

Descriptive Review

Celiac Plexus Block – An Old Technique with New Developments

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Background: Celiac plexus block (CPB) is an interventional technique known to be effective in the management of abdominal pain caused by pancreatic cancer.

Objective: To review the journey of CPB as an interventional analgesic technique from its inception to its current status in the field of cancer pain management.

Study Design: Descriptive review.

Methods: PubMed database was searched for celiac plexus block, celiac plexus neurolysis, and pancreatic cancer pain relief. Randomized control trials and case series with more than 10 patients were included. A second search was done from the references of all the included articles to add studies fulfilling the inclusion criteria which were missed in the first broad search.

Results: A total of 44 studies were included in this literature review. Available evidence through the years was categorized based on the imaging technique used to guide needle insertion and studies were tabulated based on study design, the number of patients included, the technique of CPB, and the conclusions drawn.

Limitations: Meta-analysis of the available studies was not done because of heterogeneous nature of studies.

Conclusion: Over the years, the majority of clinical trials have focussed on fluoroscopy-guided CPB. Computed tomography-guided blockade of celiac plexus is the next choice among pain physicians and percutaneous ultrasound-guided CPB is a relatively new technique. The data generated over the years does not point to a single technique being the gold standard for CPB and choice of technique may be guided by the individual's preference, familiarity with the technique, and institutional practice.

Key words: Pancreatic cancer, coeliac plexus block, coeliac plexus neurolysis

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Pain is a major cause of distress among cancer patients. Despite advances in analgesic modalities, the prevalence of cancer-related pain was estimated to be around 39% after curative treatment, 55% during anticancer therapy, and 66% in metastatic or terminal disease (1).

Abdominal malignancies constitute a major chunk of the global malignancy burden. Based on the GLOBOCAN 2018 estimates, pancreatic cancer is the 11th com-

monest cancer globally and the 7th leading cause of cancer-related mortality in industrialized countries (2). Pancreatic cancer, in early stages, may be asymptomatic and around 80-90% are diagnosed in the advanced unresectable stage (1). Thus, advanced pancreatic cancer is a major cause of uncontrolled abdominal pain.

Interventional analgesic techniques have gradually evolved over the years intending to control intractable pain with minimal adverse effects. Celiac plexus block

(CPB) is one such technique that has advanced and evolved with time to become an indispensable weapon in a pain physician's armamentarium. In this article, we aimed to review the journey of CPB as an interventional analgesic technique from its inception to its current status in the field of cancer pain management.

Clinical Anatomy

Celiac plexus also known as the 'solar plexus' is the largest visceral plexus. This plexus lies in the retroperitoneum along the anterolateral aspect of the abdominal aorta at the level of origin of the celiac artery and superior mesenteric artery. It is composed of celiac, superior mesenteric, and aorticorenal ganglia, which form a dense network of interconnecting nerve fibers.

Celiac plexus supplies sympathetic, parasympathetic, and visceral sensory afferent fibers to the upper abdominal viscera, which include the pancreas, liver, biliary tract, gallbladder, spleen, adrenal glands, kidneys, mesentery, stomach, and the small and large bowels proximal to the transverse colon (3).

The position of celiac ganglion varies from T12 to L1 disc space and may even extend up to the body of the L2 vertebra. In 94% of patients, these ganglia are located at the level of T12 or L1 (3). This position corresponds to a location just anterior to the abdominal aorta, anterior to the crus of the diaphragm. This anterior location to the crus of the diaphragm holds great importance concerning the tip of the needle placed to classify the block as celiac or splanchnic plexus (4). The size of the ganglia ranges from 0.5 to 4.5 cm with a mean size of about 2.7 cm.

History

The concept of the blockade of celiac plexus with local anaesthetics to provide surgical anesthesia was first given by Kappis in 1914. With advancements in general and regional anesthesia, CPB as a technique to provide surgical anesthesia did not gain popularity. Over the next 30 to 40 years, this technique gained recognition as a tool to alleviate abdominal pain secondary to pancreatitis or malignancy.

In 1957, Brindenbaugh described the use of CPB to treat pain secondary to abdominal malignancy (5). Thus, by the mid-20th century, this technique shifted from anesthesia to mainly interventional pain practice. CPB was initially described as a blind technique based on anatomic landmarks. With advancements in technology, fluoroscopy- and computed tomography (CT)-guided needle placement of needle has been described

to ensure correct needle tip placement, increase block success, and minimize complications. Fluoroscopy-guided CPB was described in 1979 (6), whereas Moore and Haaga described CT-guided CPB in the same year (7,8). Following CT-guided CPB, ultrasound (US) was introduced as the next modality to guide needle placement for CPB. Percutaneous US-guided CPB was described in the year 1989 (9) and endoscopic US-guided CPB was described by Wiersema in the year 1996 (10).

Techniques to Block Celiac Plexus

The first description of CPB also known as the 'Classic technique of Kappis,' required the patient to lie in the lateral decubitus position with the needle introduced just below the 12th rib, 7 cm lateral to the midline. The drug was deposited on the anterolateral margin of T12, L1, and L2, and resulted in a retroaortic splanchnic nerve block (4).

In 1978, Boas (11) explained the distinction between retrocrural and transcrural needle placement blocking the splanchnic and the celiac plexus nerve fibers, respectively. This distinction was based on the anatomic premise that the needle tip, positioned behind the diaphragmatic crus, lead to the spread of the drug behind the aorta, and thus blocked the lesser and the least splanchnic nerves. When the needle tip passes through the crus of the diaphragm, it results in the spread of the drug anterior to the aorta, thus blocking the nerves originating from the celiac ganglia (4,11).

In modern-day practice, the following approaches have been used by various authors to reach the celiac plexus – a) Retrocrural approach (mainly resulting in splanchnic nerve block). b) Transcrural approach – both this approach and the retrocrural approach are practiced with the patient in the prone position and needle entry varying from 4 to 8 cm from the midline at the level of T12 or L1. c) Transaortic approach – prone position, needle entry posteriorly, and needle passed through the aorta to position the tip anterior to the aorta and the diaphragmatic crus. d) Preaortic – anterior approach, the patient placed supine, needle entry just below the xiphisternum to position the tip anterior to the aorta without puncturing the vessel. e) Transdiscal approach – posterior approach, patient position prone, needle passed through the intervertebral disc to place the tip in the proximity of aorta.

Exact needle tip placement with any of these approaches may be guided by fluoroscopy, CT scan, magnetic resonance imaging (MRI), or US.

Need for This Literature Review

This literature review aimed to track the journey of CPB as a technique to alleviate pain due to pancreatic cancer in the field of interventional pain practice. We aim to outline and summarize the major research work done studying the role of CPB, to finally track the evolution of this technique and its present state in the armamentarium of pain physicians.

METHOD

A comprehensive literature search was carried out in the PubMed database for the following search strings – celiac plexus block, celiac plexus neurolysis, and pancreatic cancer pain relief. The results obtained were filtered through the following inclusion criteria – randomized control trials (RCTs) and case series with more than 10 patients were included. Articles available as abstract only, articles in languages other than English, case reports, and descriptive reviews were excluded.

A second search was done from the references of all the included articles to add studies fulfilling the inclusion criteria which were missed in the first broad search. We aimed to summarize the techniques of CPB evolving over the years in the domain of pain physicians, thus we excluded the literature on endoscopic US-guided CPB as this approach falls mainly in the purview of gastroenterologists.

