Coeliac plexus neurolysis for upper abdominal malignancies using an anterior approach: review of the literature

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Background: Coeliac plexus neurolysis (CPN) helps to diminish pain arising from malignancy of upper abdominal viscera. Imaging modalities have increased the success rates by enhancing technical accuracy including fluoroscopy, computed tomography and ultrasound. Advancement in the imaging modalities used has helped in the accurate depiction of anatomy and position of the needle tip.

Methods: In an anterior approach, the patient lies supine and the needle is inserted through the anterior abdominal wall into the retropancreatic space. The needle often traverses the stomach, liver or pancreas before reaching the coeliac plexus due to anatomical considerations. The literature has been reviewed regarding various imaging modalities using an anterior approach to coeliac plexus block with regard to success rate, improvement in pain scores, duration of pain relief and analgesic consumption.

Results: Successful pain relief in abdominal malignancies with an anterior approach using various imaging modalities varies between 54% and 94% of patients. Following neurolysis, many patients can be weaned off opioids. This procedure improves quality of life and reduces the risk of drug-related side effects. The duration of pain relief after an anterior approach is six to eight weeks.

Conclusion: The use of various imaging modalities in an anterior approach has improved the technical accuracy in reaching the coeliac plexus, thereby avoiding the needle piercing crucial structures and avoiding deposition of drug in the retrocrural space, thereby reducing the risk of neurological complications. Coeliac plexus neurolysis via an anterior approach using different imaging modalities does not completely abolish pain, rather it diminishes pain, helping to reduce opioid requirements and improving survival in patients with upper abdominal malignancy.

Keywords: coeliac plexus, coeliac plexus block, imaging modalities, neurolytic techniques, pancreatic pain, upper abdominal malignancy

Introduction

Pain of malignancies in the upper abdomen transmitted via the coeliac plexus (CP) is primarily from the pancreas, diaphragm, liver, spleen, stomach and small bowel.[1] It affects the quality of life and survival of patients. The symptoms of disease appear usually in the advanced stages of disease after considerable tumour growth and metastatic spread. The majority of these cases are unresectable and highly resistant to conventional chemoradiation therapy, leading to a poor prognosis. Less than 20% of patients survive their first year and only 4% survive for five years.[2] At this stage efforts are concentrated mainly on palliative treatment and pain relief. Optimal palliation of symptoms improves the quality of life in the majority of patients.[3] The pain of intra-abdominal malignancy including pancreatic cancer often necessitates opioid administration. Narcotic analgesics are effective and serve as the mainstay of pain management for most patients. However, due to severity of pain, opioids are effective only in dosages that induce significant side effects such as constipation, nausea, vomiting, anorexia, drowsiness, delirium and addiction.[4] Although drug therapy continues to be the mainstay of treatment for pancreatic cancer pain, neurolytic coeliac plexus block (NCPB) is claimed by some authors to be optimal treatment.[5,6] Percutaneous coeliac block has been used as an adjunctive therapy in such cases to produce a reduction in narcotic requirements and side effects, improving bowel motility and converting bedridden patients to ambulatory.[1,7]

Coeliac plexus neurolysis (CPN) involves the injection of a neurolytic agent (most commonly absolute alcohol) into or around the coeliac plexus to disrupt these neural impulses and effectively control pain. Since Kappis described the percutaneous neurolytic coeliac plexus block, variations and improvements in this technique have been proposed, including radiological guidance techniques that theoretically improve results, enhance technical accuracy, reduce morbidity and avoid complications.[1] The most important variations include the use of fluoroscopy and computed tomography for the posterior route and ultrasound, endoscopic ultrasound and magnetic resonant imaging (MRI) for the anterior route. These modalities help to depict the retroperitoneal anatomy accurately as well as the position of the needle, which helps to avoid crucial anatomical structures like the aorta, coeliac artery and pancreas.[8] These techniques have a variable and limited success rate for long-term pain control.

Use of a posterior approach has been associated with serious complications such as paraplegia, dysaesthesia and paraesthesia in less than 1% of patients due to posterior spread of drug towards the lumbar plexus.[9–11] To overcome these complications an anterior approach was used by a few authors which involves placing the drug anterior to the diaphragmatic crura and aorta (Figure 1).[12,13] Advantages of an anterior approach include the need for a single puncture, resulting in less discomfort to the patient, reduced procedure time, and use of a smaller volume of neurolytic agent and less risk of neurological complications. It also avoids puncture of the aorta, ensures placement of the tip of the needle anterior to the anterior spinal arteries and spinal canal, and permits the patient to remain supine for the entire procedure.[1] The objective of this article is to review various imag-
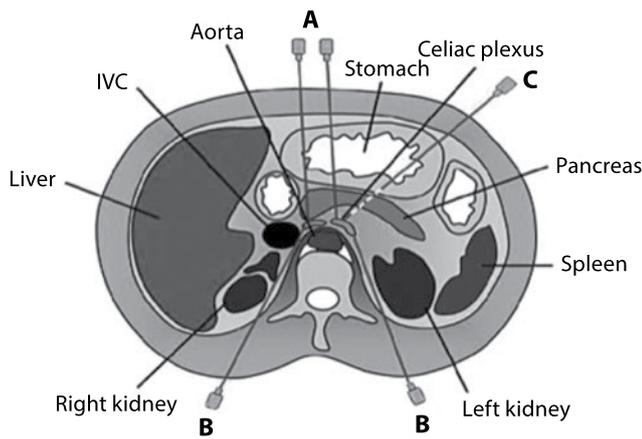
Note: A: anterior transgastric/transpancreatic. B: posterior transcrural. C: anterior oblique transgastric.

Figure 1: Access routes to PCN.

ing modalities used in an anterior approach to CPN and discuss them with regard to pain relief, success rate, analgesic consumption, duration of pain relief, complications, and the technical and clinical aspects of CPN. In this article we also describe the anatomy of the coeliac plexus, indications, contraindications, and techniques of CPB via an anterior approach.

