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Celiac plexus radiosurgery for refractory pain in metastatic pancreatic adenocarcinoma: first institutional report from Argentina

Abstract

Background: Perineural invasion in pancreatic ductal adenocarcinoma (PDAC) frequently results in severe, refractory abdominal pain due to celiac plexus involvement. Conventional analgesic strategies and neurolytic procedures often provide incomplete or transient relief. Stereotactic body radiotherapy (SBRT) targeting the celiac plexus has emerged as a non-invasive ablative alternative for pain control.

Case presentation: We report the case of a 67-year-old man with metastatic PDAC and debilitating celiac plexus–related pain refractory to high-dose opioids and prior celiac plexus neurolysis. At presentation, the patient had a Karnofsky Performance Status (KPS) of 40–50 and required a maximum daily oral morphine equivalent dose of 92 mg.

Intervention: The patient underwent single-fraction SBRT (25 Gy) directed to the celiac plexus using volumetric modulated arc therapy (VMAT) with dose-painting optimization to spare adjacent bowel structures. Pain response was assessed using the Brief Pain Inventory–Short Form (BPI-SF), and toxicity was graded according to Radiation Therapy Oncology Group (RTOG) criteria. A complete analgesic response was predefined as a pain score ≤2 without opioid requirement.

Results: SBRT resulted in a rapid and progressive reduction in pain intensity, culminating in a complete analgesic response by week 3. Pain scores decreased from 9–10/10 at baseline to complete resolution, accompanied by full opioid discontinuation (from 92 mg to 0 mg daily oral morphine equivalent). This response was sustained for three months and was associated with marked functional recovery, with KPS improving from 40–50 to 90. Treatment was well tolerated, with only Grade 1 nausea and no significant gastrointestinal toxicity.

Conclusion: Celiac plexus SBRT appears to be a safe and effective non-invasive strategy for refractory pancreatic cancer–related pain, even after failed neurolytic intervention. This case supports its integration into multidisciplinary palliative care strategies and warrants further prospective investigation.

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Introduction

Pancreatic ductal adenocarcinoma (PDAC) is an aggressive malignancy characterized by a high metastatic potential.[1] Perineural invasion (PNI) occurs early in the course of the disease with high incidence and is directly associated with poor prognosis and significant deterioration in quality of life. The management of PDAC with perineural involvement is particularly challenging, and local or regional recurrence rates may reach up to 60%.[2] PNI can lead to inflammation, neuropathic pain, sensory disturbances, numbness, and even motor dysfunction.[3] Clinically, it commonly presents as epigastric pain radiating in a band-like distribution toward the lumbar region, a manifestation known as celiac plexus pain syndrome.[4]

The celiac plexus is a dense network of interconnected nerve fibers linking the celiac, superior mesenteric, and renal ganglia.[5] Anatomically, it is located along the anterolateral surface of the abdominal aorta, surrounding the origin of the celiac trunk and superior mesenteric artery. Although it demonstrates considerable variability in size and position, approximately 94% of celiac ganglia are located at the T12 or L1 vertebral levels.[6]

Current palliative approaches rely on a multimodal strategy for pain management, including systemic analgesics, celiac nerve blockade, and systemic chemotherapy.[7,8] Opioid analgesics (e.g., morphine, oxycodone, fentanyl) are frequently required; however, the high doses often necessary are associated with dose-limiting adverse effects such as constipation, sedation, pruritus, and nausea. These toxicities may compromise adequate pain control and negatively impact patient quality of life.[9]

In refractory cases, interventional procedures such as celiac plexus block or neurolysis are employed. These techniques involve the injection of local anesthetics or neurolytic agents (ethanol or phenol) under imaging guidance.[10] Although they may provide temporary symptom relief, responses are variable, the duration of effect is often limited, and procedure-related complications may occur.[7]

In this context, stereotactic body radiotherapy (SBRT) specifically targeting the celiac plexus has emerged as a non-invasive alternative for pain control in patients with pancreatic cancer and other retroperitoneal malignancies. This approach is based on high-precision ionizing radiation–induced neural ablation, aiming to interrupt nociceptive signal transmission without the need for percutaneous intervention.[11]