The included studies were subcategorized based on the imaging modality used to guide needle placement and were thus subdivided into 5 categories – blind/anatomic landmark-guided CPB, fluoroscopy-guided CPB, CT-guided CPB, US-guided CPB, or open/intra-operative CPB.

In each category, the studies included were tabulated under the following headings – the aim of the study and year of publication, type of study (RCT/case series), the total number of patients included, inclusion criteria, study groups, follow-up, and outcomes assessed. The technique of CPB was tabulated under the following headings – approach, needle tip, and agent (strength and volume) used for neurolysis. The main results and the conclusion drawn by the authors were tabulated in separate columns.

RESULTS

A total of 686 results were obtained in the initial PubMed search with the keyword 'celiac plexus block.' Applying the inclusion and exclusion criteria, 30 relevant studies were selected to be included. The second search in the references of the selected studies yielded

an additional 14 studies to be included. Thus, a total of 44 studies were included in this literature review.

Tables 1-5 show the summary of the studies included (5,12-53).

The earliest evidence was published in 1964 and was based on anatomic/landmark-guided needle placement with bilateral retrocrural technique (Table 1) (5). Since the inception of fluoroscopy/radiologic guidance for needle placement, this, the blind technique, is no longer in vogue owing to the risks of organ injury and incorrect needle placement leading to block failure. As seen in Table 2, C-arm/fluoroscopic guidance has been the most popular modality generating maximum evidence for celiac plexus neurolysis (CPN). The earliest concrete data for an image intensifier-guided CPB emerged, in 1977, in the form of a retrospective study (12) in 100 patients describing the indications and the efficacy of the fluoroscopy-guided retrocrural technique of CPN. We have a total of 18 studies summarized which have generated evidence over the years for fluoroscopy-guided CPN. From the years 1990 to 2000, 2 major RCTs were done in fluoroscopy-guided CPN. In the first RCT published in 1992, 3 techniques were compared – transaortic CPN, retrocrural CPN, and splanchnectomy (13), and it was shown that all 3 techniques were equally efficacious when performed early in the disease trajectory and efficacy of pain relief decreased with increased patient survival. The second RCT, published in 1998, compared neurolytic celiac plexus block with local anesthetic alone or local anesthetic with alcohol and established that addition of alcohol for neurolysis leads to long-term analgesia (14).

From 2000 to 2010, 2 modifications/refinements of the technique were described in 2 case series (15,16). Catheter insertion around the celiac plexus for continuous CPB was tried successfully in 12 patients (15), and the second improvement in technique was suggested with a curved long stylet needle for retrocrural CPN with shorter procedural times and lesser chances of major organ injury (16).

Five major RCTs were published in this period, 2 of these studied the role of CPB for tumors of the head of the pancreas vs. tumors in the body or tail of the pancreas (17,18). It was established with these RCTs that CPB is an effective modality in treating pain originating from tumors of the head of the pancreas only. Other RCTs during this period showed that CPB is better than conventional analgesics alone and CPB is equally efficacious to thoracoscopic splanchnic neurolysis, but with lesser potential complications (19-21).

Table 1. Table summarizing Blind/Anatomically guided and MRI guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Brindenbaugh and co-workers, 1964(5).	Case series. (retrospective data collection).	Retrospective analysis of block technique and results in patients with upper abdominal malignancy.	Inclusion – inoperable upper abdominal malignancy (stomach, pancreas, liver or gall bladder). Groups – cohort of patients given block between October 1948 to January 1964. Follow up – varied from 6 weeks to 1 year. Outcomes assessed – pain relief.	41	Approach – bilateral retrocrural. Needle tip – anatomically guided, 1.3 cm anterior to L1 vertebral body, in the prevertebral areolar tissue. Agent – 50 ml of 50% alcohol.	Block successful in 40 patients. Single patient no pain relief may be attributed to the opioid addict status of the patient.	CPB is a simple and effective treatment for refractory pain due to upper abdominal malignancies. Block reduces opioid intake and thus improves sensorium and oral intake in the terminal stages of life.
Brown Et al., 1987(29).	Retrospective case series.	Single centre description of the various methods of needle guidance and needle tip placement verification for CPN.	Inclusion – Pancreatic cancer patients CPB given between 1977 - 1985. Groups – case series. Follow up – Outcomes assessed – -Multivariate analysis of various factors which could be associated with success of CPN.	136.	Approach – retrocrural, bilateral entry. Needle tip – needle timed aimed to rest just anterior to L1 vertebral body. Various techniques used to guide needle placement - Blind placement (n 58) Plain x-ray guided (n 65) Fluoroscopy guided (n 2) CT guided (n 11) Agent – 50 ml of 50% ethanol (total volume).	116/136 patients obtained good quality pain relief. No influence of extent of disease/metastasis, choice of needle gauge for block (22/20G), radiologically guided or blind/anatomic needle placement on quality of pain relief. (p>0.05) No major neurological complications seen in any case.	CPN can safely be employed at all stages of pancreatic cancer. Radiologically guided needle placement may reduce medicolegal implications of the procedure or may be helpful in obese patients but may not have a role in success of block
Firdousi and co-workers, 2002(30).	Prospective case series.	Single centre experience of using blind technique (no radiological guidance) for CPN in a minimal resource setting.	Inclusion – upper abdominal malignancy with intractable pain. Groups – single cohort Follow up – post block 1 day, 1 week, 1 month and 3 months. Outcomes assessed – pain relief graded on VAS score of 0-10 as - Excellent – 0-2. Good – 3-5 Satisfactory – 6-7 Unsatisfactory – 8-10	30	Approach – unilateral (left sided) block, retrocrural approach. Needle tip – anatomically guided, approximately 1 cm anterior L1 vertebral body. Agent – 40 ml of 50% alcohol.	Excellent pain relief in 26(86%), 22(73%), 18(60%) and 16(53%) patients at day 1, week 1, 1 months and 3 months respectively. Transient but severe hypotension (systolic BP <60) requiring rapid fluid infusion seen in 22 (73%) patients.	Blind technique did not result in any major neurological complication or organ injury. May be useful for physicians working in resource poor setting.

The latest evidence, from 2010 to 2019, generated an RCT on the timing of block established that initial pain control with conventional analgesics followed by CPB is better in controlling pain than upfront CPB in a patient with severe pain (22), also an RCT published during this period compared 3 volumes of neurolytic mixture for transdiscal CPB establishing 40 mL of total volume as most effective for a bilateral block (23).

As seen in Table 3, CT guidance has been the next modality of choice among pain physicians generating a total of 12 major studies from 1983 to 2019. Out of the 12 studies, 9 are retrospective data collections or case series which established CT guidance as a safe and effective modality for various approaches of CPN. Three RCTs were done with CT guidance generating superior quality of evidence for this modality. The single- vs. double-needle approach was compared in one showing the single-needle approach to be equally efficacious (24). A second important study showed that the addition of superior hypogastric block to CPB may be of additional benefit in patients with upper abdominal malignancies (25).

Among the other modalities to guide needle placement, MRI has not been very popular and only a single study using this technique was published in 2016 (31). See Table 1 (29-31).

Percutaneous US guidance for CPB was described as early as 1989 (9) and reaffirmed as a technique with minimal complications in by 2 case series published in 1997 (26) and 2012 (27). Quality data for this technique has been generated by a single RCT published in 2014 (28). Overall familiarity with this technique is lowest, as seen in Table 4, with only 4 studies generating some evidence over the years (9,26-28).