Anatomy of coeliac plexus and mechanism of pain transmission

The preganglionic sympathetic efferents come from the greater (T_5 to T_{10}), lesser (T_{10} to T_{11}) and least (T_{12}) splanchnic nerves. These synapse in the coeliac plexus and from there, post-ganglionic fibres travel with blood vessels and subsidiary plexuses to innervate abdominal viscera (Figure 2). Pain transmitted via the coeliac plexus is primarily from the upper abdomen, including the pancreas, diaphragm, liver, spleen, stomach, small bowel, ascending and proximal transverse colon, adrenal glands, kidneys, abdominal aorta and mesentery (Figure 2).[1] Thus the coeliac plexus represents the main target point of nociceptive transmission because fibres to the upper abdominal viscera can be interrupted with a single injection. The coeliac plexus, embedded in loose areolar tissue, lies within the retroperitoneal space posterior to the stomach and the pancreas and close to the coeliac axis. It is separated from the vertebral column by the crus of the diaphragm and overlaps the aorta at the level of the first lumbar vertebra. The coeliac plexus is a dense network of ganglia around the aorta with considerable variability in size, number and position, with a relatively

Preganglionic Sympathetic Fibres from T 5 through T 9 (Greater splanchic nerves), T 10 through T 11 (Lesser splanchic nerves), T 12 (Least splanchic nerves)

Preganglionic parasympathetic efferent Fibres from posterior trunk of vagus nerve

Sympathetic afferents from all the abdominal viscera except left half of colon, rectum and the pelvic organs

Lapse in coeliac ganglion

Postganglionic fibres innervate liver, gall bladder, biliary tract, stomach, pancreas,spleen,adrenals, glands, kidneys, mesentery, small & large gut proximal to transverse colon

Figure 2: Graphic depictions of the anatomy.

lower position of the left versus the right ganglion.[14] The crus of the diaphragm originates from the anterior lateral surfaces of the bodies of the upper lumbar vertebrae. The tendinous origins blend with the anterior longitudinal ligaments of the vertebral column. These represent an anatomic barrier to the spread of solutions injected anterior or posterior to the crura.

Affected nerves from the abdominal viscera transmit signals via nociceptive pathways towards the central nervous system. The coeliac plexus, which contains these autonomic fibres, plays a vital role in the transmission of pain sensation originating from most of the abdominal viscera including the pancreas, diaphragm, liver, spleen, stomach and small bowel except the left colon, rectum and pelvic organs.[15] The abdominal pain of pancreatic malignancy is usually secondary to cancer progression that causes neural invasion or nerve compression.[16] The neuropathic pain of upper abdominal malignancy is a target for effective palliation.

Coeliac plexus neurolysis
Indications

(1) Diagnostic tool: CPB with local anaesthetic agent to determine whether the flank/retroperitoneal/upper abdominal pain is mediated by the coeliac plexus.
(2) Surgical anaesthesia: for upper abdominal surgery along with intercostal nerve block when general anaesthesia is contraindicated.
(3) Pain relief:

   a. Intractable pain secondary to carcinoma of the upper gastrointestinal tract and retroperitoneal cancers.
   b. Chronic pancreatitis.
   c. Secondary to arterial embolisation of the liver.
   d. Pain secondary to ischaemia.

(4) Local anaesthetic CPB for interventional radiological procedures.
(5) To decrease inflammation: CPB with steroid and local anaesthetic for acute pancreatitis.
(6) Splenic vein thrombosis.

Contraindications

(1) Uncorrectable coagulopathy (international normalised ratio > 1.5).
(2) Thrombocytopenia (platelets < 50 000/cu mm).
(3) Altered anatomy (e.g. gastric bypass or an extensive mass or lymphadenopathy prohibiting visualisation).
(4) Local sepsis at site.
(5) Active abdominal infection.
(6) Bowel obstruction.
(7) Patients on disulfiram therapy.
(8) Patient with physical dependence and drug-seeking behaviour.

Patient preparation

The patient should be admitted overnight for observation, especially a debilitated patient with poor nutritional status. Before the procedure the patient should fast for at least eight hours. Gut preparation is done with four tablets of bisacodyl 5 mg and six charcoal tablets given at bedtime the night before the procedure. Anticoagulants should be discontinued in the preoperative period to minimise the risk of bleeding.[17] However, antihypertensives

and other medications should be continued. Opioids usually need to be continued as premedication one hour prior to CPN. Coeliac plexus neurolysis is performed under intravenous conscious sedation with agents such as midazolam (0.01–0.1 mg/kg) and fentanyl (1–2 mcg/kg). Cardiorespiratory monitoring including ECG, blood pressure, and pulse oximetry is essential. Patients are premedicated one hour prior to block. An intravenous line is established. A prophylactic antibiotic should be administered one hour prior to block. All patients should receive intravenous fluids in the form of lactated Ringer's solution 10–15 ml/kg body weight. The patient's heart rate, blood pressure and oxygen saturation are noted before the procedure and monitored during the procedure.

Neurolytic agents

The neurolytic agents commonly used to permanently destroy the coeliac plexus are ethanol and phenol. Ethanol causes immediate precipitation of endoneural lipoproteins and mucoproteins within the coeliac plexus, leading to extraction of cholesterol, phospholipid, and cerebroside from the neurilemma.[18,19] Irreversible damage to neurons and nerve fibres occurs at an ethanol concentration of more than 50%; hence, a concentration between 50% and 100% is preferred for coeliac plexus neurolysis.[19] At concentrations above 50%, the degree of destruction depends more on the distribution of ethanol within the coeliac plexus than its concentration.[19] Few authors recommend adding a long-acting local anaesthetic such as bupivacaine to ethanol as its injection may cause severe transient pain.[18,19] Iodinated contrast material is another component that is added to ethanol to help visualise the distribution of neurolytic agent in the pre-aortic space.[18,19] A cocktail of absolute alcohol (95–100%), bupivacaine and contrast material, with a ratio of 6:3:1, is the most frequently used neurolytic mixture.[20]

Phenol has a somewhat slower onset and shorter duration of action and is less effective than ethanol.[18,19] Phenol is generally injected at a concentration of 3–20%, and large amounts of phenol are toxic and cause irritation.[19] It achieves neurolysis similar to that achieved with ethanol by causing protein coagulation and necrosis of neural structures. The transient pain associated with ethanol injection does not occur with phenol because it has an immediate local anaesthetic effect. It is also more viscous than ethanol, a characteristic that limits the use of higher concentrations and makes it unsuitable for mixing with contrast material.[18,19] The needle track should be cleared with normal saline during withdrawal of the needle to avoid tracking of the neurolytic solution along the needle path.

