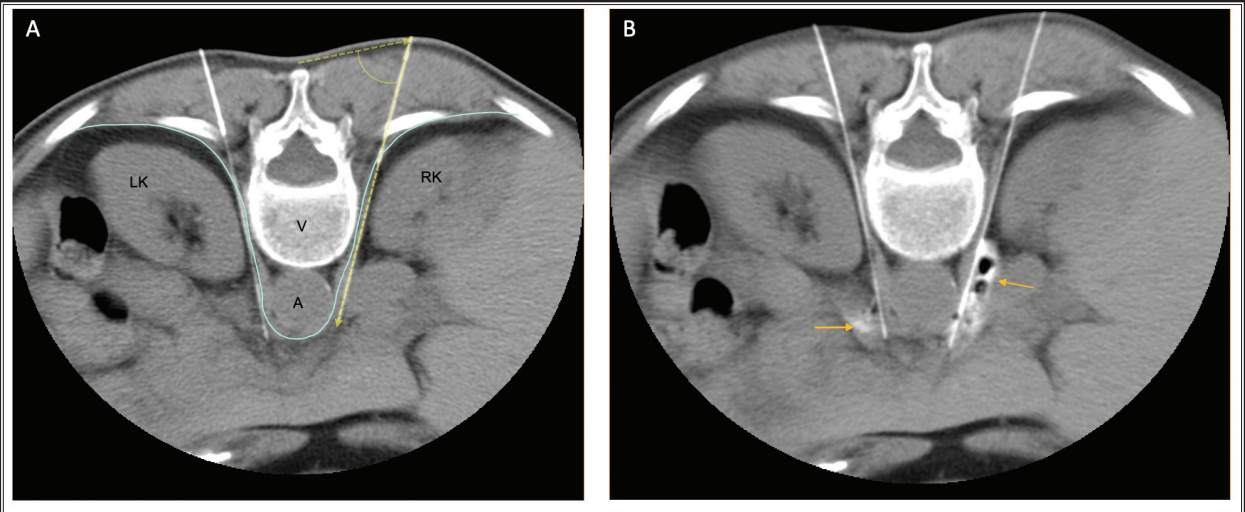

Fig. 1. *Antecrural approach to CT-guided celiac plexus block and neurolysis with double-needle technique in the prone position with posterior approach. Panel A: Yellow arrows demonstrate example measurements used to obtain technical factors including distance from midline, needle depth, and needle angle. Blue line outlines diaphragmatic crura. Panel B: Imaging from the same patient and procedure that shows post-contrast imaging as indicated by the orange arrows. Contrast spread is anterior to diaphragmatic crura confirming appropriate positioning prior to local anesthetic or neurolytic injection.*
Abbreviations: V (vertebral body); LK (left kidney); RK (right kidney); A (aorta)

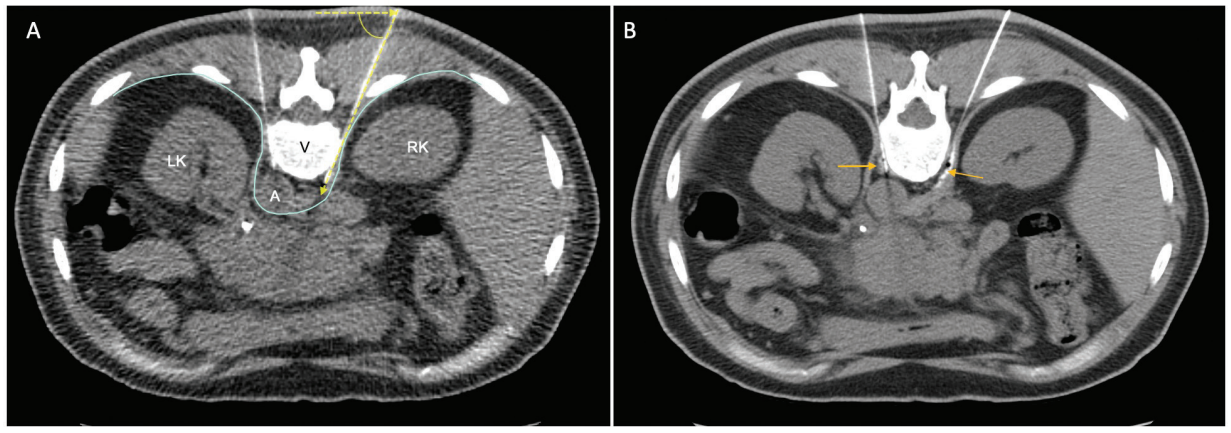

Fig. 2. *Retrocrural approach to CT-guided celiac plexus block and neurolysis with double-needle technique in the prone position with posterior approach. Panel A: Yellow arrows demonstrate example measurements used to obtain technical factors including distance from midline, needle depth, and needle angle. Blue line outlines diaphragmatic crura. Panel B: Imaging from the same patient and procedure that shows post-contrast imaging as indicated by the orange arrows. Contrast spread is posterior to diaphragmatic crura confirming appropriate positioning prior to local anesthetic or neurolytic injection.*
Abbreviations: V (vertebral body); LK (left kidney); RK (right kidney); A (aorta)

lack of standardized assessment in the retrospective dataset. Any discrepancies in data classification were resolved by consensus between 2 members of the data analysis team.