The multicenter phase II trial led by Lawrence et al. represented the first international prospective evaluation of the safety and efficacy of this strategy. In that study, 125 patients with advanced cancer (92% with pancreatic cancer) received a single fraction of 25 Gy, directed to the celiac plexus.[4] At three weeks, 53% of evaluable patients

achieved partial or complete pain response, defined as a ≥2-point reduction on the Brief Pain Inventory–Short Form (BPI-SF) scale[12] compared with baseline. A trend toward reduced opioid consumption and improvement in pain-related interference with daily activities was also observed. Regarding safety, most adverse events were mild to moderate, predominantly transient abdominal pain and fatigue, while severe gastrointestinal toxicity attributable to treatment was infrequent.

Herein, we present a case report describing the methodology and clinical outcomes of a patient treated at our institution with celiac plexus radiosurgery.

Case presentation

A 67-year-old male with metastatic pancreatic cancer was referred to our Radiation Oncology Department due to uncontrolled abdominal pain refractory to pharmacologic management and prior celiac plexus alcohol neurolysis.

Past medical history

The patient's relevant surgical history included a gastric bypass performed 25 years earlier, without subsequent complications. No significant comorbidities or relevant family oncologic history were reported.

History of present illness

The patient initially presented with a 3-month history of dyspepsia and early satiety associated with unintentional weight loss. Imaging studies revealed a pancreatic head mass with local infiltration and a spiculated celiac chain lymph node. Serum CA 19-9 level was 12,000 U/mL.

Percutaneous fine-needle biopsy of the celiac lymph node confirmed the diagnosis of pancreatic ductal adenocarcinoma. Systemic chemotherapy was initiated with nab-paclitaxel plus gemcitabine, followed by second-line treatment with CAPOX due to disease progression.

Two months after initiation of systemic therapy, the patient developed severe epigastric pain described as sharp and stabbing, radiating bilaterally in a hemi-belt distribution toward the lumbar region. Analgesic treatment was initiated with oral tramadol 50 mg every 4 hours in combination with depot corticosteroids.

Follow-up magnetic resonance imaging demonstrated a hypotrophic appearance of the pancreatic body and tail, persistent celiac lymphadenopathy measuring 30 × 28 mm (previously 24 mm), and a focal hepatic lesion in segment VIII suspicious for metastasis. During this period, pain remained partially controlled, although intermittent exacerbations required the addition of paracetamol 500 mg every 6 hours to the tramadol regimen.

One month later, the patient experienced significant pain exacerbation and underwent celiac plexus neurolysis. He reported good pain relief on the day of the procedure; however, within 24 hours, nonspecific abdominal pain recurred. Analgesia was escalated to codeine 30 mg combined with paracetamol 500 mg every 6 hours, along with pregabalin 300 mg/day.

Despite this regimen, the patient required emergency department visits every four days, during which he received 10 mg intravenous morphine for breakthrough pain. After two

weeks of persistent inadequate pain control, he was admitted for optimization of analgesic therapy, requiring intravenous morphine 10 mg every 6 hours with 3 mg rescue doses. He was subsequently referred to Radiation Oncology for further evaluation.

The patient had not previously received any form of radiotherapy.

Initial evaluation

At the time of the initial consultation in our department, the patient had been hospitalized for four days due to inadequate pain control despite receiving intravenous morphine 10 mg every 6 hours with additional 3 mg rescue doses as needed.

He described severe, sharp epigastric pain radiating bilaterally in a hemi-belt distribution toward the lumbar region.

According to the Brief Pain Inventory – Short Form (BPI-SF), the average pain intensity at rest was 9/10, with frequent exacerbations reaching 10/10 during the preceding 14 days.

Functional assessment revealed a Karnofsky Performance Status (KPS) of 40–50 and an ECOG Performance Status of 3, indicating significant impairment in daily functioning and substantial pain-related deterioration in quality of life.

