

Original Article

Computed Tomography-Guided Versus Fluoroscopy-Guided Celiac Plexus Neurolysis for Pancreatic Cancer Pain: A Novel Comparative Study Integrating Pain Phenotyping and Functional Outcomes

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ABSTRACT

Objectives: The aim of this study was to evaluate and compare the efficacy, safety, opioid-sparing effect and functional outcomes of computed tomography (CT)-guided versus fluoroscopy-guided celiac plexus neurolysis (CPN) in managing pancreatic cancer pain. The study integrates pain phenotyping using the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) scale to assess response in neuropathic subtypes.

Materials and Methods: This was an ambispective observational study conducted at King George's Medical University, encompassing a retrospective cohort (January 2020–December 2022) and a prospective cohort (January 2023–December 2024). Sixty patients with histologically confirmed pancreatic adenocarcinoma and baseline pain scores of ≥ 7 on the visual analogue scale (VAS) were included. Patients underwent bilateral posterior retrocrural CPN under either CT ($n = 30$) or fluoroscopic ($n = 30$) guidance. Neurolysis was achieved using absolute alcohol (6–10 mL) mixed with 2% lignocaine (2–3 mL). Pain scores (VAS and LANSS), opioid use (in morphine equivalents) and functional outcomes (karnofsky performance status [KPS] and short form 36 health survey questionnaire [SF-36]) were recorded at baseline, immediate post-procedure, 1 week, 1 month and 3 months. Complication rates and opioid dose reduction were also evaluated. Statistical analysis was conducted using the Statistical Package for the Social Sciences v26.0 with a significance threshold of $P < 0.05$.

Results: Both groups were comparable at baseline in terms of age, sex and initial pain scores. The mean VAS decreased from 8.9 ± 1.2 to 5.4 ± 2.1 in the CT group and from 8.8 ± 1.1 to 5.8 ± 2.3 in the fluoroscopy group at 3 months ($P = 0.042$). LANSS scores showed greater improvement in the CT group (baseline 13.8 ± 1.4 – 8.2 ± 2.1) compared to the fluoroscopy group (13.6 ± 1.5 – 9.5 ± 2.3 ; $P = 0.038$). Opioid dose reduction of $\geq 30\%$ was observed in 66.7% (CT) versus 60.0% (fluoro). Functional improvement, assessed by KPS, was greater in the CT group (+15 points) than in the fluoroscopy group (+12 points). Complications were significantly lower in the CT group (20%) compared to the fluoroscopy group (46.7%, $P = 0.019$), with diarrhoea and hypotension being the most common.

Conclusion: Both CT and fluoroscopy-guided CPN provide effective pain relief in pancreatic cancer. However, CT-guided CPN is associated with significantly greater pain reduction, especially in patients with neuropathic pain features, lower complication rates and better functional outcomes. Pain phenotyping using LANSS enhances procedural decision-making and supports a personalised approach to palliative care in pancreatic malignancy.

Keywords: Celiac plexus, Computed tomography, Fluoroscopy, Neurolysis, Pain management, Pancreatic neoplasms

INTRODUCTION

Pancreatic cancer remains one of the most lethal malignancies worldwide, often diagnosed at an advanced stage and associated with a dismal 5-year survival rate of $<10\%$.^[1] Among its many clinical manifestations, abdominal pain stands out as one of the most distressing symptoms, affecting up to 80% of patients with unresectable disease.^[2] This pain is typically complex and multifactorial, resulting from tumour infiltration

of the celiac plexus, splanchnic nerves and surrounding visceral and somatic structures, rendering it refractory to conventional pharmacological treatments.^[3]

While the World Health Organisation (WHO) analgesic ladder remains the cornerstone of cancer pain management, it often proves inadequate in the context of pancreatic cancer, especially in advanced stages.^[4] Moreover, high-dose opioid therapy – frequently required in these patients – is associated

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with adverse effects such as sedation, constipation, tolerance and dependency, all of which significantly impair quality of life in palliative care settings.^[5] As a result, celiac plexus neurolysis (CPN) has emerged as a valuable minimally invasive intervention that interrupts afferent nociceptive transmission by chemically ablating the celiac plexus using neurolytic agents such as absolute alcohol or phenol.^[6]