Techniques

Several methods, depicted in Figure 3, of performing such blocks have been described in the literature.[15] The NCPB techniques most often used are based on the percutaneous posterior approach and differ with regard to the final position of the needle, which may be precrural[21,22] or retrocrural.[23] The retrocrural site refers to injection of neurolytic agent into the space behind the diaphragmatic crura, which prevents the neurolytic agent from spreading into the coeliac plexus. The antecrural site refers to the injection of neurolytic agent into the space anterior to the diaphragmatic crura and aorta. Aims of new CPN with imaging modalities are to improve visualisation of the coeliac plexus and the spread of the neurolytic agent, provide greater comfort for the patient, and cause fewer complications.[24]

Posterior approach

In the classic technique a posterior approach was used.[25] It involves needle placement postero-cephalad to the diaphragm in the retrocrural space in a prone position (Figure 4). Later modifications included a postero-lateral approach with fluoroscopy and palpation and use of CT to guide placement of the needle.[7] A neurolytic agent can be injected in both the antecrural or retrocrural region. Retrocrural injection is performed most frequently by a posterior approach. This approach is not preferred in very obese patients or those who have difficulty maintaining a safe airway.

Anterior approach

An anterior abdominal approach provides for placement of the needle just anterior to the diaphragmatic crus at or between the origin of the coeliac and superior mesenteric arteries under guidance of ultrasound, CT or EUS (Figure 5). The procedure can be performed with two needles, one on each side of the coeliac trunk, or with a single needle. An alternative option is fluoroscopy to guide passage of the needle. Although this technique involves the passage of fine needles through the liver, stomach, small and large bowel, and pancreas to reach the coeliac ganglia, it is associated with low rates of complications. The theoretical advantages of this approach include a lower risk of neurologic injury related to the spread of neurolytic solution to the somatic nerve roots as the drug is placed in the antecrural space, and reduced discomfort during the procedure by avoiding a prolonged prone position.[26] This is understandable because the general condition of many of these patients is poor, and blood pressure and ECG monitoring and even assisted ventilation are often necessary.[27] The anterior approach also obviates transcrural placement of the needle, which may sometimes require the abdominal aorta to be crossed to achieve efficient spreading of neurolytic agent.[22]

Intraoperative injection

This is undertaken when laparotomy is planned for exploration or bypass of the gastrointestinal or biliary tract. Advantages include that no separate procedure or preparation is required and even patients with abdominal malignancy with mild pain can be given a block on the assumption that pain would increase as malignancy progresses. Disadvantages include that the drug is likely to get lost in the operative field and safe access of the coeliac plexus to the drug is decreased by bulky intra-abdominal disease. The efficacy and safety of this technique is controversial.

Imaging guidance modalities

These have evolved over the years with technical advances in imaging.

Fluoroscopy

The needle is introduced at the midline epigastrium and advanced in the horizontal plane until the tip touches the vertebral body of L1. The needle is pulled back 1–1.5 cm. Contrast injection confirms correct placement of the needle tip by fluoroscopy. Though a fluoroscopic approach is simple to perform it has poor anatomic resolution and does not distinguish the coeliac plexus from adjacent structures such as the pancreas, blood vessels, tumours and lymph nodes.[19] The needle tip cannot always be precisely placed using bony landmarks due to normal variation in soft tissue anatomy. Fluoroscopy-guided CPN is associated with a higher rate of complications such as neurologic injury resulting from imprecise tracking of the needle puncture route and indistinct display of diffusion of the neurolytic agent into the retroperitoneum.[19]

Computed tomography guidance

The use of computed tomography guidance clearly depicts the retroperitoneal structures and extent of the tumour and other

1. Posterior approach

- Precruralor retrocrural with help of fluoroscope, CT scan depending on position of needle

2. Postero-lateral approach

- Fluoroscope, CT scan

3. ANTERIOR approach

- Transgastric/transpancreatic
  - Anterior to the diaphragmatic crus between the origin of celiac and superior mesenteric arteries under guidance of ultrasound, CT or EUS

4. Intraoperative injection

Figure 3: Graphic depictions of different approaches.

Figure 4: Fluoroscopic image showing posterior approach.

causes of abdominal pain such as duodenal obstruction. The coeliac plexus may be directly identified. Visualisation of the needle is improved, its tip and surrounding structures can be clearly depicted, vital organ damage is avoided and the risks associated with the procedure are reduced.[21] It accurately depicts diffusion of the neurolytic agent and real-time monitoring of the procedure (Figure 6). Unfortunately not every procedure can be performed in the CT room[28] and there is high risk of radiation exposure.

