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Impact of celiac neurolysis on survival in patients with pancreatic cancer

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Abstract

Background—Pancreatic cancer (PC) often produces pain that is difficult to control. Celiac neurolysis (CN) is performed with the goal of improving pain control and quality of life while reducing opioid-related side effects.

Objective—We aimed to evaluate whether CN provides a survival advantage for PC patients.

Design—Retrospective case-control study.

Setting—Single tertiary-care referral center.

Patients—Review of a prospectively maintained database identified patients with unresectable PC who underwent CN over a 12-year period. Each patient was matched to 2 control patients with unresectable PC.

Intervention—CN, which included both celiac plexus neurolysis (CPN) and celiac ganglia neurolysis (CGN).

Main Outcome Measurements—Median survival in Kaplan-Meier curves and hazard ratios.

Results—A total of 417 patients underwent CN and were compared with 840 controls with PC. Baseline characteristics were similar except the CN group had greater weight loss and pain requiring opioids. A mean of 16.6 ± 5.8 mL of alcohol was administered. For patients who underwent CN, the median survival from the time of presentation was shorter compared with controls (193 vs 246 days; hazard ratio 1.32; 95% confidence interval, 1.13–1.54). There was no difference in survival with unilateral or bilateral injection. However, EUS-guided CN was associated with longer survival compared with non-EUS approaches, and those who received CPN had longer survival compared with CGN.

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Limitations—Single center, retrospective.

Conclusion—Our study suggests that CN is an independent predictor of shortened survival in PC patients. A prospective study is needed to verify the findings and determine whether shortened survival results from CN or from other features such as performance status and tumor-related characteristics. It is also imperative to verify our finding that EUS-guided CN provides a survival advantage over other approaches and whether CPN prolongs survival compared with CGN.

In the United States, pancreatic cancer (PC) is the fourth most common cause of cancer-related mortality.[1] The overall 1- and 5-year survival rates of 26% and 6%, respectively, reflect the poor prognosis associated with PC.[2] Despite advances in detection and therapies over the past 40 years, mortality rates have not improved.[3] Because the majority of PC patients have advanced disease at diagnosis, treatment is limited and focuses primarily on pain management. The World Health Organization recommends a stepwise approach with initial administration of nonsteroidal agents and acetaminophen, then subsequent opioid use for refractory pain.[4] Unfortunately, this approach is still associated with inadequate pain relief in 55% of patients.[5] Furthermore, although opioids provide some analgesic benefit, they are associated with numerous side effects. Therefore, other modalities have been advocated to help manage cancer-related pain.

Celiac neurolysis (CN) has been used to treat pain related to PC since 1914.[6] Although studies demonstrate improved pain relief, reduced need for opioid use, and fewer opioid-related side effects after CN,[7–13] the impact on quality of life and patient survival is debated.[14] Lillemoe et al[15] discovered that treatment with CN resulted in significantly prolonged survival compared with those who received placebo (21 vs 6 months, respectively). In contrast, in a randomized, controlled trial by Wong et al,[11] there was no survival advantage for patients who received CN versus a sham procedure. All such studies are limited by the number of patients included and lack of consideration of other confounding variables, potentially masking any difference in survival. Our aim was to overcome the methodological shortcomings by evaluating all patients who have undergone CN at our center and to compare outcomes with those of a large matched cohort to determine the effect of CN on survival of patients with unresectable PC.

METHODS

Patient selection

After approval from the Institutional Review Board, a prospectively maintained Life Sciences System database was reviewed to identify patients with primary PC who underwent CN from January 1, 2001 to March 31, 2013. This list was cross-referenced to prospectively maintained EUS, radiology, and surgical databases to ensure complete representation of the study cohort. All CN procedures were selected regardless of route, technique, or performing physician subspecialty. CN procedures included both celiac plexus neurolysis (CPN) and celiac ganglia neurolysis (CGN).