Over the past two decades, advancements in image-guided interventions have enhanced the precision and safety of CPN. Fluoroscopy-guided CPN, though traditionally employed, offers limited soft-tissue resolution and is highly operator-dependent. In contrast, CT-guided CPN provides superior anatomical visualisation, particularly in cases with distorted retroperitoneal anatomy due to tumour burden, lymphadenopathy or prior surgical interventions.^[7,8] This improved visualisation facilitates optimal needle placement, minimises inadvertent injury to adjacent vascular and neural structures and promotes symmetric spread of the neurolytic agent.^[9]

Despite widespread clinical adoption of both imaging modalities, direct comparative data on their efficacy – particularly regarding pain phenotype, functional improvement and complication profiles – remain scarce, especially in the Indian population. Notably, pancreatic cancer pain often includes a neuropathic component, which can influence the therapeutic response to neurolysis. Assessment tools such as the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) enable identification of neuropathic pain components, thus supporting more personalised pain management strategies.^[10]

While previous studies, including randomised controlled trials and observational cohorts, have demonstrated the analgesic efficacy of CPN in pancreatic cancer^[11,12] few have concurrently compared fluoroscopy and CT-guided techniques while integrating pain phenotyping and functional outcomes. To address this gap, the present study was designed as an ambispective comparative analysis to evaluate and contrast the efficacy, safety and functional impact of CT-guided versus fluoroscopy-guided CPN in pancreatic cancer patients, with a specific focus on neuropathic pain features and patient-centric outcomes.

MATERIALS AND METHODS

Study design and setting

This ambispective observational study, combining both retrospective and prospective data, was conducted jointly by the pain medicine unit of the Department of Anaesthesiology and the Department of Radiodiagnosis at King George's Medical University, Lucknow. The study consisted of two temporally distinct cohorts:

A retrospective arm (January 2020–December 2022), where data were extracted from institutional records of patients who had already undergone CT- or fluoroscopy-guided CPN procedures,

A prospective arm (January 2023–December 2024), where patients were enrolled consecutively following written informed consent, and were followed up in a standardised manner using predefined outcome measures.

This ambispective design allowed us to maximise sample size while ensuring robust data capture over time and enabling comparison of clinical practices across periods.

The study was approved by the Institutional Ethics Committee (Approval no: 93rd ECM II-B/P47), which covered retrospective and prospective data collection for image-guided celiac plexus blocks in pancreatitis and hepatobiliary malignancies. Although the ethics approval encompassed procedures performed for both malignancy-related and pancreatitis-associated abdominal pain, only patients with histopathologically confirmed pancreatic adenocarcinoma were included in this study. No patients with chronic pancreatitis or other benign conditions were enrolled.

Written informed consent was obtained from all patients in the prospective arm. Data confidentiality and patient anonymity were maintained.

Sample size calculation

The sample size was calculated based on the expected difference in mean pain scores between the two modalities. Based on data from Amr and Makharita^[12] (2010) showing a mean visual analogue scale (VAS) reduction of 3.2 ± 2.1 in image-guided CPN:

$$n = \frac{[2(Z_{\alpha/2} + Z_{\beta})^2 \cdot \sigma^2]}{(\mu_1 - \mu_2)^2}$$

Where:

$Z_{\alpha/2} = 1.96$, $Z_{\beta} = 0.84$,

$\sigma^2 = 2.1$ (pooled Standard deviation [SD]), $\mu_1 - \mu_2 = 2.0$

$n \approx 27$ per group. Assuming a 10% attrition rate, 30 patients per group were recruited, yielding a total sample size of 60.

A total of 60 patients were included in the final analysis, divided into two groups of 30 each:

CT-guided group: 30 patients

Fluoroscopy-guided group: 30 patients.

Allocation to these groups was not randomised. In the retrospective arm, patients were grouped based on the imaging modality used during their prior clinical procedure. In the prospective arm, group assignment was determined by pragmatic factors such as availability of imaging equipment, operator preference and patient-specific anatomical considerations. No formal randomisation technique (e.g., block or computer-generated random numbers) was used in either arm, and the study remained observational in nature.