MRI
Kristian et al. performed 14 CPB in eight patients, carried out in an open magnetic resonance (MR) scanner, offering needle guidance with an optical tracking system and near real-time image acquisition and reported good pain relief in 8 of 14 blocks (57%), a moderate effect in 5 blocks (36%), and no effect in 1 block (7%). The placement of the needle was easily guided with MR in all cases. The MR technique ensures good visualisation of soft tissue, direct monitoring of needle movement and avoids exposure to ionising radiation (Figure 7). They concluded that CPB can be carried out safely in an open MR scanner.[29]

Ultrasound guidance
The ultrasound-guided technique is faster and cheaper than the computed-tomography-guided method. It permits real-time visualisation of the aorta and visceral arteries and enables diffusion

of neurolytic agent to be viewed without the aid of contrast media (Figure 8).[19] However, the sonographic approach requires much more individual skills and training in interventional radiology. The most relevant drawback of ultrasound guidance is poor visualisation of thin needles during their progression, with the potential of the needle's improper positioning.[30] Use of real-time and colour Doppler sonography avoids complications related to an inability to visualise the needle (Figure 9).[24]

Endoscopic ultrasound guidance
The development of endoscopic ultrasound (EUS), and more recently a linear array EUS instrument that allows for ultrasound-guided fine-needle aspiration (FNA), has inspired innovative interventions for managing gastrointestinal disease.[31,32] The advent of EUS-guided FNA and ability of EUS to allow visualisation of vascular structures using colour Doppler has allowed for the development of EUS-guided coeliac plexus block. It allows real-time monitoring of neurolytic injection. This technique was initially described in a small series of patients with pancreatic cancer who reported some improvement in pain symptoms using ethanol injection.[33] It is safe and in experienced hands can be performed in a short time period. This may be attributed to the fact that EUS provides improved visualisation of the coeliac axis and hence more accurate placement of the neurolytic agent used, and lessens the risk of more serious complications like paraplegia, which is more common with translumbar/retrocrural approaches. This technique is operator dependent and invasive, therefore the risk for complications like gastric perforation and pancreatitis is present.

Clinical efficacy
Some patients respond to multimodality therapy and may become dependent on narcotic agents. However, recent reviews of the efficacy of NCPB have reached conflicting conclusions. Some investigators affirm the efficacy of NCPB for pancreatic cancer pain,[34] but others believe that its effectiveness is not yet proven.[35] Recently, it has been emphasised that only an incomplete spread may occur even when the coeliac area seems free from regional anatomical distortions.[36] Furthermore, regardless of the technique used to improve the spread of the injectate in the plexus area, failures are common due to regional infiltration by cancer tissue and anatomy distortion by either previous surgery or radiation-therapy-induced fibrosis.[22,37–40] Computed tomography and fluoroscopically guided anterior coeliac plexus blocks have been successfully used for the alleviation of deep visceral pain for interventional hepatobiliary procedures.[41]

Clinical studies
These have been depicted in Table 1.

Matamala et al. in 1989 used a percutaneous anterior approach to the coeliac plexus using ultrasound in nine patients in a supine position, aged 44 to 61 years with upper abdominal chronic pancreatic pain using a 22 G, 15 cm long needle inserted perpendicular to the L1 spinous process and its tip positioned over the coeliac plexus in the pancreatic area. Pain relief was assessed at 1–2 weeks and six months after neurolysis with 35 ml of 50% alcohol. Seven of nine patients with abdominal pain had total pain relief two weeks after neurolysis and two patients had no pain relief. After six months five patients continued with total pain relief and did not require analgesic medication. Two patients with chronic pancreatitis had moderate pain relief requiring analgesic medication. Two remaining patients had no pain relief and one died three months later. No serious complications were noted in
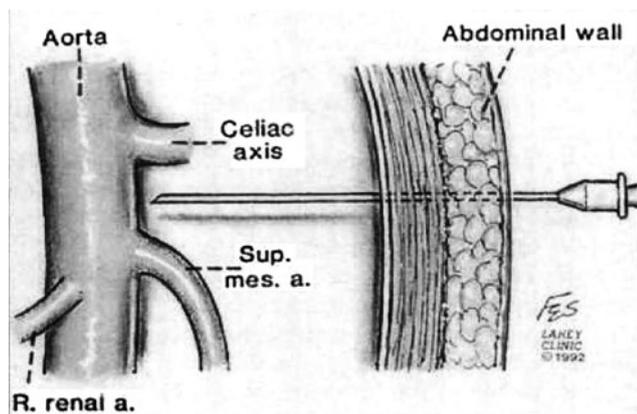
Figure 5: Diagram shows sagittal view of the aorta. The tip of the needle used for coeliac axis block is placed anterior to the aorta.

the study. Five patients had local pain that coincided with the injection of the neurolytic agent. Four patients required an intravenous hypnotic agent. Six patients had increased peristalsis, but this did not last more than 48–72 h. They concluded that an anterior approach was useful in patients with chronic pancreatic pain undergoing biopsy of the pancreas, and in terminally ill or heavily sedated patients who had difficulty in tolerating the prone flexed position.[27]

Romanelli et al. in 1992 evaluated the efficacy of CT-guided coeliac plexus neurolysis with 20 ml of absolute alcohol by an anterior approach in 17 patients with chronic abdominal pain suspected to be of coeliac ganglion origin. Pain relief was graded from 1+ (no change) to 4+ (complete relief). An objective evaluation was also obtained by comparing average daily in-hospital analgesic usage before and after the procedure. Ethanol injection was performed successfully in 13 of 14 patients with pancreatic carcinoma and in two of three patients with other causes of pain. Eleven of the 14 patients with pancreatic carcinoma had some (2+ or greater) relief of pain, and 8 of these patients had considerable or complete (3+ or 4+) relief of pain. Of the 10 patients with pancreatic carcinoma for whom complete data on use of pain medications were available, patients with complete (4+) relief of pain had an average decrease of 78% (range, 36–99%) in mean daily analgesic usage, patients with considerable (3+) relief of pain had an average decrease of 54% (range, 17–100%), and patients with mild to moderate (2+) relief of pain had an average decrease of 26% (range, 19–33%). Complete data were not available on two patients with no change (1+) in degree of pain. No significant benefit was noted in the three patients with diagnosis other than carcinoma of the pancreas. In one patient with pancreatitis, dense scarring around the aorta made injection impossible. One patient with pancreatitis did not respond to injection of neurolytic agent and one patient with adenocarcinoma of the duodenum had only mild (2+) subjective pain relief. Complete objective data on mean daily analgesic usage were available only for the latter patient, showing a decrease of 8% after the procedure. Complications, all relatively mild, were encountered in only 3 of 17 patients, and no patient had neurologic symptoms or long-term sequelae.[42]