Patients were included in the study if they were 18 years of age and older with biopsy-proven PC or a classic radiographic and clinical course for PC who underwent CN in which alcohol-based formulations were used. Patients were excluded if they underwent pancreatic

resection, participated in the previous randomized, controlled trial by Wong et al,[11] were receiving hospice care, or if data were insufficient for analysis. For patients who underwent more than 1 CN procedure, only the index procedure was the included in the analysis. Each patient who underwent CN was matched to 2 patients with PC who did not undergo CN by using the pancreatic cancer Specialized Program of Research Excellence registry. Patients were frequency matched by age, sex, and year and stage grouping at time of presentation to our institution. Stage grouping was determined by the American Joint Committee on Cancer, 7th Edition TNM classification of each patient, as shown in Appendix 1.[16]

Clinical and survival data

Each patient's medical chart was reviewed to abstract data concerning their clinical presentation, presence of pain, use of analgesics, radiologic and endoscopic findings, stage grouping at diagnosis and at presentation to our institution, details regarding the CN technique, and all PC-targeted therapies. Appendix 2 details the techniques for EUS and percutaneous CN. The time of symptom onset was approximated. Precise dates for PC diagnosis, presentation to the Mayo Clinic, and mortality were recorded.

Statistical analysis

Continuous variables are reported either as a mean ± standard deviation (SD) or median (interquartile range). Means were reported unless the data were nonparametric. Categorical variables were summarized by using frequency (%). The Student t test or Wilcoxon rank sum test was used to analyze continuous variables, and a Pearson χ^2 analysis was used for categorical variables. Survival data are based on the median number of days from the date of initial presentation to the Mayo Clinic for PC until the time of death. The date of presentation to our institution was chosen as the start date for the survival analysis because this is not only a reliable time point, but also best approximated the timing of CN and allowed standardization for both the CN and control groups. Furthermore, because many patients received their diagnosis before their presentation to the Mayo Clinic, by using the date of their diagnosis as the start point would increase the risk of an immortal time bias. Survival from the date of diagnosis was used as the start date in a secondary analysis. Differences in median survival were analyzed by using Kaplan-Meier curves and compared by a log-rank test for statistical significance. Univariate and multivariate analyses were performed by using a Cox proportional hazards regression model and presented as a hazard ratio (95% confidence interval [CI]).

RESULTS

Baseline characteristics

Among the 510 patients who underwent CN, 417 patients met study inclusion criteria. Reasons for exclusion are listed in Appendix 3. Patients were matched by using the Specialized Program of Research Excellence database to 840 control patients based on their age, sex, and year and stage grouping at the time of presentation to the Mayo Clinic. The mean age for the entire cohort was 65 ± 10 years, and 57% were male. For the collective 1257 patients, the stage grouping at presentation was IV in 51%, III in 39%, and I or II in 10%. Appendix 4 highlights how the diagnosis of PC was made in the patient cohort.

There were no differences in the length of time between the onset of clinical symptoms and presentation to the Mayo Clinic between the CN and control groups (115 ± 153 days vs 121 ± 158 days; $P = .51$). However, patients in the CN group had a shorter time interval between diagnosis and presentation to our facility (4 ± 44 days vs 28 ± 90 days, $P < .001$). Table 1 displays the baseline characteristics of the CN and control groups. As expected, the CN group had a greater proportion of patients experiencing pain (99% vs 80%, $P < .001$) and taking opioid medications (89% vs 36%, $P < .001$) at baseline. In addition, patients in the CN group had greater weight loss before presentation (median 20 lb vs 15 lb, $P < .001$) and were more commonly associated with TNM T4 stage. They also appeared to have more extensive pancreatic tumor involvement based on the percentage of patients whose tumors bridged 2 anatomic segments of the gland, but were not more likely to have lymph node involvement. Compared with those in the control group, patients in the CN group were less likely to undergo chemotherapy or radiotherapy.

CN group

CN was performed by endosonographers in the majority of patients (56%), followed by anesthesiologists (42%), surgeons, and radiologists (1% each), predominantly (96%) in an outpatient setting. CPN was performed in 82% of cases, most often (79%) by using a bilateral approach. CGN was performed under EUS guidance in the remaining 18%. The most common anesthetic used was bupivacaine at concentrations of 0.25% or 0.50% (64% or 28% of patients, respectively). A mean of 12.6 ± 7.4 mL of anesthetic was administered. The most common neurolytic agent was 98% ethyl alcohol (67%) followed by 100% ethyl alcohol (30%). A mean of 16.6 ± 5.8 mL of neurolytic was administered.