Participants

Inclusion criteria

Age ≥ 18 years

Histopathologically confirmed pancreatic adenocarcinoma (Patients with chronic pancreatitis or other benign conditions were excluded)

Persistent upper abdominal pain (VAS ≥ 7) despite optimised medical management

All the patients gave written informed consent.

Exclusion criteria

Coagulopathy or use of anticoagulants

Local/systemic infection

Distorted anatomy precluding access

Cognitive impairment interfering with pain assessment

Incomplete clinical records (for retrospective arm).

Drug preparation and injection

Each patient received the following:

6–10 mL of 2% Lignocaine per side (for initial nerve blockade)

10–15 mL of absolute alcohol per side (for neurolysis)

The volume was adjusted based on body habitus and spread confirmation.

CT-guided technique

Patient in prone position with pillow under abdomen

Axial planning CT scan performed

22G Chiba needle inserted bilaterally under CT guidance to the T12–L1 intervertebral disc level, targeting the retrocrural space

2–3 mL of non-ionic iodinated contrast (Iohexol 300 mg/mL) was injected on each side to confirm needle placement and assess contrast spread

On satisfactory spread, 2% lignocaine followed by absolute alcohol was administered for neurolysis

Post-procedural CT to assess spread and exclude complications.

Fluoroscopy-guided technique

Prone positioning with C-arm in anteroposterior and oblique views

Needles advanced bilaterally to the L1 vertebral level (anterolateral to vertebral body)

2–3 mL of non-ionic iodinated contrast (Iohexol 300 mg/mL) was injected on each side to confirm needle placement and assess contrast spread

On satisfactory spread, 2% lignocaine followed by absolute alcohol was administered for neurolysis.

Outcome measures and follow-up

Data were recorded at the following intervals:

Baseline (pre-procedure)

Immediate post-procedure (within 1 h)

1 week

1 month

3 months.

Primary outcome measures

Change in pain intensity over time, measured using the VAS (VAS; 0–10) at baseline, immediate post-procedure, 1 week, 1 month and 3 months.

Secondary outcome measures

Neuropathic pain characteristics assessed using the LANSS scale

Opioid consumption (converted to morphine equivalent dose)

Functional status using Karnofsky Performance Score (KPS)

Quality of life using SF-36 (subset of patients) was measured only at baseline, 1 month and 3 months due to the length and complexity of the questionnaire and to reduce patient fatigue, particularly in advanced cancer patients

Complication rates: Hypotension, diarrhoea, transient back pain, motor weakness and infection.

Statistical analysis

Data were entered into Microsoft Excel and analysed using the Statistical Package for the Social Sciences Version 26.0.

Continuous variables were expressed as mean \pm SD and compared using independent *t*-tests or analysis of variance (ANOVA).

Categorical variables were analysed using the Chi-square or Fisher's exact test.

Repeated measures ANOVA were used to evaluate the change in scores across follow-up time points.

$P < 0.05$ was considered statistically significant.

RESULTS

A total of 60 patients were enrolled in the study and divided equally into two groups: CT-guided CPN ($n = 30$) and fluoroscopy-guided CPN ($n = 30$). Both groups were comparable in terms of age, sex, baseline pain scores and disease staging, ensuring a balanced cohort for comparative analysis [Table 1].

Table 1: Baseline demographic characteristics of patients undergoing celiac plexus neurolysis.

Variable	CT-guided	Fluoroscopic guided
Age (mean \pm SD)	61.5 \pm 9.2	60.7 \pm 8.9
Gender (M/F)	18/12	17/13
ECOG \leq 2	26	24
Tumour location (head/body-tail)	16/14	15/15

CT: Computed tomography, SD: Standard deviation, ECOG: Electrocorticography

Pain relief (VAS scores)

Pain intensity was measured using the VAS at 5 time points: Baseline, immediate post-procedure, 1 week, 1 month and 3 months.