Das and Chapman in 1992 used a sonographically guided anterior approach to block the coeliac plexus with local anaesthetic in supine position before hepatobiliary interventional procedures in nine patients using a 20 G, 15 cm long spinal needle. In two cases injection was made on both sides of the root of the superior mes-

enteric artery. A single injection was made immediately anterior to the aorta between the roots of the coeliac axis and superior mesenteric artery in the remaining cases. The needle passed through the left lobe of the liver avoiding the stomach and above the pancreas. In two cases the needle was passed through the pancreas and splenic vein. The position of the needle tip was checked by fluoroscopy and considered satisfactory if it was overlying the body of L1. Forty ml of 1% lignocaine containing injection adrenalin (1:200 000) was injected slowly over 1–2 min. Satisfactory block was achieved in eight out of nine patients. Transient hypotension was noticed in two patients who were managed conservatively. Comparison with controls showed the coeliac block patients to require significantly less intravenous sedation and analgesia to control pain during these procedures.[43]

Gimenez et al. in 1993 evaluated the usefulness of sonographically guided percutaneous neurolysis of the coeliac plexus in patients with abdominal tumours or chronic pancreatitis in whom systemic analgesics were ineffective. Neurolysis of the coeliac plexus was performed in 38 patients, 34 with neoplastic disease, and 4 with chronic pancreatitis. Under sonographic guidance, a 22 G needle was advanced by the anterior route to the area above the coeliac plexus, and 30–40 ml of 50% alcohol was injected. Pain relief was assessed at one week, six months, and one year after the procedure. Patients subjectively rated the pain after treatment as totally relieved, partially relieved or unchanged. At one week and six months after treatment, pain was totally relieved in 61% of patients, partially relieved in 31% and unchanged in 8%. After one year pain was totally relieved in 39% of patients, partially relieved in 52% and unchanged in 9%. Complications observed were five cases of mild diarrhoea and one case of retroperitoneal pain, which subsided with conservative treatment.[44]

Wiersema and Wiersema in 1996 evaluated the safety and efficacy of performing endosonography-guided coeliac plexus neurolysis (EUS CPN) in 30 patients with pain due to intra-abdominal malignancies. Twenty-five patients had pancreatic carcinoma and five patients had intra-abdominal metastasis. Using the linear array ultrasound endoscope and a prototype needle catheter, transgastric injection of the coeliac plexus with bupivacaine and 98% dehydrated absolute alcohol was accomplished. Pain scores were significantly lower compared with baseline at 2, 4, 8, and 12 weeks after EUS CPN (median follow-up 10 weeks). At these follow-up intervals, 82% to 91% of patients required the same or fewer pain medications and 79% to 88% of patients had persistent improvement in their pain scores. Patients with metastasis revealed higher initial pain scores and a greater decline in pain scores. Complications were minor and consisted of transient diarrhoea in four patients. They concluded EUS CPN to be a safe and effective means for improving pain control in patients with intra-abdominal malignancy.[33]

De Cicco et al. in 2001 evaluated the CT pattern of neurolytic (mixed with contrast) spread by an anterior approach in 177 cancer patients who underwent computed-tomography-guided single-needle neurolytic coeliac plexus block. A radiologist, blind to the aim of the study, retrospectively selected 105 patients with abnormal anatomy of the coeliac area as judged by CT images obtained before the block. The coeliac area was divided into four quadrants, upper right and left and lower right and left, as related to the coeliac artery. The results were expressed as the number of quadrants into which the contrast spread. The patterns of contrast spread according to number of quadrants with anatomical

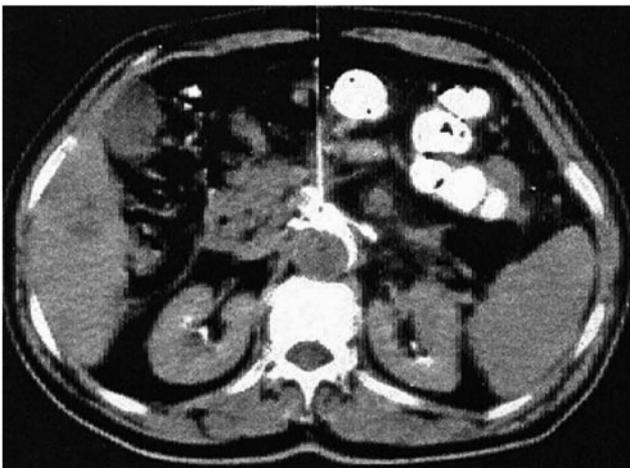**Figure 6:** CT scan showing the access to coeliac plexus block.

Figure 7: MRI image showing the anterior approach to coeliac plexus block.

distortion were analysed. Patient assessment by visual analogue scale was reviewed to evaluate the degree of pain relief. Pain relief 30 days after block was considered long lasting and it was found that 4, 3, 2 and 1 quadrants with contrast were observed in 9 (8%), 21 (20%), 49 (47%), and 26 (25%) patients respectively. An inverse correlation was observed between the number of quadrants with anatomical distortions and the number of quadrants with contrast ($p < 0.001$). Pain relief was noticed in 9 of 9 patients with contrast in 4 quadrants, and 10 of 21 patients with contrast in 3 quadrants ($p < 0.01$). None of 75 patients with contrast in 2 quadrants or 1 quadrant experienced good pain relief. They concluded that the neurolytic spread in the coeliac area is highly hampered by regional anatomic alterations. It also appears that only complete neurolytic spread in the coeliac area can guarantee complete analgesia.[45]