By using the definitions of adverse events adopted by the American Society for Gastrointestinal Endoscopy, mild adverse events requiring overnight observation for pain exacerbation, nausea or vomiting, or orthostasis occurred in 7 patients.[17] Moderate to severe adverse events occurred in 5 patients, requiring hospitalizations for 1 to 13 days for pain exacerbation (n = 2), duodenal perforation (n = 1), alcohol tracking to the lumbar roots causing persistent T12/L1 numbness (n = 1), and anterior spinal cord infarction with permanent paralysis (n = 1). After CN performed by an anesthesiologist, 1 patient had persistent numbness but no motor deficits in her thigh in a T12/L1 distribution, which improved slightly after 1 month. The patient with an endoscopic duodenal perforation required surgical repair with omental patch duodenotomy closure. The patient with permanent paralysis underwent EUS-guided CGN and was previously presented as a case report.[18]

Survival analysis

Survival from the date of presentation—The median survival from the date of presentation to the Mayo Clinic was significantly lower for patients who underwent CN compared with controls (193 vs 246 days, $P < .001$) (Fig. 1). The survival difference was consistent in all stage grouping categories (Table 2, Figs. 2A–C).

The unadjusted hazard ratio of survival from the date of presentation to the Mayo Clinic in the CN group was 1.32 (95% CI, 1.15–1.52) compared with controls. On multivariate

analysis with adjustment for age, sex, white race, body mass index at presentation, weight loss before presentation, stage grouping, TNM T stage, site of pancreas involvement, lymph node status, and whether the patient was treated with chemotherapy, radiation, and/or a surgical procedure other than resection, the HR remained approximately the same at 1.35 (95% CI, 1.14–1.60).

Univariate analyses of risk factors for shortened survival from date of presentation—For the composite group of 1257 patients, factors that correlated with a shortened survival included older age at presentation, presence of pain, opioid use, stage grouping IV, tumors located within the pancreatic tail, positive lymph node status, and not undergoing chemotherapy or radiotherapy (Table 3).

Among the CN group alone, there was no survival difference based on the volume of neurolytic administered or technique of bilateral versus unilateral injection (Table 4). However, patients who underwent EUS CN had longer survival times compared with those who underwent neurolysis by using non-EUS approaches. In addition, patients who underwent CPN had longer survival duration than those who underwent CGN. Notably, patients who experienced more weight loss after CN survived longer than those who experienced little or no subsequent weight loss.

Survival from time of diagnosis—Secondary analysis looking at survival from the time of diagnosis revealed a similar decrease in survival in patients who underwent CN compared with those who did not receive CN (196 vs 281 days, $P < .001$) (Appendix 5). The same patient and CN characteristics that were statistically significant on univariate analyses performed by using the date of presentation to the Mayo Clinic as the start date for survival remained significant when the date of diagnosis was used, except that the presence of pain at presentation only trended toward significance (245 vs 282 days in patients with and without pain, respectively, $P = .08$).

DISCUSSION

The sensation of pain arising from the pancreas and most intra-abdominal organs (excluding the left side of the colon, rectum, and pelvic organs) is transmitted via the celiac plexus.[19] Although the pain associated with PC is multifactorial, neural tumor involvement is considered the key contributor. Perineural invasion of intra- and ex-trapancreatic nerves is seen in 90% to 100% and 52% to 80%, respectively, with remote microscopic perineural migration to the celiac ganglia also reported.[20–22] Surgical and autopsy data reveal that patients with intra- and/or extrapancreatic neural involvement demonstrate a worse prognosis, shortened survival, and increased risk of tumor recurrence compared with those without neural invasion.[20,21]

Contrary to the theory that CN prolongs survival, in our study, patients with unresectable PC who underwent CN had a shorter survival compared with control patients who did not undergo CN. The shortened survival persisted on multivariate analysis. This shorter survival could not be attributed to the length of time between the onset of clinical symptoms and presentation to our facility.

It is unclear whether the shortened survival was a consequence of the CN itself, or whether the use of CN reflects a patient cohort that possessed other clinical and/or tumor related characteristics that conferred worse prognosis. For instance, although patients were stage matched, the shorter survival among the CN group may be related to a lower performance status as indicated by the greater initial weight loss, presence of pain, opioid use, and less-common use of chemotherapy and/or radiotherapy. Patients who underwent CN also probably had larger and more locally advanced tumors because they were more likely to have T4 tumors and tumors involving more than 1 anatomic segment of the pancreas. However, patients with CN were not more likely to have a positive lymph node status. In addition, physicians seeing patients with PC may have been biased toward offering CN to those who appeared sicker and were experiencing more discomfort. This may have been particularly true in patients with stage grouping I and II cancers who might have been unfit for surgery due to their poor performance status, comorbidities, and debilitation, leading to a lower than expected median survival of patients in this stage grouping.

