Celiac Plexus Block and Neurolysis in the Management of Chronic Upper Abdominal Pain

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Abstract

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Chronic upper abdominal pain occurs as a complication of various malignant and benign diseases including pancreatic cancer and chronic pancreatitis, and when present may contribute to lower quality of life and higher mortality. Though various pain management strategies are available as part of a multimodal approach, they are often incompletely effective and accompanied by side effects. Pain originating in upper abdominal viscera is transmitted through the celiac plexus, which is an autonomic plexus located in the retroperitoneum at the root of the celiac trunk. Direct intervention at the level of the plexus, referred to as celiac plexus block or neurolysis depending on the injectate, is a minimally invasive therapeutic strategy which has been demonstrated to decrease pain, improve function, and reduce opiate dependence. Various percutaneous techniques have been reported, but, with appropriate preprocedural planning, use of image guidance (usually computed tomography), and postprocedural care, the frequency and severity of complications is low and the success rate high regardless of approach. The main benefit of the intervention may be in reduced opiate dependence and opiate-associated side effects, which in turn improves quality of life. Celiac plexus block and neurolysis are safe and effective treatments for chronic upper abdominal pain and should be considered early in patients experiencing such symptoms.

Objectives: Upon completion of this article, the reader will be able to describe the indications, techniques, complications, and efficacy of image-guided celiac plexus block and neurolysis.

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Chronic pain is experienced by half of all patients with cancer and 71% of those with advanced disease; the prevalence is even higher among those with pancreatic and gastric malignancies.^{1,2} A multimodal approach is usually employed for pain management, with opiates providing the

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cornerstone as the top rung of the WHO cancer pain ladder.³ However, chronic administration is often accompanied by adverse effects including nausea and vomiting, constipation, sedation, and pruritus, as well as the need for dose escalation as tolerance develops. Similarly, non-opiate treatments including chemotherapy, radiotherapy, surgery, and rehabilitation have their own specific limitations.^{4,5} As such, cancer pain remains undertreated in up to half of patients.⁶ Inadequate pain control is significant not just for its adverse effects on patient mood, function, and quality of life, but for its correlation with poor clinical outcomes, including higher overall mortality.^{2,7-10} In patients with abdominal malignancy, percutaneous image-guided celiac plexus block and neurolysis are minimally invasive therapeutic modalities which, when used as a part of a multimodal approach to pain management, can help decrease pain, improve function, and reduce opiate dependence.

Numerous classifications for cancer pain exist, but most emphasize the distinction between nociceptive and neuropathic pain. Nociceptive pain results from stimulation of pain receptors by injury or insult, and may be further subdivided into somatic and visceral.¹¹ Somatic pain is caused by direct injury to bone, muscle, or superficial soft tissue and is sharp and well localized, whereas visceral pain results from injury to thoracic or abdominal organs and is generally described as crampy and vague.¹¹ Neuropathic pain, in contrast, results from direct neural injury or irritation and is often associated with sensory deficits; it is described as burning, shooting, or numbness by those who experience it.^{11,12} The clinical relevance of this distinction manifests in the different treatments for each type of pain; nociceptive pain is generally responsive to nonsteroidal anti-inflammatory drugs and opiates, whereas neuropathic pain is more resistant.¹² Pancreatic cancer is neurotropic and has a uniquely high propensity for perineural invasion, which has been suggested to underlie the high prevalence of pain experienced by those with the disease.¹³⁻¹⁵ The resulting pain has both nociceptive and neuropathic components which complicates management, especially as most patients are not surgical candidates at presentation.¹⁶ Direct intervention at the level of the celiac plexus acts downstream of the pain generators to disrupt the transmission of the pain signal regardless of signal type, and is therefore effective in simultaneously treating both types of pain.

In general, celiac plexus block refers to temporary interruption of pain transmission via injection of corticosteroids or long-acting anesthetics, whereas neurolysis describes permanent destruction of the plexus by injection of a neurolytic substance, usually ethanol or phenol.¹⁷ Image-guided percutaneous approaches have been described using fluoroscopy, ultrasound, and computed tomography (CT), but the third one has emerged as the preferred modality given its cross-sectional nature which allows good tissue distinction, preprocedural planning, intraprocedural needle tip localization, and direct visualization of injectate diffusion.^{17,18} Preliminary results suggest magnetic resonance guidance is also feasible and effective, though likely at the expense of increased cost and decreased accessibility.^{19,20} Endoscopic ultrasound (EUS) is a more recently-developed but well-established technique

typically performed by gastroenterologists, and may have unique benefits compared with percutaneous approaches.