These results were analyzed by the Massachusetts General Hospital Anesthesia Research Center (ARC), using descriptive statistics. Groups were stratified by treatment indication as either malignancy- or non-malignancy-related pain. Data were described using median values, and interquartile ranges and differences were reported using standardized mean difference (SMD) and interquartile ranges as appropriate. SMD values of 0.2-0.5 were considered small, values of 0.5-0.8 were considered medium, and values > 0.8 were considered large when analyzing the data. All authors (MD, ED, VP, PR, TA, AT, and DH) contributed to this work, including conception, design, data collection, analysis, and writing of the manuscript.

Results

There were 141 patients who underwent CPN and/or CPBs in the study period and were included in the data analysis (Table 1). A total of 99 patients (70.2%) underwent CPBs and/or CPN for malignancy-related pain, with 9.9% receiving the procedure as a repeat intervention for abdominal pain. Pancreatic cancer was the most common primary malignancy in this group, accounting for 72 patients (72.7% of those with malignancy). The overall median ASA Physical Status Classification was 3.0. Compared to nonmalignancy cases, patients with malignancy had higher rates of type 2 diabetes mellitus (38.4% vs. 9.5%, SMD 0.741) and COPD (8.1% vs. 5.7%, SMD 0.419), while rates of chronic kidney disease were similar between the groups (7.8% vs. 6.1%, SMD 0.205). Most patients were on a home opioid regimen, with only 17.7% not prescribed opioids at the time of the procedure.

Regarding procedural findings, intraoperative complications were documented in 7.8% of patients (Table 2), occurring infrequently across both groups. The most commonly reported issues were patient intolerance to the procedure (2.1%), suboptimal contrast spread leading to procedure abortion (2.1%), and technical difficulty (2.1%). Serious intraoperative complications were rare, with one case each of neurologic injury (0.7%) and pneumothorax (0.7%). Postoperative complications were also uncommon, occurring in 8.5% of patients, and included bleeding (2.8%) and neurologic injury (0.7%). Commonly reported side effects of CPN include diarrhea, hypotension, and pain at the needle insertion site. In this cohort, the most frequently observed side effect was hypertension (54.6%), followed by diarrhea (22.7%), localized pain (16.3%), and hypotension (12.1%). These findings were similar to those reported in a retrospective study of CT-guided CPN for refractory abdominal pain (20).

The primary technical differences between the malignancy and nonmalignancy groups were procedure

Table 1. *Baseline characteristics and demographics*.

	Overall n = 141	Malignancy Pain n = 99	Nonmalignancy Pain n = 42	SMD
Male Gender	67 (47.5)	50 (50.5)	17 (40.5)	0.202
Age, years	58.5 [47.8, 68.5]	62.1 [53.7, 69.3]	43.4 [34.3, 58.2]	1.119
Repeat Procedure	14 (9.9)	9 (9.1)	5 (11.9)	0.092
ASA Class	3.0 [2.0, 3.0]	3.0 [2.0, 3.0]	3.0 [2.0, 3.0]	0.124
Diabetes Mellitus Type 2				0.741
Yes	42 (29.8)	38 (38.4)	4 (9.5)	
DM due to Pancreatic Insufficiency	3 (2.1)	1 (1.0)	2 (4.8)	
COPD	8 (5.7)	8 (8.1)	0 (0.0)	0.419
Chronic Kidney Disease	11 (7.8)	6 (6.1)	5 (11.9)	0.205
Home Opioid Use				1.550
Buprenorphine	2 (1.4)	0 (0.0)	2 (4.8)	
Fentanyl	11 (7.8)	11 (11.1)	0 (0.0)	
Oxycodone and Fentanyl Patch	1 (0.7)	1 (1.0)	0 (0.0)	
Hydrocodone	1 (0.7)	0 (0.0)	1 (2.4)	
Hydromorphone	27 (19.1)	20 (20.2)	7 (16.7)	
Hydromorphone and Fentanyl Patch	2 (1.4)	2 (2.0)	0 (0.0)	
Methadone	11 (7.8)	10 (10.1)	1 (2.4)	
Morphine	15 (10.6)	14 (14.1)	1 (2.4)	
Oxycodone	39 (27.7)	32 (32.3)	7 (16.7)	
Tramadol	7 (5.0)	4 (4.0)	3 (7.1)	
None	25 (17.7)	5 (5.1)	20 (47.6)	
Second Home Opioid Prescription	75 (53.2)	57 (57.6)	18 (42.9)	0.298