Given that CN is typically reserved for patients with moderate to severe pain, our findings may also reflect a disparate disease course among patients with no to mild pain compared with patients with moderate to severe pain. Significant pain and opioid use have been previously shown to be independent risk factors for poorer outcomes. In patients with pancreatic cancer, the presence of abdominal or back pain may reflect intra- and/or extrapancreatic neural involvement and has been shown to be a predictor of unresectability and lower survival.[23,24] Furthermore, pain is closely related to mood, functional ability, and stress, all factors that can affect quality of life and survival. Although controversial, opioid medications may indirectly and directly affect tumor growth and recurrence.[25,26]

In our study, patient and cancer characteristics that were associated with shortened survival included advanced age, presence of pain and opioid use at presentation, T4 status, tumors within the pancreatic tail, positive lymph node involvement, and chemotherapy or radiotherapy. Although other studies have also identified each of these factors as predictors of shortened survival,[27–29] this is the first study to demonstrate that CN is an independent predictor of shortened survival.

Factors related to the CN procedures that were associated with prolonged survival included EUS-guided CN versus non-EUS techniques, CPN versus CGN, and greater postprocedure weight loss. No prospective studies have been conducted directly comparing EUS-guided and percutaneous neurolysis. The improved survival with EUS-guided CN may be partly attributed to the more precise targeting of the injectate. The practice of often performing CN at the time of EUS-guided FNA diagnosis may have resulted in a lead time bias. However, because the time between the onset of clinical symptoms and presentation to our institution did not differ between the 2 groups, it is not believed that a significant lead time bias would account for this difference in survival. In addition, patients with larger tumors, those with metastases amenable to percutaneous biopsy, or those with comorbidities prohibiting monitored anesthesia care may have been less likely to undergo EUS versus percutaneous biopsy and neurolysis. Our data indicate a need to prospectively compare EUS with percutaneous approaches. One study that compared CGN with CPN found that patients who underwent CGN had greater pain relief.[30] However, our finding that patients undergoing

CGN had shortened survival raises concern regarding this approach and indicates a need for additional study. Because greater weight loss is typically associated with worse nutritional status and survival in patients with cancer, the finding that patients with increased weight loss after CN had longer survival was unexpected and not readily explicable.[31–35] Data are conflicting as to whether unilateral or bilateral injection more effectively relieves pain, but in our study, neither technique resulted in a survival advantage.[36–39] The ideal volume of neurolytic that should be injected during CN has not been established, with most studies using a total of 10 to 20 mL. Similarly, our data did not identify a dose of injectate that affected survival.

This study has several limitations. Despite the fact that the shortened survival among CN patients persisted on multivariate analysis after controlling most known key variables, the retrospective nature did not allow us to evaluate other potential factors such as the performance status. Potential surrogate markers of performance status including greater initial weight loss, presence of pain, opioid use, and less common use of chemotherapy and/or radiotherapy may suggest a difference in clinical status between those managed with and without CN. Furthermore, due to the nature of a tertiary referral hospital and retrospective study, the medical records could not adequately address this particular variable for many patients. The impact of this variable was addressed by performing the multivariate analysis. Also, our study cannot address whether pain severity and duration, analgesic dose, or the success of CN in terms of pain relief, analgesic use, and other endpoints may have affected survival.

In summary, this is the first study to demonstrate that CN is an independent predictor of shortened survival in patients with PC. It is unclear whether the shortened survival was a direct or indirect consequence of the CN itself or whether the patients who underwent CN possessed other unidentified clinical and/or tumor-related characteristics that conferred the worse prognosis. Although the shortened survival among CN patients persisted on multivariate analysis after controlling most key patient and tumor characteristics, the impact of variables such as performance status and the success of CN in managing pain and analgesic dosing remains uncertain. Overall, the use of CN in patients with pancreatic cancer–related pain should be carefully considered until prospective, randomized data are available to clarify whether (1) the shortened survival results from CN or from other features such as performance status and tumor-related characteristics, (2) EUS-guided CN provides a survival advantage over other approaches, and (3) CPN prolongs survival compared with CGN. These data are needed to develop more effective approaches to pain management and improve outcomes in patients with PC.