Gress et al. in 2001 performed a prospective study to evaluate the

efficacy of endoscopic ultrasound (EUS-) guided coeliac plexus block in 90 subjects (40 males, 50 females) with a mean age of 45 years (range 17–76 years) under the guidance of linear array endosonography using a 22 G fine needle inserted on each side of the coeliac area, followed by injection of 10 cc bupivacaine (0.25%) and 3 cc (40 mg) triamcinolone on each side of the coeliac plexus. A significant improvement in overall pain scores occurred in 55% (50/90) of patients. The mean pain score decreased from 8 to 2 post EUS coeliac plexus block at both 4 and 8 weeks' follow-up ($p < 0.05$). In 26% of patients there was persistent benefit beyond 12 weeks, and 10% still had persistent benefit at 24 weeks including 3 patients who were pain free between 35 and 48 weeks. One patient developed peripancreatic abscess five days after the block and responded to antibiotic therapy. Three patients experienced diarrhoea post EUS coeliac block, which resolved in 7–10 days. However, it was unclear whether this diarrhoea was due to the block or to refractory disease. A cost comparison between the EUS and CT techniques showed the EUS coeliac block to be less costly and more cost efficient in a subset of subjects. They concluded EUS guided coeliac plexus block to be safe, effective, and economical for controlling pain in few patients with chronic pancreatitis.[46] Younger patients (< 45 years of age) and those having had previous pancreatic surgery for chronic pancreatitis did not benefit from the EUS-guided coeliac block.

Gunaratnam et al. in 2001 prospectively studied 58 patients who underwent EUS CPN for pain secondary to inoperable pancreatic cancer. Neurolysis was performed by injecting 10 ml of 0.25% bupivacaine and 10 ml (98%) alcohol into both sides of the coeliac region. Pain scores were assessed using a standardised 11-point (0–10) visual analogue scale. Forty-five patients (78%) experienced a drop in pain scores two weeks after EUS CPN ($p = 0.0001$). However, only 31 (54%) experienced a decline of more than two points, a measure of improvement that some consider necessary to signify efficacy. This effect was sustained for 24 weeks when adjusted for morphine use and adjuvant therapy. Chemotherapy with or without radiation also decreased pain after EUS CPN ($p = 0.002$). Procedure-related transient abdominal pain was noted in five patients. There were no major complications. Minor complications were mild and transient and included hypotension (20%), diarrhoea (17%), and pain exacerbation (9%).[47]

Tran et al. in 2006 reported the use of endoscopic ultrasound (EUS) for CPN and simultaneously allowing a tissue diagnosis in a 42-year-old male patient with adenocarcinoma of the pancreas. A 22 G EUS needle was introduced transgastrically under ultrasound guidance. Once the needle was in the anterocephalad position to the coeliac artery take-off, 3 ml of normal saline was injected to flush the channel, followed by 20 ml of 0.25% bupivacaine. Lastly, 20 ml of dehydrated alcohol was injected at the site. An echogenic cloud seen at the target site after alcohol injection confirmed that the substance was injected in the region of coeliac artery take-off. The needle apparatus was withdrawn, and there was no evidence of immediate complications. Within 72 h of the procedure the patient reported significant relief of abdominal pain and graded his pain as 2 on the 10-point scale. After seven months, his abdominal pain returned, and he had a repeat CPN. The patient had adequate pain relief until he died two months later.[48]

A retrospective review of 10 procedures of EUS-guided CPN by the same authors performed between February 2003 and June 2005 in 8 subjects showed immediate pain relief in 7 patients, amongst whom 4 died within 7 months of diagnosis. Two proce-
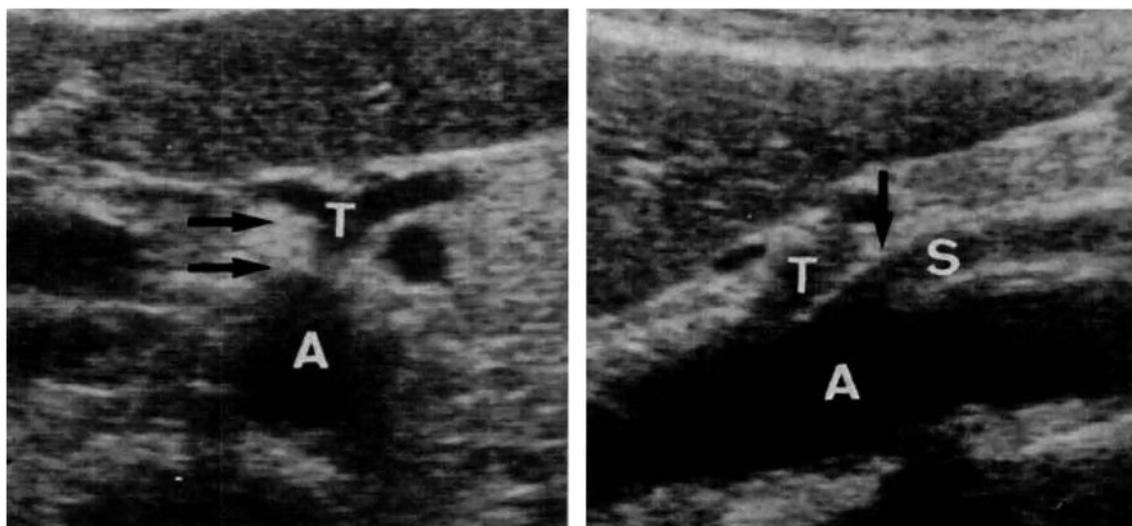
Figure 8: Transverse and longitudinal sonograms show anatomy of coeliac trunk (T) and abdominal aorta (A). For neurolysis of coeliac plexus (arrows), the needle is placed anterior to the aorta, between the coeliac axis and superior mesenteric artery (S).

dures did not result in alleviation of pain. One of these patients required multiple stents to alleviate symptoms of obstructive jaundice due to malignancy. She required increasing amounts of narcotics until her death three months after diagnosis. One patient was lost to follow-up, and no outcome of the procedure was obtained.[48]