Data are presented as median [quartile 1, quartile 3] or n (%) depending on variable type.
Abbreviations: SMD (standardized mean difference); ASA (American Society of Anesthesiologists Physical Status Classification); DM (Diabetes Mellitus); COPD (Chronic Obstructive Pulmonary Disease)

type and block volume. In the malignancy group, 66.7% of patients underwent both a block and neurolysis, where only 16.7% of patients in the nonmalignancy group did (SMD 1.716). Additionally, the volume of local anesthetic was higher in the nonmalignancy group (9.0 mL [IQR 2.0, 10.5] than in the malignancy group (2.0 mL [IQR 2.0, 4.0]). Other technical parameters such as needle position, distance from midline, angle of insertion, and depth from skin did not differ meaningfully between the 2 groups. After the procedure, 67.4% of patients reported subjective improvement in pain, as documented by free-text comments in the medical record.

Limitations

A major limitation of this study is the absence of standardized pain outcome measures and reliable data on opioid consumption. Although we assessed pain relief by extracting provider-documented impressions from free-text clinical notes, this qualitative approach is inherently subjective and lacks consistency across providers. Given the retrospective design and variability in pain reporting, we did not perform a quantitative analysis of pre- and post-procedural pain scores. Additionally, opioid use was inferred from prescription records, which might not have reflected actual patient consumption accurately. Complications were limited to those documented during the hospital encounter, so delayed or post-discharge events may have been missed. Despite these limitations, the study provides important insight into the patient population, procedural characteristics, and technical variability of CPB and CPN in clinical practice at a large academic institution.

Conclusions

This retrospective study provides one of the more detailed analyses to date of the technical characteristics and complication rates associated with CT-guided CPB and CPN across both malignant and nonmalignant abdominal pain indications. Most patients in our cohort un-

Table 2. *Indications for procedure, intraoperative complications, postoperative complications, and technical factors.*

	Overall n = 141	Malignancy Pain n = 99	Nonmalignancy Pain n = 42	SMD
Tumor Type				5.696
Pancreatic	73 (51.8)	72 (72.7)	1 (2.4)	
Other	27 (19.1)	26 (26.3)	1 (2.4)	
N/A	41 (29.1)	1 (1.0)	40 (95.2)	
Non-malignancy Indications				-
Median Arcuate Ligament Syndrome	12 (28.6)	-	12 (28.6)	
Pancreatitis	15 (35.7)	-	15 (35.7)	
Other	15 (35.7)	-	15 (35.7)	
Presence of Intraoperative Complications	11 (7.8)	9 (9.1)	2 (4.8)	0.171
Neurologic Injury	1 (0.7)	1 (1.0)	0 (0.0)	
Patient Intolerance to Procedure	3 (2.1)	2 (2.0)	1 (2.4)	
Pneumothorax	1 (0.7)	1 (1.0)	0 (0.0)	
Suboptimal Contrast Spread	3 (2.1)	3 (3.0)	0 (0.0)	
Technical Challenge	3 (2.1)	2 (2.0)	1 (2.4)	
None	130 (92.2)	90 (90.9)	40 (95.2)	
Presence of Postoperative Complications	12 (8.5)	8 (8.1)	4 (9.5)	0.051
Bleeding	4 (2.8)	1 (1.0)	3 (7.1)	
Neurologic Injury	1 (0.7)	1 (1.0)	0 (0.0)	
Other	7 (5.0)	6 (6.1)	1 (2.4)	
None	129 (91.5)	91 (91.9)	38 (90.5)	
Diarrhea	32 (22.7)	24 (24.2)	8 (19.0)	0.126
Hypotension	17 (12.1)	13 (13.1)	4 (9.5)	0.114
Hypertension	77 (54.6)	52 (52.5)	25 (59.5)	0.141
Localized Pain	23 (16.3)	15 (15.2)	8 (19.0)	0.104
Subjective Pain Improvement	95 (67.4)	71 (71.7)	24 (57.1)	0.355
Procedure Type				1.716
Block Only	25 (17.7)	1 (1.0)	24 (57.1)	
Neurolysis Only	43 (30.5)	32 (32.3)	11 (26.2)	
Block and Neurolysis	73 (51.8)	66 (66.7)	7 (16.7)	
Needle Position				0.841
Antecrural	99 (70.2)	60 (60.6)	39 (92.9)	
Retrocrural	34 (24.1)	31 (31.3)	3 (7.1)	
Antecrural and Retrocrural	8 (5.7)	8 (8.1)	0 (0.0)	
Block Volume Used, mL	2.0 [2.0, 7.0]	2.0 [2.0, 4.0]	9.0 [2.0, 10.5]	1.022
Neurolysis Alcohol Volume Used, mL				
Left	10.0 [6.0, 15.0]	10.0 [6.0, 15.0]	10.0 [10.0, 14.8]	0.169
Right	10.0 [6.0, 15.0]	10.0 [5.0, 15.0]	10.0 [6.0, 10.0]	0.222
Needle Distance from Midline, mm				
Left	47.4 [39.6, 61.7]	49.6 [39.7, 64.7]	44.9 [37.7, 53.3]	0.256
Right	62.9 [48.5, 77.5]	62.9 [46.3, 76.8]	63.5 [51.3, 77.6]	0.148
Needle Tip Angle from Midline				
Left	11.0 [8.0, 14.0]	11.0 [9.0, 14.0]	10.0 [7.8, 13.3]	0.131
Right	4.0 [2.0, 8.0]	5.0 [2.0, 8.0]	3.0 [1.0, 7.0]	0.341