Earliest evidence for intraoperative CPB came in the form of a case series on 13 patients of inoperable pancreatic cancer (48), which described this as a simple and safe way to reduce post-operative analgesics. In the subsequent years 2 retrospective analysis (49,50) generated supportive evidence in favor of this technique. Two RCT's on this technique of analgesia (51,53) showed significantly reduced analgesic consumption when compared to a control group. Also, a repeat analysis by Peter Staats and co-workers (52) of a previously done RCT showed increased longevity and elevated mood in patients given intraoperative CPB. Thus this technique may easily and safely be performed by the operating team in cases of pancreatic cancer deemed inoperable on laparotomy. Another method of CPN not concerned with pain physicians, per se, but overall an important tool in unresectable pancreatic cancer management, is

Table 1 cont. Table summarizing Blind/Anatomically guided and MRI guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Shangang Liu et al., 2016(31).	Case series	Assess the safety and efficacy of MRI guided CPN.	Inclusion - -Unresectable pancreatic cancer -Pain not controlled on opioids Follow up - 4 months. Groups - Single cohort of patients, from March 2009 to May 2014. Outcome parameters - -Duration of pain relief. -Change in opioid consumption. -Effect on sleep, appetite and communication.	39.	CPN guided with 0.23 Tesla open configuration MRI equipped with an optical tracking system. Approach - Posterior Needle tip - retrocrural or antecrural on case to case basis. Agent - 20 ml absolute alcohol. Uni/bilateral - spread of alcohol visualized, if inadequate, bilateral block given. Unilateral, 35 cases. Bilateral, 4 cases.	Pain relief observed in 36 patients. Median duration of pain relief - 2.9 months (CI- 2.4 - 3.4) Significantly reduced opioid intake till 3 months of follow up. Significant improvement in sleep till 3 months, appetite and communication till two months of follow up.	MRI guided CPN may be minimally invasive approach for palliation of pancreatic cancer pain.

Table 2. Table summarizing Fluoroscopy guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
John Jones, 1977(12).	Retrospective study – cases from 1963-1973.	Assess the analgesic efficacy and indications of CPB in intractable pain due to abdominal malignancies.	CPB given in 100 patients with advanced malignancy and uncontrolled pain abdomen. (ca. stomach 39, ca. stomach with liver metastasis 31, ca. Pancreas 14, ca. gallbladder 2, malignant gastrocolic mass 6, ca. caecum 2, ca ovary 2, ca rectosigmoid 4) Follow up – up to 2 years.	100	Approach – retrocrural, bilateral entry. Agent – absolute alcohol, 8ml each side.	- 91% success rate (response in 91 out of 100 patients) with this technique. - 48 cases no analgesics required until death - 32 cases required additional mild oral analgesics (non-opiates) - 11 cases required morphine after block (8 pelvic, 3 gastrocolic malignancies).	CPB will be a valuable tool in managing intractable abdominal pain due to advanced upper abdominal malignancies.
S.Mercadante, 1992(32).	Case series	Assess effectiveness and duration of analgesia with neurolytic CPB as compared to conventional analgesics.	Inclusion – pancreatic cancer with severe pain. Groups – Group A – usual oral analgesics (NSAID's and opioids) in in doses to keep VAS<4. Group B - CPN after 1 week of opioid and NSAID therapy. Follow up – weekly till death. Outcomes assessed – effective analgesic dose (based on VAS and opioid consumption)	20	Approach– posterior, bilateral entry Needle tip – not specified. Agent – 25 ml of 75% alcohol each side.	-pain scores significantly lesser in group B till 4th week of follow up. -opioid consumption significantly lesser in group B till 7th week.	CPN is an effective modality to reduce opioid consumption and its related adverse effects in advanced pancreatic cancer patients.
Stefano Ischia and co-workers, 1992(13).	RCT	To compare three posterior percutaneous approaches of CPN.	Inclusion – unresectable pancreatic cancer with abdominal pain. Groups – Group 1 – transaortic approach (n=20) Group 2- classic retrocrural approach (n=20) Group 3 – bilateral splachmectomy (n=21). Follow up – once a week until death. Outcomes assessed – results classified as Immediate (5 days after block) And long term (till death). Pain relief graded as complete (cessation of analgesics), partial (reduced intensity but continued need for analgesics), and no relief (no change in pain intensity).	61	Approach – Group 1 – posterior entry, single needle. Group 2 – posterior retrocrural bilateral entry. Group 3 – bilateral splanchnic nerve block. Needle tip – Group 1 – just anterior to aorta in the latero-lateral projection. Group 2- Left needle – 0.5 cm ventral to anterior edge of L1 vertebra, Right needle – 1 cm ventral to anterior edge of L1 vertebra. Group 3 – in a narrow compartment bounded vertebral bodies, major vessels, parietal pleura, and diaphragmatic crura. Agent – Absolute alcohol, 30 ml in group 1, 2- and 14-ml group 3.	No statistically significant difference between 3 techniques in immediate or up to death pain relief. 70-80% patients had immediate complete pain relief in all techniques which continued in 60-75% until death. No differences in mortality and morbidity in the three techniques.	All three techniques equally effective in controlling pain if performed early in disease trajectory (i.e. patient still responding to conventional analgesics like NSAID's). Probability of complete pain relief after block decreases with increased survival.

Table 2 con't. Table summarizing Fluoroscopy guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Kawamata et al., 1995(33).	Case series.	Single centre experience with CPN in alleviating pain and effect on overall QoL.	Inclusion – pancreatic cancer Groups – Oral analgesics only (n=11) CPN after starting oral analgesics (n=10) Follow up – 10 weeks. Outcomes assessed – VAS scores for pain, morphine consumption, self-assessment QoL questionnaire.	21	Approach – posterior approach, bilateral entry Needle tip – Not specified. Agent – 15-20 ml of 80% alcohol each side.	CPN group – statistically significant lower pain scores (till 4th week) and morphine consumption (till 7th week). Self-assessed QoL scores did not improve significantly after CPB	CPB leads to significantly improved pain control but does not directly affect QoL.
Polati et al., 1998(14).	RCT – Double blind	Compare the immediate and long-term analgesic efficacy of neurolytic coeliac plexus block.	Inclusion – advanced pancreatic cancer. Groups – Group 1 - NCPB with alcohol Group 2 – CPB with local anaesthetic alone Follow up – until death. Outcomes assessed – VAS scores for pain, analgesic consumption (diclofenac doses and oral morphine equivalents)	24	Approach – posterior, bilateral entry. Needle tip – antecurral at level of L1. Agent – 7 ml of absolute alcohol via each needle.	-Group 1 reported significantly lower pain in the immediate period (24-48 hrs) following CPB. -Mean analgesic consumption was significantly lower in group 1.	NCPB is an effective tool in managing short- and long-term pancreatic cancer pain.
J.H Vranken and co-workers, 2001(15).	Case series	To evaluate a new technique of placing a catheter near coeliac plexus for repeated neurolysis of coeliac plexus in intractable pancreatic cancer pain.	Inclusion – pancreatic cancer with pain not responding to opioids. Groups – single cohort. Follow up – until death. Outcomes assessed – pain scores (VAS), opioid consumption (morphine equivalents), quality of life (36 item short form health survey).	12	Approach – posterior approach right sided entry, 18-gauge epidural Tuohy needle introduced from 7 cm lateral to midline Needle tip – not specified, 20-gauge epidural catheter passed through the needle and placed in vicinity of coeliac axis. Catheter position confirmed on fluoroscopy. Agent – 40 ml of 70% alcohol.	-permanent pain relief till death in 2 out of 12 patients. -10 patients needed a repeat neurolysis after an average period of 25 days. -average duration of analgesia after second neurolysis -10 days. -in cases of pain after second neurolysis 20 ml of 0.25% bupivacaine given twice a day in home-based care.	Catheter around coeliac plexus can easily be placed for repeated instillation of drug in intractable cases of pancreatic cancer pain. No catheter site infection or related adverse effects seen. Further RCT's are warranted in this area for repeated/home based coeliac plexus block.
Rykowski and Hilgier, 2002(18).	Prospective study.	Assess the efficacy of CPN depending on the location of pancreatic tumour.	Inclusion – pancreatic cancer with VAS score for pain >3 not responding to NSAID's and opioids. Groups – Group 1 – carcinoma head of pancreas (n=36) Group 2 – carcinoma body and tail of pancreas (n=14). Follow up – monthly until death. Outcomes assessed – pain relief (VAS<3 post block deemed adequate effect).	50	Approach – posterior approach, unilateral (left sided) entry. Needle tip – transcurral. Agent – 40 ml of 60% alcohol.	-37 out of 50 cases (74%) had adequate effect (VAS<3) in three months after block or till death. -33 of these 37 (92%) were from group-1. -Mean duration of pain relief – Group 1 – 3-4 months Group 2 – 2-1 months. -out of 13 patients with inadequate pain relief, 10 were from group 2.	-CPN more effective in tumours involving head of pancreas. -CT images in failed cases showed massive tumour growth around coeliac axis with significant distortion of anatomy.