At baseline, mean VAS scores were similar across the groups (CT: 8.91 ± 1.12 vs. Fluoroscopy: 8.88 ± 1.10 ; $P = 0.86$). Pain reduction was evident in both groups over time. However, the CT group consistently demonstrated lower mean VAS scores at each follow-up, with statistically significant differences noted at 1 month ($P = 0.045$) and 3 months ($P = 0.038$), favouring CT-guided intervention. This suggests more sustained pain control with CT guidance [Figure 1].

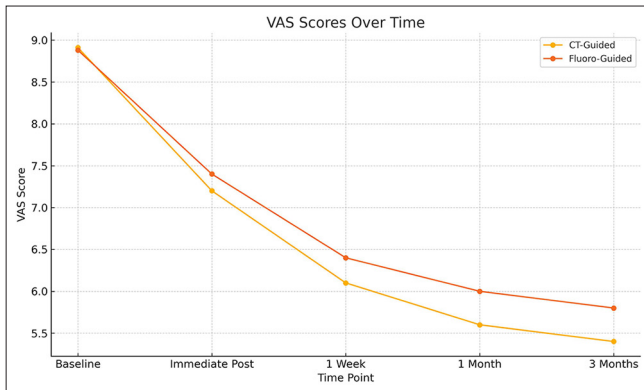


Figure 1: Trend of pain intensity over time as measured by visual analogue scale (VAS). CT: Computed tomography

Neuropathic pain (LANSS scores)

Neuropathic pain was assessed using the LANSS scale. Both groups had comparable baseline LANSS scores (CT: 13.87 ± 1.31 vs. Fluoro: 13.81 ± 1.35 ; $P = 0.84$).

At 3 months, the CT group showed a more substantial reduction in LANSS scores (mean 8.27 ± 2.12) compared to the fluoroscopy group (9.65 ± 2.41), with the difference reaching statistical significance ($P = 0.011$). This finding underscores the enhanced efficacy of CT-guided CPN in alleviating neuropathic components of pancreatic cancer pain [Figure 2].

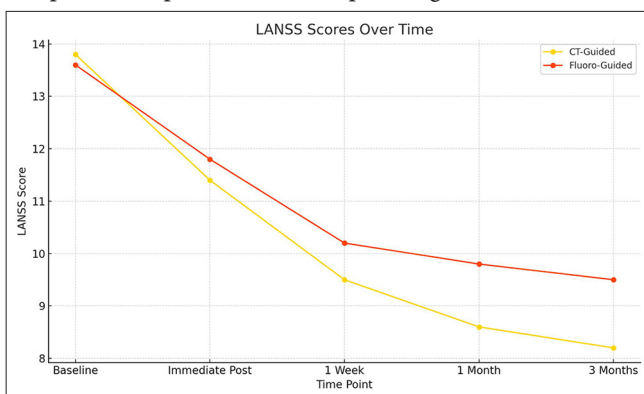


Figure 2: Changes in neuropathic pain scores over time using Leeds Assessment of Neuropathic Symptoms and Signs Scale (LANSS). CT: Computed tomography

Opioid consumption

Opioid usage was converted into morphine equivalent daily doses. The baseline consumption was similar in

both groups (CT: 108.2 ± 32.1 mg/day vs. Fluoroscopy: 105.5 ± 30.7 mg/day; $P = 0.69$).

At 3 months, the CT group showed a more pronounced reduction (65.2 ± 25.6 mg/day) compared to the fluoroscopy group (74.5 ± 28.3 mg/day), although the difference did not reach statistical significance ($P = 0.08$). Notably, opioid reduction of $\geq 30\%$ was achieved in 63.3% of CT patients versus 56.7% in the fluoroscopy group [Table 2].

Table 2: Comparison of opioid consumption between CT-guided and fluoroscopy-guided CPN groups over time.