Table 2 cont. *Indications for procedure, intraoperative complications, postoperative complications, and technical factors.*

	Overall n = 141	Malignancy Pain n = 99	Nonmalignancy Pain n = 42	SMD
Needle Depth from Skin, mm				
Left	119.0 [102.0, 133.0]	115.0 [99.7, 129.0]	127.0 [115.8, 148.3]	0.657
Right	127.5 [109.0, 144.0]	124.0 [108.0, 144.0]	137.0 [117.0, 152.0]	0.489

Data are presented as median [quartile 1, quartile 3] or n (%) depending on variable type.
Abbreviation: SMD (standardized mean difference); mL (milliliters); mm (millimeters).

derwent interventions for malignancy-related pain, with pancreatic cancer being the predominant etiology. This phenomenon was consistent with the findings of prior literature, emphasizing the strong association of relief from pancreatic cancer pain with celiac plexus-targeted interventions (19). Among nonmalignant indications, chronic pancreatitis and median arcuate ligament syndrome were represented most commonly. These conditions are recognized for their visceral pain components and potential benefit from sympathetic blockades. Most patients were receiving home opioids, highlighting how CPB/CPN was often pursued in refractory cases as part of a multimodal pain management strategy.

We found that intra- and postoperative complication rates were low and comparable to those reported in prior meta-analyses (3). Side effects such as hypotension (12.1%), diarrhea (22.7%), and localized pain (16.3%) occurred in a minority of patients and might have reflected parasympathetic predominance following effective sympathetic blockades (8). Hypertension was a common finding (54.6%), most likely due to underlying chronic hypertension or to procedural discomfort during sedation. More serious complications, such as permanent neurologic injury and pneumothorax, may arise due to the close anatomical relationship of the celiac plexus to the spinal canal and diaphragm. Neurologic injury and pneumothorax occurred only once each in this study, reflecting the safety and low incidence of serious complications of CPB and CPN. According to the subjective reports used in the study, 67.4% of patients experienced improvements in pain after the procedure. These post-procedure outcomes—a low incidence of complications as well as improvements in pain—make CPB/CPN a favorable technique for those with medication-refractory abdominal pain.

Technical variations between the malignant and nonmalignant groups were observed primarily in the realms of procedure type and block volume. Patients with malignancy were significantly likelier to undergo both diagnostic block and neurolysis, while nonmalignant cases received higher volumes of local anesthetic, reflecting a more conservative, reversible approach. This practice aligns with ASA Choosing Wisely guidelines, which advise against the use of neurolytic blocks for non-cancer pain. Despite the potential of malignancy to cause anatomical distortion, we found no significant differences between the groups in major procedural metrics such as needle placement, angle, depth, or laterality—suggesting that a consistent technical approach could be maintained across patient populations. Most procedures were performed via a posterior (prone) approach, and the vast majority targeted the antecrural space. Needle trajectory occasionally traversed nearby structures, including the bowel, liver, vertebral disc, or kidney, yet complications remained infrequent. These findings suggest that careful technique with real-time imaging allows for effective and safe targeting of the celiac plexus, even in anatomically complex scenarios. The combination of a low complication rate, technical variability, and reported pain improvement suggests that contrast-enhanced imaging can reliably confirm the celiac plexus location and facilitate an effective block and/or neurolysis in experienced hands.

In this single-institution retrospective analysis, CT-guided celiac plexus interventions were safe and well tolerated across both malignant and nonmalignant pain populations. Technical parameters were generally consistent between groups, with the main differences observed in procedure type and injectate volume. Complication rates were low, and common side effects were in line with the known physiological consequences of sympathetic blockades. These findings underscore the feasibility and safety of CT-guided CPB and CPN and highlight the need for future prospective studies to evaluate the relationship between technical variation and clinical outcomes, including pain relief and opioid reduction.

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