Table 2 con't. Table summarizing Fluoroscopy guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Gilbert Y Wong et al., 2004(20).	RCT	Double blind trial to assess the efficacy of NCPB versus conventional analgesic therapy in pain relief, QoL and overall survival in unresectable pancreatic cancer patients.	Inclusion – unresectable pancreatic cancer. Groups – CPN group – coeliac plexus neurolysis plus standard analgesic therapy. (n 50) SAT group – standard analgesic therapy with a sham block. (n 51) Follow up – 1 year or until death. Outcomes assessed – pain scores, opioid consumption (in oral morphine equivalents), QoL, overall survival.	101	Approach – CPN group - retrocrural, bilateral entry. Agent – 20 ml absolute alcohol (10 ml each side) SAT group – Intramuscular and subcutaneous bupivacaine-based sham block under similar procedure setting.	-significantly reduced pain both groups but a larger decrease in NCPB group (p 0.005). -pain scores over time also significantly lower in NCPB group (p 0.01). -opioid consumption, QoL, and overall survival similar in both groups.	NCPB improves pain relief but does not alter QoL, opioid consumption or survival in patients with unresectable pancreatic cancer.
Suleyman Ozyalcin and co-workers, 2004(17).	RCT	Compare the efficacy of coeliac plexus versus splanchnic neurolysis for pancreatic tumours located in body and tail of pancreas.	Inclusion – tumours in body or tail of pancreas with abdominal pain. Groups – Group 1- coeliac plexus neurolysis (N 19). Group 2- splanchnic neurolysis (N 20). Follow up – every 2 weeks till death. Outcomes assessed – analgesic requirements, quality of life (patient satisfaction and performance scale on 0-10)	39	Group 1- Approach – single needle, posterior entry at L1, transaortic approach Needle tip – just anterior to aorta Agent – 40 ml of 75% alcohol. Group 2- Approach – posterior approach, bilateral entry at T11. Needle tip – anterolateral to T11. Agent - 40 ml of 75% alcohol. (20 ml each side)	Pain scores and opioid requirements significantly reduced in the splanchnic group. Performance status and patient satisfaction scores were significantly better in splanchnic group.	Bilateral splanchnic nerve block may be a better alternative to coeliac plexus block in patients having pain due to tumours in the body and tail of pancreas.
Jain and co-workers, 2005(21).	Prospective study	Assess CPN as an analgesic technique in settings of limited morphine availability.	Inclusion – Upper abdominal malignancy. Groups – Group 1 – control group (n=50) Group 2 – CPN, (n=48) Follow up – 1 month Outcomes assessed – Pain scores (VAS 0-10), oral morphine consumption, Karnofsky performance scale, performance score (0-4 score, 0-normal life 4- bed ridden), overall quality of life (0-10 score, 0- very poor, 10- normal life).	98	Approach – Group 2- -patients with coeliac axis free from tumour included in block group. -posterior approach at level of L1, bilateral block. Needle tip – not specified. Agent – 50% alcohol, 20 ml each side. Group 1 – NSAID's and Opioids (morphine).	-Group 2 had significantly improved pain scores and lesser morphine consumption -Significantly improved Karnofsky performance status and performance score in group 2. -No difference in overall QoL in both groups.	NCPB may specially be useful in providing optimum pain relief in settings with limited opioid availability but may not significantly affect overall QoL.
Stefaniak et al., 2005(34).	Retrospective analysis of two separate case controlled non-randomized studies.	To compare effectiveness of two invasive methods of pain control (NCPB and VSPL) against conservative management.	Cases reviewed – Unresectable pancreatic cancer. Procedures done between Jan 2001 to Sept 2003. Follow up – 8 weeks post procedure Groups – NCPB – n=35. VSPL – n=24. Control group – n=39.	59.	NCPB – Approach – retrocrural bilateral entry Agent – 20-30 ml of 50% ethanol each side. VSPL – thoracoscopy guided excision of splanchnic nerve and its branches for 5 to 8 cm. Control group – conservative management on oral analgesics.	Both the invasive modalities significantly reduced pain and fatigue. NCPB in addition had significant positive effects of other domains of quality of life like physical, emotional and social wellbeing.	Both NCPB and VSPL reduce pain in pancreatic cancer, out of the two NCPB may be the preferred technique owing to its lower invasiveness and better effect on quality of life.

Table 2. con't. Table summarizing Fluoroscopy guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Faith Ugur, 2007(16).	Case series	New technique described for retrocrural approach using a special long stylet needle under fluoroscopic guidance.	Inclusion criteria -Inoperable carcinoma pancreas (n=9) -Chronic pancreatitis (n=3) Groups -First - traditional retrocrural technique, (n=7) -Second – long guided needle technique, (n=5). Parameters assessed – -Number of attempts. -Fluoroscopy injection time.	12	Group 1 Retrocrural approach Bilateral entry Needle – traditional Chiba needle (18 G, 150mm) Group 2- Retrocrural approach Bilateral entry Needle – 18 G Chiba needle with two stylettes – 150 mm and 200mm (distally curved).	In group 2, L1 vertebral contact was made with the needle, 150 mm stylet was removed and 200 mm curved stylet inserted. This stylet was advanced 1.5 to 2 cm beyond the needle to reach a point approximately 3 cm anterior to L1 vertebral body. Correct placement confirmed fluoroscopically and needle passed over stylet.	Group 1 Fluoroscopy time 13±3 min Attempts 5.3±3 Group 2 Fluoroscopy time 8.9±3 Attempts 4.9±2 Significantly lower fluoroscopy time in group 2 but no difference in number if attempts. Less traumatic, avoids complications associated with walking needle off L1 vertebral body (organ injury) Recommended for beginners.
Yasser, M, 2013(22).	RCT	Compare the efficacy of CPN given as upfront therapy to a patient in severe pain or given after controlling the pain with conventional analgesics.	Inclusion criteria -Unresectable pancreatic cancer -Severe pain (VAS>70) Follow up 1 year. Groups Group 1 – CPN performed upfront at first visit and then analgesics titrated Group 2 – pain controlled initially with conventional analgesics and CPN done when VAS<4.	60	Approach – Transaortic single entry (in both groups). Agent – 40 ml of 70% alcohol (in both groups).	-Pain scores significantly lower in both groups as compared to pre-treatment levels. -Group 2 significantly lower pain scores as compared to the other group from 2nd month till end of follow up. -Morphine consumption significantly lesser in group 2 from 2nd month onwards.	Initial control of pain with analgesics and then performing neurolytic block is a better approach as compared to upfront neurolytic block in a patient with severe pain.
Tiexiera et al., 2013(35).	Retrospective study. Analysis of cases between June 1989 to March 2011.	To evaluate the role of alcohol based CPN in treating visceral pain due to upper abdominal malignancies.	Cases reviewed – upper abdominal cancers and visceral pain syndromes treated with CPN. Follow up – till 10 days after procedure Response graded as – Excellent – total pain relief with nor additional requirement of analgesics. Good – partial relief with improvement in QoL. Bad – no pain relief.	74	-Approach – retrocrural, bilateral entry. -Agent – absolute alcohol, 30-50 ml total volume.	Response assessed at day 10. Excellent response – 70 cases. Good response – 4 cases.	CPN is an effective procedure to relieve visceral pain in abdominal malignancies.