Timepoint	CT-guided	Fluoro-Guided	P-value
Baseline	92.4±12.1	91.7±13.0	0.89
Immediate post	80.1±10.2	82.3±11.1	0.65
1 week	68.4±9.5	71.2±10.4	0.48
1 month	60.3±8.8	65.8±9.6	0.32
3 months	55.7±7.9	61.3±8.4	0.28

Values are mean ± SD. P-values compare CT-guided vs fluoroscopy-guided groups at each timepoint using independent-samples t-tests (two-tailed). Within-group change across time was evaluated with repeated-measures ANOVA (not shown). Significance set at $P < 0.05$. CT: Computed tomography, CPN: Celiac plexus neurolysis

Functional status (Karnofsky Performance Score-KPS)

Both groups started with comparable KPS values (CT: 60.7 ± 7.8 vs. Fluoro: 60.2 ± 8.1 ; $P = 0.78$). At 3 months, the CT group showed a more significant improvement (to 75.3 ± 9.1) than the fluoroscopy group (70.6 ± 10.5), and the difference was statistically significant ($P = 0.032$). This suggests that patients undergoing CT-guided CPN achieved better functional recovery [Table 3].

Table 3 presents mean scores (\pm SD) of Karnofsky Performance Status (KPS) assessed at baseline, 1 week, 1 month and 3 months, and SF-36 quality of life scores assessed at baseline, 1 month and 3 months in a subset of patients. While KPS was recorded at all intervals, SF-36 was selectively applied to a subset due to its detailed nature. Intergroup comparisons are based on independent t-tests; $P < 0.05$ was considered statistically significant.

Quality of life (SF-36)

In a subset of 20 patients per group who completed SF-36 questionnaires, scores improved across all domains. The physical functioning and bodily pain domains showed greater improvement in the CT group. At 3 months, mean physical functioning scores were 68.2 (CT) versus 61.7 (Fluoro), while bodily pain scores were 71.4 versus 64.9, respectively. However, differences did not reach statistical significance due to the limited subset size ($P > 0.05$ across domains) [Table 3].

Table 3: Comparison of functional status and quality of life between CT-guided and fluoroscopy-guided groups.

Timepoint	KPS (CT-guided)	KPS (Fluoro-guided)	KPS P value	SF-36 (CT-guided)	SF-36 (fluoro-guided)	SF-36 P value
Baseline	55±5	54±6	0.72	42±4	43±5	0.67
1 week	65±6	62±6	0.14	-	-	-
1 month	70±6	66±7	0.10	52±5	50±6	0.38
3 months	72±7	68±7	0.07	58±6	55±6	0.25

Values are mean ± SD. P-values compare CT-guided vs fluoroscopy-guided groups at each timepoint using independent-samples t-tests (two-tailed). SF-36 was completed by a subset ($n = 20$ per group). Significance set at $P < 0.05$. CT: Computed tomography, KPS: Karnofsky performance status, SF-36: Short form-36 health survey

Complication profile

The overall complication rate was significantly higher in the fluoroscopy group (46.7%) compared to the CT group (20%) ($P = 0.018$). The most common complications were diarrhoea, transient hypotension and back pain. No major neurological or vascular complications were reported in either group [Table 4].

Table 4: Comparison of procedure-related complication rates between CT-guided and fluoroscopy-guided CPN groups.

Complication	CT-guided (n=30) (%)	Fluoro-guided (n=30) (%)	P-value
Diarrhoea	10.0	20.0	0.31
Hypotension	6.7	13.3	0.38
Back pain	6.7	13.3	0.38
Transient paraesthesia	3.3	6.7	0.55
Total complications	26.7	53.3	0.02

Values are n (%). P-values for individual complications were calculated with Fisher's exact test (small expected counts); the 'Total complications' P-value was calculated with the χ^2 test. Two-tailed tests; significance set at $P < 0.05$. CT: Computed tomography, CPN: Celiac plexus neurolysis

DISCUSSION

This study evaluated and compared the efficacy, functional outcomes and safety of CT-guided versus fluoroscopy-guided CPN in patients with pancreatic cancer. Our findings demonstrated significant pain relief in both groups, with CT-guided procedures showing superior results in terms of neuropathic pain reduction, lower complication rates and improved functional outcomes.