Intervention

The patient provided written informed consent prior to treatment. In preparation for stereotactic radiotherapy, systemic chemotherapy was temporarily suspended from 6 days before treatment until 6 days after irradiation to minimize the risk of overlapping toxicities.

On the day of treatment, prophylactic antiemetic therapy was administered intravenously, consisting of dexamethasone 4 mg and ondansetron 8 mg prior to radiation delivery. In addition, pantoprazole 40 mg daily was prescribed for one month following treatment for gastric protection.

Pain control and quality-of-life outcomes were prospectively monitored using the validated Brief Pain Inventory–Short Form (BPI-SF).[12] Gastrointestinal toxicity was assessed according to the Radiation Therapy Oncology Group (RTOG) acute radiation morbidity scoring criteria.[13]

Treatment planning and delivery

Treatment preparation and delivery were performed according to our institutional SBRT protocols, as detailed below.

Simulation and immobilization

A dedicated simulation computed tomography (CT) scan was obtained for treatment planning. The patient was positioned supine using a stereotactic body immobilization system

(BodyFix®, Sedetech) incorporating a customized vacuum cushion (Vac-Lok) conforming to the patient's body contour, along with a knee support to enhance comfort and reproducibility.

A helical CT scan was acquired with 2.5 mm slice thickness. Images were transferred to the Eclipse® treatment planning system (Varian Medical Systems, Palo Alto, CA, USA) for contouring and dosimetric planning.

Target volume delineation

The clinical target volume (CTV) was defined as a 5 mm radial expansion around the abdominal aorta in the anterior and lateral directions from T12 to L2 vertebral levels (CTV shown in Figure 1), corresponding to the anatomical location of the celiac plexus.

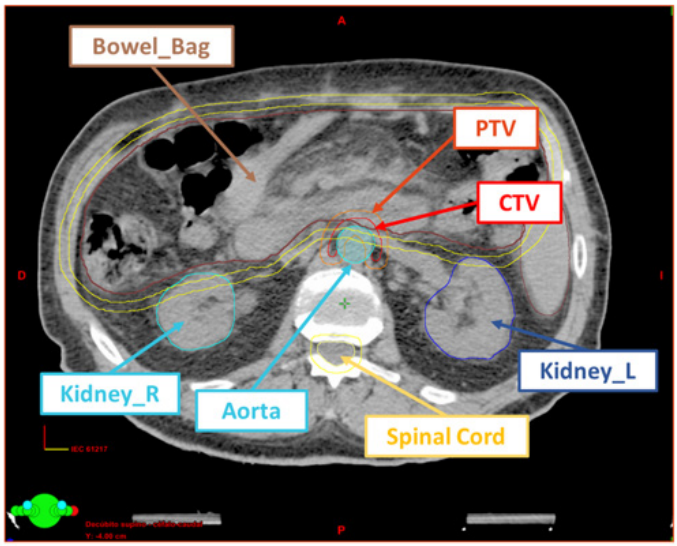

Figure 1 Target volume and organs-at-risk delineation.

A 5 mm isotropic expansion was applied to generate the planning target volume (PTV) (Figure 1).

- CTV volume: 25.8 cc
- PTV volume: 96.4 cc

Organs at risk (OARs) delineated included distal esophagus, stomach, small bowel, spinal cord, liver, and kidneys (Figure 1).

To enhance bowel protection, planning organ-at-risk volumes (PRVs) were generated by applying 5 mm and 10 mm expansions to the bowel contour (PRV_5mm_Bowel and PRV_10mm_Bowel, respectively). A spinal cord PRV was also created.

Dose prescription and planning technique

The prescribed dose was 25 Gy delivered in a single fraction, using volumetric modulated arc therapy (VMAT) with five coplanar 6 MV arcs on a Trilogy linear accelerator (Varian Medical Systems), operating in SRS mode with a dose rate of 1000 MU/min.

Dose-painting strategy

To optimize bowel sparing while maintaining ablative dosing to the celiac plexus region, a dose-painting approach was implemented.