Abbreviations

CI	confidence interval
CGN	celiac ganglia neurolysis
CN	celiac neurolysis
CPN	celiac plexus neurolysis

PC	pancreatic cancer
SD	standard deviation

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APPENDIX 1. AMERICAN JOINT COMMITTEE ON CANCER, 7TH EDITION PANCREATIC CANCER STAGING

Primary tumor (T) *

TX: Primary tumor cannot be assessed

T0: No evidence of primary tumor

Tis: Carcinoma in situ or PanInIII

T1: Tumor limited to the pancreas and ≤2 cm in greatest diameter

T2: Tumor limited to the pancreas and >2 cm in greatest diameter

T3: Tumor extends beyond the pancreas but does not involve the celiac axis or SMA

T4: Tumor involves the celiac axis or SMA

Regional lymph nodes (N)

NX: Regional lymph nodes cannot be assessed

N0: No regional lymph node involvement

N1: Regional lymph node metastases

Distant metastases (M)

M0: No distant metastases

M1: Distant metastases

Stage grouping based on TNM classification			
0	T0, Tis	N0	N0
I	T1 or T2	N0	M0
II	T3	N0	M0
	T1–T3	N1	M0
III	T4	Any N	M0
IV	Any T	Any N	M1

* Primary tumor was assessed by contrast-enhanced CT scan.

APPENDIX 2. CELIAC NEUROLYSIS TECHNIQUE

Some aspects of the procedures were uniform regardless of the approach, including need for informed consent, routine administration of intravenous fluids to decrease the risk of post–celiac neurolysis (CN) hypotension, and 1- to 2-hour postprocedure observation to assess for adverse events. The following is a brief discussion regarding the general techniques adopted at our institution, realizing that minor technical variance exists among physicians and for individual patients.

Endoscopic ultrasound

EUS-guided CN was performed by using a curvilinear echoendoscope (GF-UC30P, GF-UC140P-AL5, GF-UCT180, or GF-UC160P-AT8; Olympus America, Center Valley, Pa) and a 22-gauge FNA needle (EUSN-3; Cook Medical Inc, Winston-Salem, NC). Doppler

imaging was used to avoid intervening vessels along the needle path. Either celiac ganglia neurolysis (CGN) or celiac plexus neurolysis (CPN) was performed. If CGN was performed, then treatment was delivered to as many ganglia as could be accessed, injecting approximately 1 to 3 mL of injectate into each ganglion, while the remaining was injected unilaterally or bilaterally in the region of the celiac artery takeoff. If only CPN was performed, the same technique was used to inject the entire solution into the celiac plexus area by using either a bilateral or unilateral approach.

Percutaneous neurolysis

Percutaneous neurolysis was performed by radiologists or anesthesiologists under the guidance of fluoroscopy. Patients were placed in the supine position and by using fluoroscopy, the L1 vertebral body was identified. An entry point approximately 7 cm lateral to the L1 caudal border and below the 12th rib was marked, and the area was sterilely prepped and draped. After lidocaine was injected into each entry point, a 22-gauge spinal needle was advanced under fluoroscopic view to the midbody of L1. Typically after aspirating to ensure no return of blood, Omnipaque 180 contrast was injected to confirm linear spread along the anterior vertebral body with no intravascular, intrathecal, intracrural, intramuscular, or intradiscal spread. Furthermore, the percutaneous technique uses digital subtraction angiography (DSA) to detect any flow into the anterior spinal artery. After confirmation of no spread outside of the targeted area, bupivacaine was injected. After waiting 15 minutes and after a sensorimotor examination to ensure no neurological complications, sterile dehydrated alcohol was injected. This was usually performed bilaterally unless prohibited by patient anatomy or discomfort.

APPENDIX 3. REASONS TO EXCLUDE CELIAC NEUROLYSIS PATIENTS FROM ANALYSIS

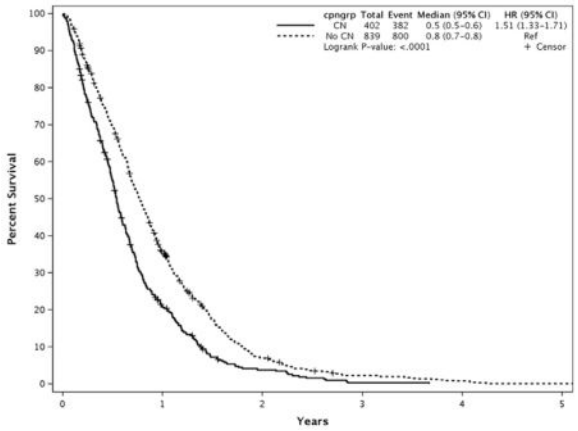
Reason for exclusion	No.
Repeat celiac neurolysis	33
Nonadenocarcinoma tumor type	27
Surgically resected tumor	26
Receiving hospice care	7