Levy et al. in 2008 determined safety and initial efficacy at 2–4 weeks of coeliac ganglion injection with endoscopic ultrasound in patients with moderate to severe pain secondary to un-resectable pancreatic carcinoma or chronic pancreatitis. Thirty-three patients who underwent 36 direct coeliac ganglia injections for unresectable pancreatic cancer (coeliac ganglion neurolysis [CGN] n = 17, coeliac ganglion block [CGB] n = 1) or chronic pancreatitis (CGN n = 5, CGB n = 13) with bupivacaine (0.25%) and alcohol (99%) for CGN or Depo-Medrol™ (80 mg/2 ml) for CGB. Cancer patients reported pain relief in 16/17 cases (94%) when alcohol was injected and 0/1 (00%) when steroid was injected. For chronic pancreatitis patients 4/5 (80%) who received alcohol reported pain relief versus 5/13 (38%) receiving steroids. Thirteen (34%) patients experienced initial pain exacerbation, which correlated with improved therapeutic response (p < 0.05). Patients were contacted by phone 2–4 weeks following EUS, which was possible in 29 patients. Evaluation of the other 6 patients was based on later contact, at 5–10 weeks in 4 patients, or chart review alone in 2 patients. Transient hypotension and diarrh0ea developed in 12 and 6 patients respectively. They concluded that endoscopic-ultrasound-guided direct coeliac ganglion block or neurolysis was safe. Alcohol injection into ganglia appeared to be effective in both cancer and chronic pancreatitis.[49]

Garcia et al. in 2009 performed a percutaneous CPN in a 68-year-old male patient using the anterior transgastric route guided by colour Doppler ultrasonography (CDU). Magnetic resonant image (MRI) revealed a large solid mass in the head of the pancreas invading the coeliac trunk and superior mesenteric vessels with diffuse dilatation of the main pancreatic duct. The patient experienced worsening of his abdominal pain despite high doses of opioid analgesics since three months previously. A 22 G, 15 cm needle was passed through the stomach to reach the retroperitoneal space around the coeliac plexus under continuous flow apnoeic ventilation under general anaesthesia. Continuous flow of oxygen allowed adequate oxygenation and minimised carbon dioxide retention. Interruption of respiratory movements allowed excellent control of abdominal structures, rendering the procedure faster and more precise. Continuous injection of sterile saline was used to improve ultrasonographic visualisation of the fine needle. A dose of 30 ml of absolute alcohol was injected in the vicinity of the coeliac plexus in front of the aorta. The procedure took eight minutes. The patient reported marked pain relief immediately after the procedure and there were no major complications. Moderate postural hypotension due to the collateral effect of neurolysis for five weeks was observed, which disap-
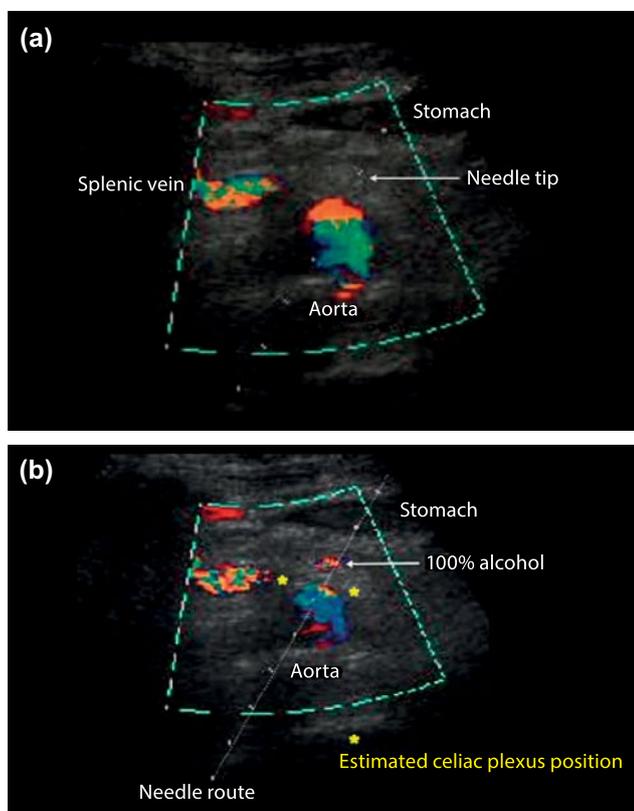
Note: (A) Abdominal puncture. The thin needle (22 G) is poorly visualised in front of the aorta. (B) The needle position is nicely depicted after continuous injection of saline.

Figure 9: US-guided transgastric CPN.