Within the initial PTV, four sub-volumes were defined according to their proximity to the bowel (Figure 2):

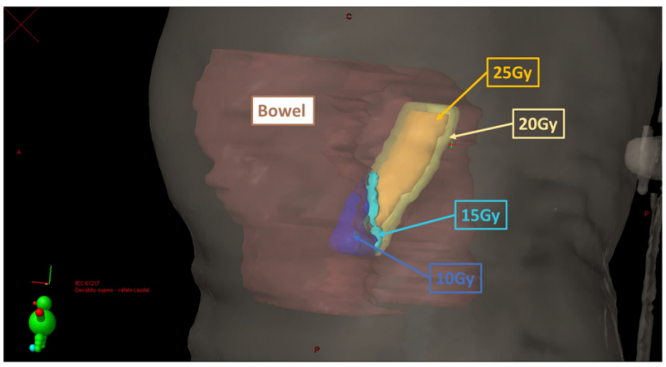

Figure 2 Definition of dose levels within the PTV.

- 25 Gy volume: CTV located >10 mm from bowel
- 20 Gy volume: PTV located >10 mm from bowel
- 15 Gy volume: PTV located 5–10 mm from bowel
- 10 Gy volume: PTV located <5 mm from bowel

This strategy allowed heterogeneous dose coverage (Figure 3), delivering ablative doses to regions safely distant from bowel while reducing dose near critical structures to minimize toxicity risk.

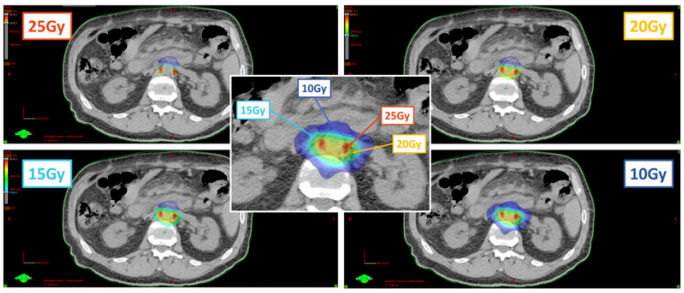

Figure 3 Dose distribution obtained using the Dose-Painting technique to protect the intestine.

The maximum bowel dose was 11.7 Gy, and bowel D30cc was 8.8 Gy.

Quality assurance

Prior to treatment delivery, the plan underwent comprehensive quality assurance according to institutional protocols, including:

- Independent monitor unit (MU) calculation
- Portal dosimetry verification
- Point-dose measurement using micro-chamber dosimetry

These procedures confirmed agreement between calculated and delivered dose distributions.

Image guidance and treatment delivery

On the day of treatment, the patient was positioned identically to simulation (Figure 4). A cone-beam CT (CBCT) was acquired for image guidance and positional verification (Figure 5).

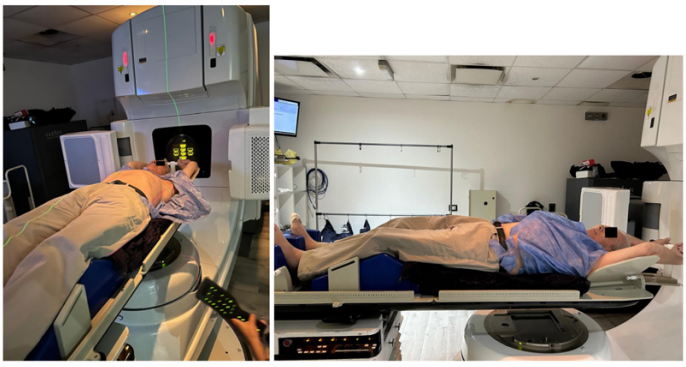

Figure 4 Patient positioning on the treatment equipment.

Treatment was delivered without complications. Total session time, including setup and imaging verification, was approximately 15 minutes.

Clinical outcomes

Pain assessment was performed from one month prior to radiotherapy until three months after treatment (Table 1). Evaluations

were conducted immediately after stereotactic body radiotherapy (SBRT), at 12 hours, 1 week, 3 weeks, and 3 months post-treatment. A complete analgesic response was defined as a pain score ≤2 without opioid requirement.