APPENDIX 4. DIAGNOSTIC TECHNIQUES TO DIAGNOSE PC

Diagnostic modality	%
EUS-guided FNA	52
Pancreatic mass	47
Metastatic site (eg, liver, lymph node)	5

Diagnostic modality	%
Percutaneous biopsy	34
Pancreatic mass	14
Metastatic site (eg, liver)	20
Surgical biopsy	7
Brushing/biopsy during ERCP	4
Radiographic and/or EUS imaging and clinical course consistent with pancreatic cancer	3

APPENDIX 5. SURVIVAL OF CELIAC NEUROLYSIS GROUP AND CONTROLS FROM DATE OF DIAGNOSIS



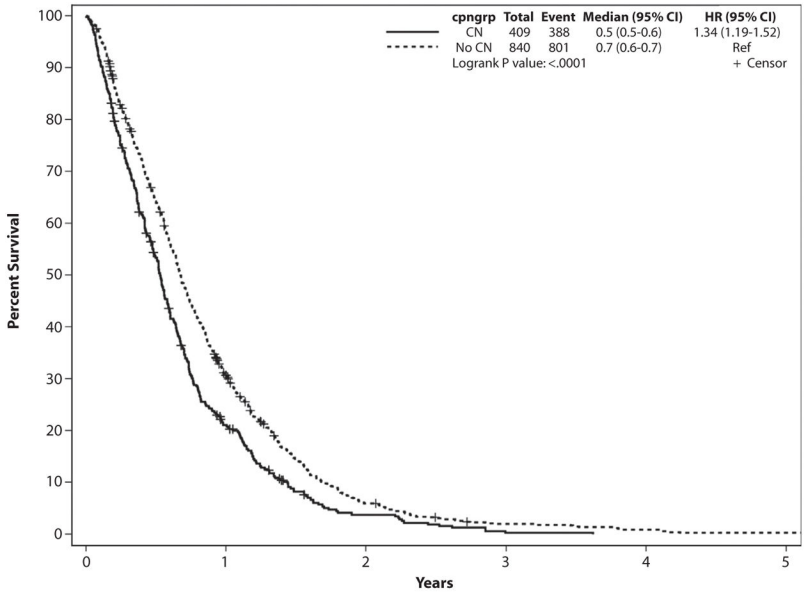


Figure 1.

Survival of celiac neurolysis group and controls from date of presentation to the Mayo Clinic. *CI*, confidence interval; *CN*, celiac neurolysis; *cpngroup*, whether CN was performed; *HR*, hazard ratio.