Table 1: Review of various studies

Author	Modality used	Diagnosis	Drug and volume	No. of pts	No. of procedures	Percentage pain relief			Follow-up period	Complications
						Good	Fair	Poor		
Matamala et al. (1989)	USG	Pancreatic carcinoma Chronic pancreatitis	Alcohol 50% 35 ml	72	9	7/9 (78%)		2/9 (22%)	6 months	Local pain, 5 pts Diarrhoea, 6 pts
Romanelli et al. (1992)	CT	Pancreatic carcinoma Other causes of chronic pain	Absolute alcohol 20 ml	143	17	8/14 (57%)	3/14 (21%)	3/14 (21%) 3/3 (100%)		Diarrhoea, 2 pts Diarrhoea with hypotension, 1 pt
Das and Chapman (1992)	USG	Hepatobiliary interventional procedures	Lidocaine 1% with ADR, 40 ml	9	9	8/9 (88%)	1/9 (12%)			Hypotension, 2 pts
Gimenez et al. (1993)	USG	Abdominal tumours Chronic pancreatitis	Alcohol 50%, 30–40 ml	344	38	23/38 (61%)	12/38 (31%)	3/38 (8%)	1 year	Diarrhoea, 5 pts Retroperitoneal pain, 1 pt
Wiersema et al. (1996)	EUS	Pancreatic carcinoma Intra-abdominal metastasis	Alcohol 98%	255	30	79–88%			12 weeks	Diarrhoea, 4 pts
Kristian et al. (2000)	MRI	Chronic abdominal pain		8	14	8/14 (57%)	5/14 (36%)	1/14 (7%)		
Di cicco et al. (2001)	CT	Upper abdominal pain of coeliac origin	Neurolytic solution mixed with contrast, 30 ml	177	105	19/105 (18%)	11/105 (10.5%)	75/105 (71.5%)	30 days	
Gress et al. (2001)	EUS	Chronic pancreatitis	Bupivacaine 0.25% 10 cc. Triamcinolone 40 mg(on each side of CP)	90	90	50/90 (55%)			52 weeks	Diarrhoea, 3 pts Peripancreatic abscess, 1 pt
Gunaratnam et al. (2001)	EUS	Pancreatic carcinoma	Bupivacaine 0.25%, 20 ml Alcohol 98%, 20 ml	58	58	31/58 (54%)	14/58 (24%)		24 weeks	Abdominal pain, 5 pts, hypotension, 20%, diarrhoea, 17%, pain exacerbation, 9%
Tran et al. (2003–05)	EUS	Pancreatic carcinoma		8	10	7/10 (70%)		2/10 (20%)	7 months	
Tran et al. (2006)	EUS	Pancreatic carcinoma	Bupivacaine 0.25%, 20 ml Dehydrated alcohol 20 ml	1	2	100%			7 months	None
Levy et al. (2008)	EUS	Pancreatic carcinoma Chronic pancreatitis	Bupivacaine 0.25% and alcohol 99%, 2–20 ml Depo-medrol 80 mg/2 ml	1818	36	16/17* (94%)4/5* (80%)	5/13# (38%)	0/1# (00%)	4 weeks	Transient hypotension, 12 pts, diarrhoea, 6 pts
Garcia et al. (2009)	USG	Pancreatic carcinoma	Absolute alcohol 30 ml	1	1	100%			5 months Lasted till death	Postural hypotension

*Alcohol cases.
#Steroid cases.

peared spontaneously.[50]

Complications

An anterior approach is associated with a lower rate of complications when performed under CT guidance. Since the needle is inserted through the anterior abdominal wall and into the retroperitoneal space, the needle has to traverse the stomach, liver and pancreas before reaching the coeliac plexus (see Table 2). It also minimises potential injury to the kidney. There is no retrocrural spread of drug to the somatic nerve roots, minimising the risk of neurological complications.[18,19] Serious complications are rare events. Theoretically a decreased incidence of neurologic complications is expected with the anterior techniques where injection is well away from somatic nerves.[51] Sonography allows blood vessels to be identified thereby minimising the risk of puncture of these vessels. Common adverse effects, including local pain reported in 8.5–55% of patients, diarrhoea in 3.3–67%, and hypotension in 6–33%, are transient. Pain may be a pressure or burning sensation in the epigastrium, chest or mid-back immediately after injection of neurolytic solution. This reaction lasts for up to 30 min and may be blunted by concomitant administration of local anaesthetic or intravenous narcotics. Transient postural hypotension by sympathetic block results from a regional vasodilatation and pooling of blood within the splanchnic vessels and a relative hypovolemic state. Elderly, arteriosclerotic, or hypovolemic patients are more prone to these haemodynamic effects. Adequate perioperative treatment using plasma expanders generally prevents important haemodynamic variations until compensatory reflexes appear. Compensation usually takes two days as permanent denervation of the coeliac plexus is unlikely to be attained.[52] Diarrhoea may occur as a result of unopposed parasympathetic activity. It is generally self-limited, lasting 1–2 days though is occasionally severe and persistent.[53]

Paraplegia following NCPB has not been reported in any of the studies using the anterior approach. It usually occurs due to spasm of the artery of Adamkiewicz caused by needle trauma by a posterior approach or neurolytic solution.

Inadvertent colonic puncture, pancreatic puncture and abscess formation are potential complications that were considered but

the colon usually lies caudal to the site of coeliac block and puncture of the colon by a fine needle is thought to be harmless. Complications from fine-needle pancreatic puncture are rare.[54] Abscess formation from contaminated local anaesthetic is another potential complication but can be avoided by providing antibiotic cover. Unintentional penetration into the aorta or inferior vena cava, as well as a perforation of the adjacent viscera, is not serious in the absence of severe coagulopathy. As the needle advances in an anterior approach, it frequently crosses structures such as the left hepatic lobe, the stomach, the pancreas, or intestinal loops. Possible complications associated with visceral puncture can be minimised by using a fine 22 G needle. None of the studies have mentioned this complication.

Conclusions

The patient's discomfort appears to be less when the anterior approach with the patient in the dorsal decubitus position is used than when the posterior approach with prone position is used. NCPB via an anterior approach using various imaging modalities does not completely abolish pain, rather it diminishes pain, helping to reduce opioid requirements and their related side effects and improving survival in patients with upper abdominal malignancy. It optimises palliative treatment for cancer of the upper abdominal viscera. It is capable of providing complete pain relief until death in a few cases and therefore should be considered as an adjuvant treatment in the analgesic strategy. Combination palliative therapy is necessary in most cases. Failure of the block may be attributed to tumour metastasising beyond the nerves that conduct pain via the coeliac plexus and the component nerves that form it. Concomitant pain of somatic origin, frequently observed in upper gastrointestinal cancer because of significant peritoneal involvement, requires other therapeutic measures.

Future directions

Faster image acquisition and higher resolution will continue to make CT guidance an attractive option for CPN. The pain specialist gains a better understanding of the functional anatomy by the three-dimensional image of a CT scan and allows a further refinement of these neurolysis techniques. As gastroenterologists are gaining more experience with GIT endoscopy, so EUS and even

Table 2: Complications[43,44]

Common
1. Hypotension (6–33%)
2. Pain (8–55%)
3. Transient diarrhoea (3.3–67%)

Rare
1. Haemorrhage
2. Fistula formation
3. Perforation of viscera
a. Colon
b. Pancreas
c. Stomach
d. Liver
4. Chemical peritonitis
5. Abscess formation

the use of ultrasound alone will play a great role in the evolution of the anterior approach.

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