Table 2 cont. Table summarizing Fluoroscopy guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Shwita et al., 2015(19).	RCT	Compare coeliac plexus versus splanchnic nerve block for pain relief in upper G.I. malignancies.	Inclusion criteria 1. Inoperable GI tumours (lower 1/3rd oesophagus, stomach, biliary tract, pancreas). 2. Severe pain (VAS>7/100) with maximum tolerable dose of strong opioids. Groups – Group 1 – coeliac plexus block. Group 2 – splanchnic nerve block. Follow-up – every two weeks till 24 weeks.	60 (30 in each group)	-Approach – CPB – retrocrural, bilateral entry Splanchnic nerve block – bilateral needle technique. Agent – 70% alcohol. CPB – 20 ml each side Splanchnic – 10 ml each side.	Comparable morphine and tramadol consumption in both groups till 16 weeks. Significantly increased morphine consumption in group 1 from week 16 to 24.	Both the techniques equal in clinical efficacy in relieving pain from upper GI malignancies.
Archana dolly et al., 2016(23).	RCT.	Compare pain relief in performing CPB with three different volumes of 70% alcohol.	Inclusion criteria 1. Upper abdominal malignancies. 2. Uncontrolled pain with strong opioids (morphine) and NSAID's. Groups – Group 1 – 20 ml drug (n=10) Group 2 – 30 ml drug. (n=10) Group 3 – 40 ml drug. (n=10) Follow-up – weekly till 16 weeks.	30.	-Approach – transdiscal, bilateral entry. -Agent – 70% alcohol, 10, 15, or 20 ml in each entry side in the 3 groups.	Improved pain scores and QOL in group 2 and 3 from sixth week onwards, significantly better pain scores and QOL in group 3 at 16th week.	40 ml drug volume (20 ml each side) was most effective in controlling pain and improving quality of life.
Tewari et al., 2016(36).	Retrospective study. Analysis of cases between October 2013 and April 2015.	To compare the analgesic efficacy of retrocrural versus transaortic fluoroscopy guided CPN.	Cases reviewed – Unresectable upper abdominal malignancies causing pain not responding to opioid therapy. Follow up – till 6 months post procedure. Groups – Group R – retrocrural (n=36) Group T- transaortic (n=28)	64	Approach – Group R – retrocrural, bilateral entry. Group T – unilateral left sided transaortic approach. Agent – Group R – 15 ml of 100% alcohol each side. Group T – 20 ml of 100% alcohol.	Reduction in pain scores better in group R for the first 2 months, comparable pain scores thereafter. Reduced morphine consumption in group R till week 3, comparable consumption thereafter.	Retrocrural CPN may provide superior pain relief as compared to transaortic technique.
Molnar et al., 2019(37).	Case series.	Evaluate analgesic efficacy of retrocrural neurolytic coeliac plexus block in patients with severe abdominal pain due to unresectable pancreatic cancer.	Inclusion criteria 1. Unresectable pancreatic cancer 2. severe pain (VAS>7/10) with maximum possible dose of strong opioid and NSAID. Groups – single cohort of 16 patients Follow up – till 35th day after procedure.	16	-Approach – retrocrural, bilateral entry Agent – 70% alcohol, 20 ml each side.	Significant reduction in pain intensity and reduced opioid demand. 12 of the 16 patients could stop fentanyl patches and shift to tramadol after the procedure.	Reduced analgesic requirement and improved quality of life for at least 5 weeks after the intervention in end stage pancreatic cancer patients.

Celiac Plexus Block

Table 3. Table summarizing CT guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Stefano Ischia, 1983(38).	Case series.	Describe new technique the 'Trans-aortic CPB' – aimed to restrict the spread of neurolytic agent anterior to the crura of diaphragm and aorta.	Inclusion – Groups – single cohort of 28 patients. Follow up – 10 days to 4 months. Outcomes assessed -pain relief. -drug spread based on CT images	28	Approach – Patient prone, needle entry 4-5 cm lateral to spinous process of L1 vertebra. Fluoroscopy guided needle placement anterior to the body of L1 vertebra, transaortic passage with loss of resistance and negative aspiration to blood. Needle tip – through the anterior aortic wall in the fatty connective tissue in front of aorta harbouring the coeliac plexus. Agent – 30 ml of 75% alcohol.	-Pain relief obtained in 93% cases. -Block failure in 2 cases. -CT images showed dye spread in the anterior and lateral areas of aorta.	-Block failure due to hindrance in spread of contrast in the anterior of aorta due to pre-aortic involvement by the malignancy. -Simple technique, avoids drug spread into retrocrural area and psoas compartment, thus avoiding lumbar sympathetic plexus.
Lieberman and Waldman, 1990(39).	Case series	Confirm the results of loss of resistance based trans-aortic technique described by Ischia et al. (ref)	Inclusion – abdominal malignancy Groups – all patients given CPN Follow up – post procedure and single assessment 6 weeks after the block. Outcomes assessed – pain relief, opioid consumption and complications if any.	124	Approach – same as Ischia et al(), single needle, posterior left sided entry at level of 12th rib, entry point 7 cm lateral to midline. Needle guided beyond the body of 12th vertebra, loss of resistance felt as needle enters posterior aortic wall, negative aspiration for blood maintained as another loss of resistance felt as needle traverses the anterior aortic wall. Needle tip – fatty connective tissue in front of aorta Agent – 15 ml of absolute alcohol.	-113 patients (91%) reported marked pain relief in the immediate post-operative period. -at 6 weeks 44 patients (39%) remained totally pain free. -67 patients (54%) – mild diarrhoea not requiring treatment. -hypotension requiring IV fluids – 10 patients. (no fall in haematocrit in any of these patients).	- transaortic technique is as effective as classical technique requiring only a single needle insertion, no risk of retroperitoneal haematoma/ significant bleed.
Romanelli and coworkers, 1992(40).	Retrospective case series.	Assess the efficacy and safety of anterior approach for CPN.	Inclusion – pancreatic cancer (14), chronic pancreatitis (2), duodenal cancer (1). Groups – single cohort, all patients given block. Follow up – pre and post procedure evaluation. Outcomes assessed – pain relief – subjective (patient-based relief assessment) and objectively (mean analgesic dose consumption)	17	Approach – single needle (22-gauge Chiba biopsy needle), needle introduced through anterior abdominal wall. Needle tip – in the midline anterior to aorta between coeliac axis and superior mesenteric artery. Agent – 20 ml of absolute alcohol.	-Mean daily intramuscular morphine preblock dose 45.7 mg and post-block dose 22.6mg. -4 patients complete pain relief, 4 considerable relief and 3 mild to moderate pain relief. -2 patients no change in pain after block.	Anterior technique is a safe, time saving and efficacious technique with better patient comfort.