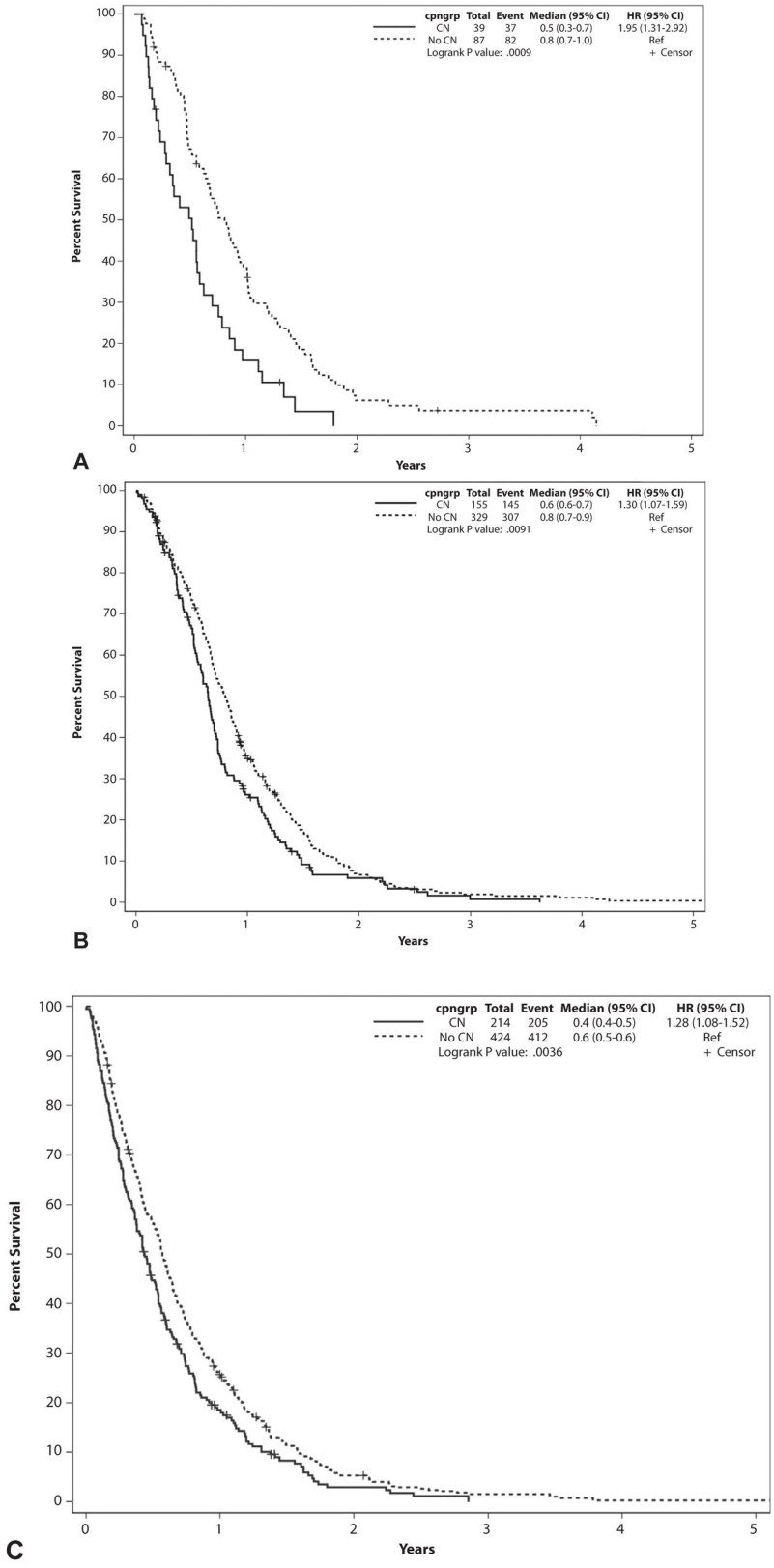


Figure 2.

Survival from date of presentation to the Mayo Clinic based on stage grouping. **A**, Stage grouping I and II patients. **B**, Stage grouping III patients. **C**, Stage grouping IV patients. *CI*, confidence interval; *CN*, celiac neurolysis; *cpngroup*, whether CN was performed; *HR*, hazard ratio.

TABLE 1

Baseline characteristics of the CN and control groups

Baseline characteristics	CN (n = 417)	Controls (n = 840)	*P* value
Patient characteristics at presentation to the Mayo Clinic			
Age, y, mean (SD)	65 (11)	65 (10)	.91
Male, %	56.6	56.8	.95
White, %	81.1	79.9	.33
BMI, kg/m^2, mean (SD)	26.3 (5.4)	26.8 (6.3)	.53
Weight loss, lb, median (IQR)	20 (10–30)	15 (5–26)	<.001
Presence of pain, %	99	80	<.001
Opioid use, %	89	36	<.001
Cancer characteristics at presentation to the Mayo Clinic			
Stage grouping, %			.80
I	0	0	
II	9	10	
III	38	39	
IV	53	51	
TNM T stage, %			.02
0 *	3	1	
1	2	3	
2	6	8	
3	30	35	
4	59	53	
Site of involvement, %			.005
Head/uncinate	43	49	
Neck	4	5	
Body	20	16	
Tail	8	11	
Bridge 2 sites †	25	19	

Baseline characteristics	CN (n = 417)	Controls (n = 840)	*P* value
Lymph node status, %			.18
Negative	62	66	
Positive	38	34	
Treatment characteristics			
Chemotherapy, %			<.001
Yes	49	49	
No	20	7	
Unsure	31	44	
Radiation therapy, %			<.001
Yes	22	20	
No	70	63	
Unsure	8	17	
Surgery, %‡			.08
Yes	10	15	
No	90	85	

CN, Celiac neurolysis; *SD*, standard deviation; *BMI*, body mass index; *IQR*, interquartile range.