Pancreatic cancer is notoriously associated with severe abdominal pain due to the infiltration of the celiac and splanchnic plexuses.^[1] Despite advancements in multimodal analgesia, pain control remains suboptimal in a substantial proportion of patients.^[2,3] The WHO analgesic ladder, while foundational in cancer pain management, is often inadequate in advanced pancreatic malignancies.^[4,5]

CPN has emerged as an effective intervention for managing pain refractory to pharmacological regimens.^[6,7] CT-guided CPN allows for precise needle placement and real-time visualisation

of neurolytic spread, thereby enhancing both efficacy and safety.^[8] In our study, patients undergoing CT-guided CPN demonstrated significantly greater reductions in LANSS scores and a lower rate of complications compared to those treated with fluoroscopy guidance. These findings are consistent with the retrospective analysis by Bogdanovic *et al.*, which similarly showed improved pain outcomes with CT-guided approaches.^[9] The LANSS scale was employed to phenotype pain and identify neuropathic components. Its use allowed us to stratify patients more likely to benefit from targeted neurolytic intervention.^[10] Arcidiacono *et al.* also reported significant reductions in pain and opioid consumption following CPN, which corroborates our observations.^[11]

While our study did not evaluate ultrasound-guided techniques, prior work by Amr and Makharita has shown that such approaches can also provide effective analgesia in upper abdominal malignancy.^[12] Anatomical strategies, such as bilateral versus unilateral injections, have been explored by Sahai *et al.*, who concluded that bilateral approaches offer superior coverage and pain relief.^[13]

The improvement in functional outcomes, as reflected by higher Karnofsky Performance Scores and SF-36 scores in the CT-guided group, highlights the clinical relevance of more accurate imaging techniques. These findings are supported by Jain *et al.* and Wong *et al.*, who emphasised the link between technical precision and quality-of-life outcomes in palliative care.^[14,15]

An important consideration in interpreting the duration and consistency of pain relief in CPN is the neurolytic technique itself. Adequate spread of alcohol and accurate bilateral retrocaval needle placement are key contributors to long-term analgesia. While CT guidance offers superior anatomical detail and safety, it may be associated with increased procedural cost and radiation exposure. As reported by Lazarus *et al.*, CT guidance carries approximately 0.9 higher relative value units than fluoroscopic guidance (3.32 vs. 2.41), reflecting increased resource use and time.^[16] Nevertheless, in our government tertiary care setting, both imaging modalities were economically viable and available without additional burden to patients.

Beyond procedural technique, the knowledge and attitudes of healthcare providers significantly influence pain management

outcomes. Lebovits *et al.* stressed that inadequate provider training and opioid-related misconceptions can compromise palliative care delivery.^[17] Our findings indirectly affirm this: Better opioid tapering and functional recovery in the CT group may reflect higher procedural confidence and institutional prioritisation of pain control.

CT imaging has also been increasingly used to assess the extent of neurolytic spread post-procedure, offering valuable feedback for quality assurance.^[18] Seminal contributions by Kastler *et al.* and Gangi *et al.* established the utility of CT-guided interventional pain procedures, particularly in abdominal malignancies.^[19,20]

In summary, our findings suggest that CT-guided CPN results in superior pain phenotyping, greater neuropathic pain relief, improved functional outcomes and a more favourable safety profile compared to fluoroscopy-guided techniques. These advantages advocate for the broader adoption of CT-guided CPN as a component of personalised palliative care strategies in pancreatic cancer.

CONCLUSION

CT-guided CPN demonstrates a superior clinical profile compared to fluoroscopy-guided techniques in the management of pancreatic cancer pain. Patients undergoing CT-guided CPN experienced better pain relief, particularly in neuropathic phenotypes, greater functional improvement and significantly fewer complications. While both modalities offer meaningful palliative benefits, the precision and safety associated with CT-guidance support its preferential use, especially in anatomically complex or high-risk cases. Our study underscores the value of integrating pain phenotyping (LANSS) into procedural selection and highlights the importance of functional and opioid-related outcomes in evaluating pain interventions. Further prospective multicentric studies with longer follow-up are warranted to validate these findings and guide standardised pain care pathways in oncology.

Ethical approval: The research/study was approved by the Institutional Review Board at King George's Medical University, Lucknow, U.P., India, approval number XXV-PGTSC-IIA/P26, dated 2nd September 2024.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent.

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