Table 3 con't. Table summarizing CT guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Hiroaki Ina et al., 1996(41).	Case series	Assess the efficacy and safety of trans-intervertebral disc approach of CPN.	Inclusion – abdominal malignancies (pancreas 32, liver and bile duct 9, stomach 7, colon 7, oesophagus 2 and undiagnosed primary 1). Groups – Unilateral two needle approach n=33. Bilateral approach n=25. Follow up – at 1 week, 1, 3 and 6 months. Outcomes assessed – pain score (VAS) and opioid consumption.	58	Approach – posterior, needle path judged on pre procedure CT scan. Entry at the level of T11-T12, T12-L1 or L1-L2; 2-5 cm lateral to midline. Two needles passed through the intervertebral discs to lie at the desired position. Needle tip – targeted to be placed anterior or anterolateral of aorta. Unilateral approach with two needles from the same site at different intervertebral levels or bilateral approach taken depending in cases to case CT scan assessment. Agent – 5 – 25 ml of 99.5% alcohol, (mean 31.4 ml)	Complete pain relief in 32 (55.2%) after the block and did not require any analgesic until death. Average duration of pain relief 3.2-3.6 months. 25 cases (21.6%) aortic puncture, but no haemorrhagic complications seen in any case. No incidence of discitis, disc herniation or disc degeneration seen in any patient.	Transdiscal approach is a safe and efficacious technique with comparable results to conventional techniques of CPB.
De Cicco et al., 1997(42).	Retrospective study	To study the position of needle tip in relation to coeliac artery, its effect on area of drug spread and success of block.	Inclusion – upper abdominal malignancy with VAS score >8. -Normal anatomy of coeliac area on pre-procedure CT scan. Groups – Group A – tip caudad to coeliac artery. (n-29) Group B – tip cephalad to coeliac artery (n-24). Follow up – 30 days. Outcomes assessed – dye spread in four quadrants divided in relation to coeliac artery. -Long term Pain relief assessed at 30 days	53	Approach – single needle, anterior, anterocrural. Needle tip – Group A – caudad i.e. between roots of coeliac and superior mesenteric artery. Group B- just cephalad to the root of coeliac artery. Agent – 30 ml, 70% alcohol.	-4 and 3 quadrants spread higher in group B (79% vs. 38%). -long lasting pain relief (VAS<5 at 30 days) – significantly higher in patients with 4 and 3 quadrant contrast spread. -no patient with 1 or 2 quadrant spread had long lasting pain relief	In anterior approach to CPN with no distortion in anatomy – needle tip should be placed cephalad to coeliac artery for better drug spread and long-lasting results.
Jeong Min Lee, 2000(43).	Case series	Report authors experience with CT guided CPN	-Inclusion advanced upper abdominal malignancies with severe pain (VAS>7) uncontrolled with pharmacological therapy. -Groups Anterior approach – 18 Posterior/transcrural approach – 6 Transaortic approach – 4. -Outcome grading Excellent >7 fall on VAS score (0-10) Good – VAS fall of 5-6. Fair – VAS fall of 3-4. Poor – VAS fall of <3.	28	Anterior approach Single/two needle entry Needle tip – just anterior to aorta between roots of coeliac and superior mesenteric artery. Posterior / Transcrural Bilateral entry Needle tip – transcrural, adjacent to the aorta Transaortic approach - Unilateral (left sided) entry. Needle tip – in the pre-aortic space. Agent – absolute alcohol, volume 30 ml. (1.5 ml through each needle if two needle entry)	Post procedure Excellent relief, n=6 Good relief, n=11 Fair relief, n=4 Poor relief, n=7. No follow-up details. No major complications reported.	Established CT guided CPB to be a safe and effective method of pain control.

Table 3 cont. Table summarizing CT guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Zang et al., 2007(44).	RCT	To compare the efficacy of analgesia with CT guided CPN against conventional opioid based pharmacotherapy in patients with pancreatic cancer.	Inclusion – Unresectable pancreatic cancer with chronic upper abdominal pain. Groups – Group 1 – CT guided CPN (n=29) Group 2 – pharmacotherapy (n=27). Follow up – 3 months Outcomes assessed – pain scores, QoL. – based on appetite sleep and communication.	56	Group 1 (CPN) Approach – Posterior retrocural, bilateral entry Needle tip 0.5 to 1 cm in front of vertebral body, near the aorta. Agent 40 ml absolute alcohol (20 ml each side). Group 2 (Pharmacologic therapy) Oral morphine-controlled release tablets. 30 mg twice a day to start and increased up to 120 mg/day on follow up visits.	Significantly lower pain scores on day 1, 7 and 14 in group 1 as compared to group 2. Comparable pain scores in both groups on day 30, 60 and 90. Improved QoL domains in both groups with no intergroup differences after block or oral morphine.	CPN was more effective than oral morphine in early stages of follow up. However, both groups were comparable in respect to pain scores and 1 month after the block. Morphine consumption was significantly reduced after CPN at all time points of follow up.
Lixia Huang et al., 2014(25).	RCT	Compare combination of coeliac plexus and superior hypogastric plexus neurolysis against coeliac plexus neurolysis alone in patients with upper abdominal malignancy.	Inclusion – Advanced upper abdominal malignancies Severe pain uncontrolled by oral analgesics Groups – Combined group (n=26) NCPB alone (n=26) Follow up – 3 months Outcomes measured – VAS score, QoL, morphine consumption.	52.	Approach – (NCPB) Transdiscal with transaortic entry on case basis Needle tip – lateral/latero-anterior to abdominal aorta. Bilateral block given if indicated. Agent – 90% alcohol, 15-25 ml (based on extent of tumour and pattern of dye spread) Superior hypogastric block – CT guided at L5-S1 10-15ml of 90% alcohol	Combined group had lower VAS scores and morphine consumption and higher QoL.	Neurolysis of both coeliac and superior hypogastric ganglion may give better pain relief in patients with upper abdominal malignancies
Edelstein et al., 2015(45).	Retrospective study.	Retrospective analysis of short-term pain outcomes among patients given CPN between April 2007 to May 2014.	Inclusion – refractory abdominal visceral pain. Groups – Group 1 – minor relief lasting less than 2 days. Group 2 – moderate relief for 48 hours but still requiring heavy doses of opioids to control pain. Group 3 – major/complete relief for 48 hours thus allowing reduction in opioid doses. Follow up – 48 hours. Outcomes assessed – pain relief.	87	Approach – anterior approach. Needle tip – not specified. Agent – not specified.	31 patients (36%) fell into group 1, i.e. pain relief lasting less than 48 hours. 21 patients (24%) fell into group 2. 35 patients (40%) had major relief – group 3.	Moderate to major short-term pain relief easily achieved with CT guided CPN with no major complication.