*Primary tumor was not detected by CT, but diagnosed by other imaging modality.

†Tumors that were reported to bridge 2 adjacent regions of the pancreas (eg, body and tail).

‡Surgical procedure other than resection.

TABLE 2

Survival (days) from presentation based on stage grouping

	N	No. of events	Censors	Median survival	Survival difference	*P* value
Stages I and II						
CN group	39	37	2	188	3.6 mo	<.001
Control group	87	82	5	296		
Stage III						
CN group	155	144	11	236	1.9 mo	.012
Control group	329	307	25	292		
Stage IV						
CN group	214	205	9	158	1.6 mo	.003
Control group	424	411	13	207		

CN, Celiac neurolysis.

Gastrointest Endosc. Author manuscript; available in PMC 2018 June 25.

TABLE 3

Survival from date of presentation to the Mayo Clinic (all patients)

	N	No. of events	No. of censors	Median survival, days	*P* value
Patient characteristics at presentation to the Mayo Clinic					
Age, y (quartiles)					.004
≤58	364	343	21	252	
59–65	282	272	10	242	
66–72	307	290	17	221	
≥73	296	282	14	175	
Sex					.57
Male	707	664	43	234	
Female	542	523	19	219	
Race					.26
White	1004	950	54	234	
Other	45	43	2	194	
BMI, kg/m^2 (quartiles)					.26
≤22.7	303	287	16	236	
22.8–25.6	302	287	15	218	
25.7–28.9	303	284	19	238	
≥29	302	290	12	229	
Weight loss, lb (quartiles)					.46
≤7	280	267	13	229	

	N	No. of events	No. of censors	Median survival, days	*P* value
7–15	279	262	17	243	
16–30	329	319	10	211	
>30	208	194	14	203	
Presence of pain					.04
Yes	1075	1028	47	223	
No	172	157	15	255	
Opioid use					<.001
Yes	637	617	20	202	
No	570	529	41	261	
Cancer characteristics at presentation to the Mayo Clinic					
Stage grouping					<.001
I	5	5	0	172	
II	121	114	7	247	
III	484	451	33	263	
IV	638	616	22	195	
TNM T stage					.003
0*	17	17	0	289	
1	30	29	1	219	
2	88	88	0	190	
3	373	361	12	204	
4	625	580	45	253	

	N	No. of events	No. of censors	Median survival, days	*P* value
Site of cancer					.006
Head/uncinate	579	553	26	234	
Neck	52	49	3	237	
Body	213	198	15	253	
Tail	124	122	2	178	
Bridge 2 sites†	256	241	15	226	
Lymph node status					<.001
Negative	739	697	42	252	
Positive	402	386	16	204	
Treatment characteristics					
Chemotherapy					<.001
Yes	582	553	29	281	
No	133	131	2	71	
Unsure	471	443	28	211	
Radiation therapy					<.001
Yes	243	232	11	339	
No	775	738	37	197	
Unsure	170	159	11	242	

BMI, Body mass index.

*Primary tumor was not detected by CT, but diagnosed by other imaging modality.

†Tumors that were reported to bridge 2 adjacent regions of the pancreas (eg, body and tail).

TABLE 4

Survival from date of presentation (CN patients only)

	N	No. of events	No. of censors	Median survival, days	*P* value
Approach					<.001
EUS	230	208	22	206	
Anesthesia	170	170	0	177	
Radiology	4	4	0	60	
Surgery	5	5	0	153	
Type					.03
CPN	330	313	17	200	
CGN	73	68	5	154	
Location					.72
Unilateral	56	55	1	187	
Bilateral	208	208	0	190	
Neurolytic volume, mL					.32
<10	47	46	1	193	
10–19	84	83	1	171	
20	233	214	19	197	
>20	7	7	0	159	
Weight loss after CN, lb (quartiles)					.002
≥12	39	38	1	341	
5.7–12	38	36	2	252	
1.5–5.6	39	35	4	255	

	N	No. of events	No. of censors	Median survival, days	*P* value
≤1.5	35	32	3	194	

CN, Celiac neurolysis; *CPN*, celiac plexus neurolysis; *CGN*, celiac ganglia neurolysis.