Table 1 Analgesic consumption and quality of life-related brief pain inventory-short form parameters

	2 months before RT	1 month before RT	1 week before RT	Hours after RT	1 week after RT	3 weeks after RT
Opioid consumption*	30	15.2	92	92	10	0
ECOG score	3	3	3	1	1	1
KPS	40	40	40	40	90	90
Brief pain inventory-short form 0-10 scale						
Pain at its worst in the last 24h	10	8	10	10	2	1
Pain at its least in the last 24h	9	7	9	9	1	1
Pain on average	10	8	10	10	2	1
Pain right now	9	8	10	10	1	0
Quality of life						
How the pain has interfered with the following aspects of life during the last 24 hours 0-10 scale. 0 (no pain interference), 10 (complete pain interference)						
General activity	9	8	9	9	2	0
Mood	9	8	6	6	2	0
Walking ability	8	4	5	5	2	0
Relations with other people	5	4	5	5	3	0
Normal work	9	8	9	9	3	0
Sleep	9	8	10	10	3	0

*The conversion factors presented as oral morphine equivalent dose (mg) were: 80 for codeine orally. 5 for intravenously morphine. 100 for tramadol orally. ECOG, eastern cooperative oncology group. KPS, karnofsky performance status; RT, radiotherapy

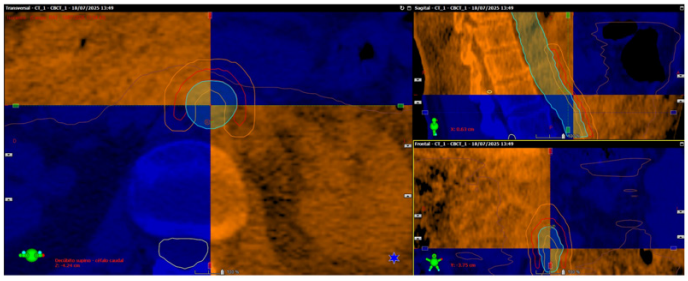

Figure 5 Image fusion between simulation CT and cone-beam CT (CBCT) for pre-treatment positioning verification.

The treatment was delivered on July 18, 2025. In the immediate post-radiotherapy period, the patient reported persistent baseline abdominal pain and Grade 1 nausea according to the Radiation Therapy Oncology Group (RTOG) toxicity criteria. During hospitalization, he maintained the same analgesic regimen required prior to treatment, consisting of intravenous morphine 10 mg every 6 hours with two additional 3 mg intravenous rescue doses.

Within the first week following SBRT, pain intensity began to decrease progressively (Figure 6). The patient was discharged on day 3 post-treatment with pregabalin 150 mg daily and tramadol 50 mg every 8 hours.

During the week preceding radiotherapy, the patient required a maximum daily dose equivalent to 92 mg of oral morphine. By week 3 after SBRT, opioid requirement had decreased to 0 mg per day, fulfilling criteria for complete analgesic response. This response was sustained throughout the subsequent three months, during which the patient remained free of opioid therapy and had fully resumed activities of daily living (Figure 7). No acute radiation-related toxicities beyond Grade 1 nausea were observed.

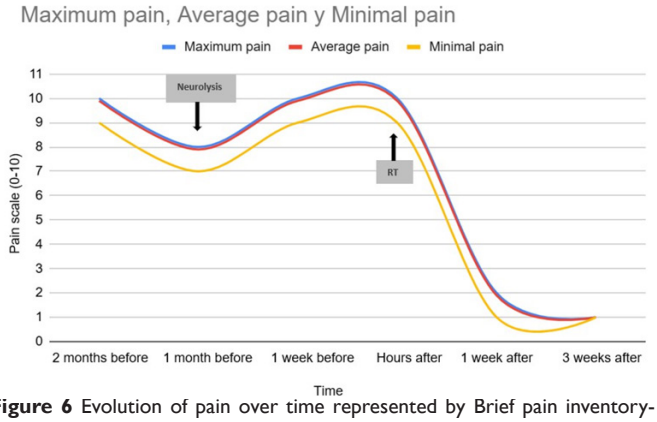

Figure 6 Evolution of pain over time represented by Brief pain inventory-short form (0-10 scale) in relation to solar plexus neurolysis and radiotherapy.