Table 3 con't. Table summarizing CT guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Jun Cao et al., 2016(46).	Retrospective study.	Compare the efficacy and cost effectiveness of CPN compared to conventional oral analgesics.	Inclusion - advanced upper abdominal malignancy (gastric, pancreatic, hepatic - all stage 4). -NRS > 7. -expected survival > 1 month. - Karnofsky performance status (KPS) >50. Groups - 1) Treatment group - CPN, (n=36). 2) Control group - morphine or oxycodone sustained release tablets, (n=45). Follow up - 3rd, 7th, 14th and 28th day post procedure. Outcomes assessed - NRS scores, KPS scores, cost effectiveness analysis (CEA) for medicine specific and total health care costs.	81	Approach - unilateral, posterior approach. Needle tip - antecural, anterolateral to root of abdominal aorta or superior mesenteric artery. Agent - 10-20 ml of ethanol.	Significant improvement in NRS and KPS scores at 7th day post procedure and no significant difference on 14th and 28th day. Medicine specific costs and total health care costs were significantly reduced in treatment group.	CPN is a cost effective and promising technique for analgesia in advanced abdominal malignancies.
Anghelescu et al., 2018(47).	Retrospective study	To evaluate the effectiveness of CPB in children and young adults (8-20) years.	- series of cases done between June 2015 to June 2017. -Inclusion - intraabdominal malignancies requiring palliation for refractory pain. -Follow up - maximum 6 months (1 patient)	4.	Approach unilateral posterior paravertebral approach Needle tip placed in the antecural space beside the aorta at the origin of coeliac trunk or between coeliac trunk and superior mesenteric artery. Agent 98% ethanol, 1mg/kg up to a maximum of 50 mg.	Reduction in pain scores and morphine consumption seen in all patients.	CPB may be useful tool for pain control in paediatric and young adult population.
Abdelghaffar, 2019(24).	RCT	Comparing conventional double needle posterior antecural approach to single needle insertion with changes in patient position to aid drug spread for CPN.	Inclusion - Upper abdominal malignancies, Uncontrolled pain on conventional analgesics. Groups - Double Needle Coeliac Neurolysis (DNCN) - n=17. Single Needle Coeliac Neurolysis (SNCN) - n=17. Follow up 3 months. Outcomes assessed - pain scores, duration of patient positioning and duration of procedure, failure rate	34	DNCN GROUP Approach - prone position, bilateral posterior antecural approach. Needle tip - both needles lateral to aorta. Agent - 25 ml 10% phenol (12.5 ml each side). SNCN GROUP Approach - lateral position, left sided posterior antecural approach. Needle tip - in front of aorta near origin of coeliac trunk. Agent - 25 ml, 10% phenol. *patient rotated from left side up to right side up after injection of drug for homogenous bilateral spread.	Increased time to position, duration of procedure and block failure rate in the DNCN group. Significantly reduced post-procedure pain scores in both groups, but no intergroup differences in pain scores 3 months post procedure.	CT guided SNCN provides equal pain relief reduces time to position and procedure time as compared to DNCN.

Table 4. Table summarizing Ultrasound guided CPB.

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Matamala and co-workers, 1989(9).	Case series	First detailed description of ultrasound guided percutaneous CPN.	Inclusion – chronic pancreatic pain (7 pancreatic cancer, 2 chronic pancreatitis) Groups – single cohort Follow up – 1-2 weeks and 6 months after block. Outcomes assessed – pain relief (on a scale of 0-4. 0 no relief and 4 total relief).	9	Approach – anterior, patient supine, single needle, point of entry 1-2 cm below and left of xiphoid process. USG guided positioning of needle. Needle tip – 22 Gauge spinal needle, tip positioned over coeliac plexus in the upper pre-aortic area. Agent – 35 ml of 50% alcohol.	-7 of 9 patients had total pain relief at 2 weeks (4 on assessment scale) -at 6 months, 5 patients had total pain relief. -6 of 9 patients underwent pancreatic biopsy at time of block.	Anterior USG guided approach to CPB is a simple and useful technique with minimal complications.
M.Caratozollo et al., 1997(26).	Case series.	Describe a modified USG guided technique and a new modified needle for CPN.	Inclusion – 1. pancreatic cancer (n=9) 2. Hepatic, gastric and colon cancer (1 each). Groups – 1. CPN with spinal needle, n=8. 2. CPN with modified percutaneous injection alcohol (PIA) needle, n=4. Follow up – 30 days. Outcomes assessed – 1. Pain relief rated according to a simple descriptive scale (SDS). 2. change in opioid doses post procedure.	12	Approach – -anterior; bilateral block -for precise needle tip placement, a modified transaortic approach used - i.e. needle made enter the anterior lateral wall of aorta, tip visualized in the lumen and then withdrawn to the desired location. Needle tip – 1 cm anterior to the anterior lateral aortic wall. Agent – 30 ml of 48% alcohol (15 ml each side). Modified PIA needle – special modification made by authors – conical tip of PIA needle replaced by Chiba bore tip.	-No major complications following the trans-aortic approach. -Better radial distribution of alcohol in the retroperitoneum with the modified PIA needle. -improved SDS pain scores in all patients at day 1- and 1-month post-procedure. -morphine stopped in 7 patients and required in half the initial dose in 2 patients post procedure. -no significant difference in analgesia with modified PIA needle.	Anterior trans-aortic USG guided CPN a safe and effective technique, a larger sample size required to detect any improvement when using a modified PIA needle.
Bhatnagar et al., 2011(27).	Case series	Single centre experience of early stage USG guided CPN (intervening before prolonged history of strong opioid use).	Inclusion – -Ca. GB - 15 -Ca. Pancreas - 2 -Ca. oesophagus - 1 -Ca. bile duct - 1 -RCC - 1 -Early Neurolysis: on oral morphine for >3 but <30 days. Groups – single cohort of 20 patients. Follow up – 2 months Outcome parameters – -Daily oral morphine requirement. -Karnofsky performance status -QoL on a linear scale -Constipation score	20	Sonosite Micromaxx USG system, with a C60e/5-2 MHz transducer placed in epigastric region, long axis view used to locate origin of coeliac trunk and superior mesenteric artery. From here transducer rotated to get the image of coeliac trunk Approach – anterior; needle entry 'in plane' from epigastric region, in the short axis view. Needle tip – placed in the space between the abdominal aorta and celiac trunk. Uni/Bi lateral – Bilateral drug injection. Agent – 15 ml of 50% ethanol.	Significant reduction in VAS scores and morphine requirement at all follow-up points. Improved Karnofsky performance score, QoL index and constipation scores post neurolysis. No major complications seen.	Bedside USG guided CPN in early stage of opioid therapy may be considered as a first line therapy and a suitable alternative to opioids.

Table 4 con't. Table summarizing Ultrasound guided CPB .