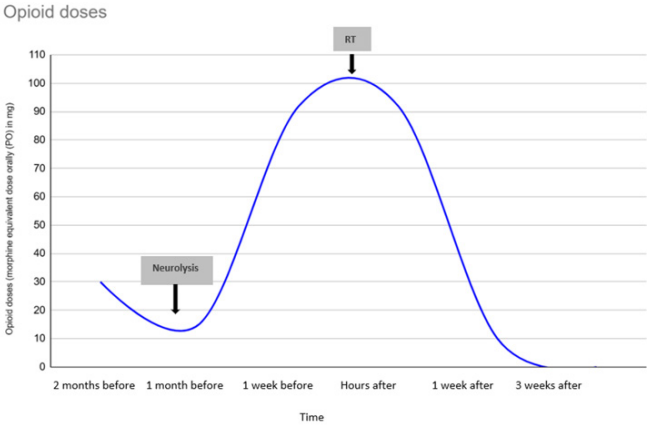

Figure 7 Morphine equivalent dose curve required by the patient over time, in relation to solar plexus neurolysis and radiotherapy.

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At three months of follow-up, the patient reported intermittent right upper quadrant abdominal pain of oppressive character. According to the Brief Pain Inventory – Short Form (BPI-sf), the average resting pain intensity was 2 out of 10, without significant exacerbations and with adequate control using oral analgesics. Functional assessment demonstrated a Karnofsky Performance Status of 90 and an ECOG Performance Status of 1, with no clinically meaningful deterioration in quality of life attributable to pain.

Magnetic resonance imaging of the abdomen performed during reassessment revealed nodular lesions suggestive of metastatic progression. The patient subsequently underwent additional SBRT in our department and, at the time of manuscript preparation, remains alive and receiving a new line of systemic therapy.

Discussion

Pain in advanced pancreatic cancer represents a major therapeutic challenge, as it is frequently severe, refractory to standard analgesic regimens, and associated with perineural invasion,[2] with a profound impact on quality of life.[3] Although opioids remain the cornerstone of cancer-related pain management, their efficacy is often incomplete and their use is limited by well-recognized adverse effects—including nausea, constipation, sedation, confusion, and dependence—as emphasized by the World Health Organization.

To our knowledge, this is the first published clinical case in Argentina describing celiac plexus radiosurgery for pain control in pancreatic cancer. This treatment was originally developed at Sheba Medical Center and has been evaluated in a phase II trial demonstrating safety and efficacy in patients with advanced pancreatic cancer and pain attributed to celiac plexus involvement.[4] That study included patients with ECOG performance status 0–2, and only 2% had previously undergone celiac plexus block or neurolysis.

In contrast, our patient presented with severe, disabling pain refractory to high-dose opioids, neuromodulators, and even prior neurolytic treatment, making stereotactic radiosurgery the last available therapeutic option. This observation positions radiotherapy not only as an early alternative but also as a potential salvage strategy after failure of invasive techniques, which may themselves be associated with acute complications.

From a technical standpoint, treatment delivery was highly reproducible. As in the phase II experience, a single ablative fraction of 25 Gy was prescribed, a dose intended to induce axonal degeneration and sustained neuromodulatory effects. The planning target volume (PTV) in our case was smaller than that reported in the trial (96.4 cc versus 157.3 cc), which may have contributed to the excellent gastrointestinal tolerance observed, particularly at the level of the duodenum. The phase II study reported Grade 3 toxicities including duodenal hemorrhage and obstruction occurring four weeks after radiotherapy, which were not observed in our patient. Acute toxicities in that series most frequently consisted of Grade 1–2 fatigue, abdominal pain, and nausea,[13] similar to the mild nausea experienced in our case.

The most remarkable finding in our report was the magnitude of pain response and complete opioid discontinuation. In the study by Hammer et al., published in 2022, treatment significantly reduced pain interference scores, decreasing from a baseline of 7.1 to 3.1 and 1.8 at three and six weeks post-treatment, respectively (both $P < 0.001$).[14] In our case, a progressive reduction in pain intensity was observed following treatment, accompanied by a decrease in maximum daily oral morphine equivalent dose from 92 mg pre-treatment to complete discontinuation by week three. This translated into a clinically meaningful improvement in quality of life, allowing full and unrestricted resumption of activities of daily living for a sustained three-month period.

In the trial by Lawrence et al.[4] baseline daily opioid use was substantial (equivalent to 31 mg intravenous morphine), and opioid administration was not restricted during the study.

Although a modest decrease in opioid consumption was observed after treatment, this reduction appeared to lag approximately three weeks behind the improvement in pain scores. The lack of early opioid reduction—even among patients with significant pain relief—may reflect the presence of non-celiac pain syndromes, such as hepatic or osseous metastases, and underscores the complexity of pain assessment in advanced malignancy. Notably, neither that study nor the study by Hammer et al. reported complete discontinuation of analgesic medication.

In our patient, based on the reported symptom characteristics and semiologic features, pain attributable to celiac plexus infiltration was clearly distinguishable from pain related to hepatic metastases in terms of location, radiation pattern, and intensity. Even after hepatic progression, the patient maintained a favorable performance status, enabling subsequent systemic therapy and SBRT to liver metastases.

When comparing this technique with endoscopic ultrasound-guided celiac plexus neurolysis (EUS-CPN) or celiac ganglia neurolysis (EUS-CGN), previous studies have demonstrated significant efficacy, reporting pain relief in approximately 70–80% of patients with pancreatic cancer.[15] Kaufman et al. reported an overall effectiveness of 72.5%.[16] Wyse et al. demonstrated that early EUS-CPN was associated with greater pain reduction at three months and a trend toward lower morphine consumption, although without impact on quality of life or survival.[17] Although most complications are not severe, significant adverse events have been reported, including retroperitoneal hemorrhage, abscess formation, and ischemic complications.[18] In our patient, alcohol neurolysis provided only 24 hours of pain relief. In contrast, stereotactic radiosurgery proved to be a non-invasive intervention associated with durable symptom control and sustained reduction in opioid use.

Conclusion

This case suggests that stereotactic body radiotherapy (SBRT) directed to the celiac plexus may represent an effective and well-tolerated palliative strategy for the management of refractory pain in patients with advanced pancreatic cancer, particularly after failure of conventional pharmacologic and interventional approaches. In this context, SBRT provided durable symptom control, complete opioid discontinuation, and preservation of functional status, without clinically significant toxicity.

Although the available evidence remains limited and continues to evolve, our experience supports consideration of celiac plexus radiosurgery within a multidisciplinary framework, both as an alternative to invasive neurolytic procedures and as a salvage option in selected patients. Further prospective studies are warranted to better define optimal patient selection, dosimetric parameters, long-term safety, and comparative effectiveness against established interventional techniques.

Limitations

This report is limited by its single-patient design, which precludes generalization of efficacy and safety outcomes. Pain assessment,

although performed longitudinally and incorporating validated instruments, remains inherently subjective and may be influenced by concomitant systemic therapy, psychological factors, or fluctuations in disease burden. In addition, the relatively short follow-up period restricts conclusions regarding long-term durability of analgesic response and late toxicity, particularly with respect to adjacent gastrointestinal structures.

Another limitation is the absence of standardized comparative data against established interventional approaches, such as endoscopic ultrasound-guided celiac plexus neurolysis, which limits definitive conclusions regarding relative efficacy. Finally, dosimetric parameters and target delineation strategies for celiac plexus radiosurgery are not yet universally standardized, and inter-institutional variability may influence reproducibility.

Prospective studies with larger cohorts, standardized pain endpoints, and longer follow-up are required to better define the therapeutic role of this technique within the multidisciplinary management of pancreatic cancer–related pain.

Acknowledgement

None.

Conflict of interest

The author declares that he has no competing interests.

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