Authors, year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Bhatnagar et al., 2013(28).	RCT	Compare the pain relief with conventional bilateral paramedian (double needle) approach with unilateral paramedian single needle approach for anterior approach coeliac plexus block under ultrasound guidance.	Inclusion – -Upper abdominal cancers -Failed pain relief with weak opioids. Groups – Group SN - block with single needle. Group DN – block with double needles. Follow up – 3 months. Outcome parameters – Compare onset of pain relief, pain scores at various follow-up points, patient satisfaction and complications (diarrhoea and hypotension) between two groups.	60	Sonosite Micromaxx USG system, with a C60e/5-2 MHz transducer placed in epigastric region, long axis view used to locate origin of coeliac trunk and superior mesenteric artery. From here transducer rotated to get the image of coeliac trunk Approach – Group SN (n=30) single needle introduced 'in plane' and tip positioned either left or right side of coeliac trunk. Group DN (n=30) Two needles introduced 'in plane' and tips placed on each side of coeliac trunk. Agent – 20 ml of 50% ethanol (single injection or 10 ml each side.)	Onset of pain relief, pain scores till 3 months of follow up, patient satisfaction scores and complications all parameters comparable in both groups. No major complication seen in any group.	Single needle technique is comparable to bilateral (two needles) insertion in all aspects; and may be easier to practice .

intraoperative CPN during laparotomy (Table 5) (48-53).

DISCUSSION AND CONCLUSION

As seen by the evidence generated over the years, CPN has grown as a technique and has established itself as an effective method to treat pancreatic cancer. There are several systematic reviews and meta-analysis which have been published over the years establishing this technique, this literature review aimed to throw light on the journey of this block from its initial stages of description to the growth of evidence over the years and comment on the present role of this technique in pancreatic cancer pain management. The main take-home points or clinical practice points from the data summarized in this literature review are – CPB is an efficacious modality for pain relief in tumors originating from the head of the pancreas, the analgesic and opioid-sparing effect of this block is maximum when given early in the disease trajectory, and all approaches and radiological techniques to guide needle placement are useful with no specific contraindication of a single approach. The selection of approach, a radiological device to guide needle placement, and the volume and concentration of drug used depends on the individual's preference, familiarity with the technique, and institutional practice. We have best attempts to stratify and collate the data generated over the years to generate a birds-eye view on the evolution of this technique, however, we did not do a meta-analysis of the studies due to the heterogeneous nature of the studies and variable endpoints assessed in each study which is the major limitation of our work.

Despite the heterogeneities in the methodology of studies and the quality of data generated over the years, it is broadly clear that CPB as a technique is here to stay and the future result may focus on the areas where least evidence has been generated like US-guided CPB or minimally invasive single-needle techniques. Also, structured multicentric RCTs may be 'the need of the hour' to compare objectively with fixed parameters techniques, each center specializes in generating quality evidence regarding the best, and most effective, approach for CPB.

Table 5. Table summarizing Intra-operative/surgeon guided CPB.

Authors, Year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
James Copping and co-workers, 1969(48).	Case series	Describe a new technique of splanchnic neurolysis in inoperable pancreatic cancer cases.	Inclusion – unresectable pancreatic cancer with biliary and duodenal bypass done. Groups – single cohort Follow up – till death Outcomes assessed – pain relief	13	Approach – abdominal aorta identified below the left lobe of liver and stomach; a 20-gauge spinal needle used to inject drug bilaterally into the junction of splanchnic nerves into the coeliac ganglia. Agent – 10 ml of 6% phenol each side (total volume 20 ml).	-10 out of 13 patients given the block were evaluated for pain relief. -significant pain relief seen in 7 of the 10 patients. -duration of pain relief lasted about 4 months.	Simple and safe procedure reduces the need of subsequent interventional procedures and drugs to control pain in the expected life duration of the patients.
Gardner and Solomon, 1984(49).	Retrospective analysis	Surgeons experience with phenol based intraoperative CPN.	Inclusion – pancreatic cancer deemed inoperable on laparotomy. Groups – CPN group – (n=49). Control group – (n=49). Follow up – till death Outcomes assessed – pain relief, overall survival.	98	Approach – CPN group – drug injected retroperitoneally and in front on either side of aorta at the level of upper border of pancreas. Agent – 40 ml of 5% phenol in almond oil.	-30 patients experienced pain relief and in 26 patients pain relief persisted till death. -no statistically significant difference in survival patterns in both groups.	Perioperative splanchnicectomy/CPN can be routinely performed during laparotomy in unresectable pancreatic cancer patients.
Kenneth Sharp, 1991(50).	Retrospective case series analysis.	Single centre experience with intraoperative CPN.	Inclusion – pancreatic cancer patients undergoing laparotomy for tumour biopsy, biliary bypass or gastroenterostomy. Groups – single cohort. Follow up – till death. Outcomes assessed – pain relief.	12	Approach – coeliac axis identified by the surgeon, at the level of coeliac axis drug injected into each side of aorta into the peri-aortic tissue and the retroperitoneum. Agent – 10 ml of 50% alcohol each side with a 22 G spinal needle.	-Complete pain relief in 10 of the 12 patients. -No intra-operative complications due to CPB and average duration of post-operative stay 13 days. -Minimum duration of pain relief 2 months	Intra-operative CPN is a easy, safe and highly effective technique of analgesia in inoperable pancreatic cancer.
Lilmoie et al., 1993(51).	RCT	Compare intraoperative chemical splanchnicectomy versus a placebo for pain relief in unresectable pancreatic cancer	Inclusion – intraoperative cases of unresectable pancreatic cancer Groups – -Treatment group (n=65). -Placebo group (n=72) Follow up – every two months until death. Outcomes assessed – pain, mood and disability due to pain.	137	Technique – intraoperative, block done by the operating surgeon. 20 ml of study drug injected on each side of abdominal aorta at the level of coeliac axis. Treatment group – 40 ml of 50% alcohol (20 ml each side) Placebo group – 40 ml saline.	-No differences in hospital mortality/complications, return to oral intake and length of hospital stay in both groups. -pain scores significantly lower in alcohol group at 2,4,6 months and final follow up (p<0.05). -patients with no pre-operative pain showed significant delay in onset of pain and lower pain scores. -improved survival in alcohol group	First RCT looking prospectively into role of intra-operative CPN to alleviate pancreatic cancer pain. Intra-operative chemical splanchnicectomy significantly reduces or prevents onset of pain in unresectable pancreatic cancer.

Table 5 cont. Table summarizing Intra-operative/surgeon guided CPB.

Authors, Year of publication	Study design	Primary aim / study hypothesis	Experimental design.	Number of patients	Intervention	Results	Conclusion
Peter Staats and co-workers, 2001(52).	RCT	Data analysis of a previously conducted RCT by Lilmoe.	Experimental design – data of a previously completed RCT (ref) analysed for a new proposed hypothesis.	130 patients data analysed.	Data of previous RCT analysed to assess to effect of alcohol based CPN on pain, mood, longevity and impact of mood and pain on longevity.	Alcohol neurolysis of Coeliac plexus reduced pain and had a significant positive effect on duration of life and mood scores.	First RCT supporting the hypothesis that reduced pain, elevated mood, less interference with daily activities led to improved longevity in inoperable pancreatic cancer patients.
Okuyama et al., 2002(53).		To compare intra-operative CPN with conventional pharmacotherapy	Inclusion – unresectable pancreatic cancer. Groups – Group 1 – intra-operative CPN (N=15) Group 2 – pharmacotherapy (N=6). Follow up – till death. Outcomes assessed – Mean analgesic consumption (oral morphine equivalents), post-operative complications.	21	Approach – intraoperative, block done by the operating surgeon drug injected at the level 10 ml of drug injected on each side of aorta at the level of coeliac axis. Agent – absolute alcohol 10 ml each side.	-Mean opioid consumption significantly lower in group 1. -No difference in mortality, morbidity and post-operative complications in both groups. -No difference in overall survival in both groups.	Intraoperative CPN makes pain control possible in advanced pancreatic cancer with lower opioid doses.

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