Anatomy and Physiology

The celiac plexus is the largest autonomic plexus, located in the retroperitoneum at the roots of the celiac trunk and superior mesenteric artery (SMA).^{17,18,21} It is composed of the paired celiac ganglia as well as the superior mesenteric and aorticorenal ganglia, which derive their fibers from presynaptic sympathetic nerves carried by the greater (T5-T9), lesser (T10-T11), and least (T12) splanchnic nerves.^{17,21,22} The plexus also contains parasympathetic fibers derived from the posterior branch of the vagus nerve, and traversing visceral sensory afferent fibers.^{17,18,22,23} It supplies all three fiber types to the pancreas, liver, spleen, biliary tract, gallbladder, adrenals, kidneys, mesentery, stomach, and bowel to the level of the proximal transverse colon, as well as the blood vessels of the abdomen.^{17,22-24}

The celiac ganglia are variable in number, size, and location. There may be anywhere from one to five ganglia present, each measuring between 0.5 and 4.5 cm in diameter with an average size of around 2.7 cm.^{18,21,25} The ganglia are located in the retroperitoneal fat anterolateral to the aorta and posterior to the stomach and pancreas.^{17,18,23,25} They lie in the antecrural space anterior to the diaphragmatic crura, which separate them from the retrocrural splanchnic nerves and the vertebral bodies.¹⁷ The craniocaudal relationship is most reliable with respect to the celiac artery which can be used as a landmark; the left ganglion lies 0.9 cm caudal to the celiac artery and slightly below the right ganglion, which itself lies 0.6 cm below the artery.^{17,21} The relationship to bony landmarks is somewhat more variable, though in most cases the ganglia will be at the level of T12 or L1.²⁵

In a study by Wang et al investigating the appearance of the celiac ganglia on contrast-enhanced CT, the left ganglion was visualized more frequently than the right (89 vs. 67% of scans).²⁶ The shape was described as multilobulated in two-thirds of cases and discoid in one third; attenuation was identical to the adjacent adrenal glands on nonenhanced and portal venous phase CT, but was higher on delayed scans in the majority of cases.²⁶

Patient Selection

Although celiac plexus neurolysis is most often employed in the management of pain resulting from pancreatic cancer (► **Fig. 1**), it should in theory be effective for managing any chronic pain resulting from stimulation of nerve fibers that traverse the celiac plexus.¹⁸ Thus, patients with pain from other upper abdominal malignancies, such as esophageal cancer, gastric cancer, metastatic hepatic cancer, biliary cancer, and any malignancy causing retroperitoneal nodal metastases, should be considered for intervention. Patients with nonmalignant etiologies of pain, particularly chronic pancreatitis, may also be considered, although the response rate may be somewhat lower in those with chronic pancreatitis compared with those with pancreatic cancer (► **Fig. 2**).²⁷⁻³⁰

Fig. 1 Bilateral posterior antecrural approach celiac plexus neurolysis performed in a 33-year-old man with metastatic pancreatic adenocarcinoma and intractable abdominal pain resulting in prolonged hospital admission. (a) Needle tips (arrows) were positioned immediately anterolateral to the aorta in the region of celiac trunk. (b) A small amount of dilute contrast (arrows) was injected through each needle to confirm position. (c) 30 mL of 100% ethanol (arrows) was then injected through each needle. The patient's pain subsequently improved and he was discharged home. He subsequently developed recurrent pain attributable to disease progression and returned for repeat neurolysis 6 months later (not shown).

Fig. 2 Bilateral posterior antecrural approach celiac plexus neurolysis performed in a 19-year-old female patient with median arcuate ligament syndrome (MALS) who had undergone surgical release 1 year prior to presentation and continued to experience intractable pain. She first underwent diagnostic celiac plexus block to confirm pain transmission through the plexus, and subsequently underwent neurolysis. (a) Needle tips (arrows) were positioned immediately anterolateral to the aorta at the level of the celiac trunk (dashed arrow). Dilute contrast was then injected to confirm position (not shown). (b) 5 mL of mepivacaine and 25 mL of 100% ethanol (arrows) were then injected into each needle. The patient's pain subsequently improved and she was discharged without complication.

Importantly, celiac plexus neurolysis is effective only in managing pain which is transmitting through the plexus itself. Thus, pain arising in the upper abdominal viscera is likely to be successfully treated, whereas somatic pain originating in the abdominal wall or pain centered in the pelvis is not. In many cases, pain may be multifactorial and the response incomplete. Despite this, a benefit may still be achieved in the form of improved function or reduction in narcotic dosage and side effects, even if additional pain management modalities remain necessary. Although few reports have evaluated optimal timing for neurolysis with respect to disease course, for those with malignant disease, neurolysis may be more effective when performed early before development of a substantial somatic component, leading some authors to advocate for its use as a first-line treatment modality.^{31–33} As such, once unresectability has been determined, patients should promptly be referred for evaluation. Of note, reports of combined celiac, inferior mesenteric, and superior hypogastric plexus blocks for the management of pain resulting from advanced cancer have been published, but the results are preliminary and beyond the scope of this review.³⁴

There are few contraindications to celiac plexus neurolysis. As with most percutaneous procedures, uncorrectable coagulopathy and thrombocytopenia increase the risk of hemorrhage. In those with abdominal aortic aneurysms or extensive atherosclerotic calcification of the abdominal aorta, a transaortic approach should be avoided.^{17,18} Local or intra-abdominal infection is an absolute contraindication to all approaches.³⁵ Because celiac plexus neurolysis results in unopposed parasympathetic activity and thus increased bowel peristalsis, it should not be performed in patients with bowel obstruction.³⁵ Though not an absolute contraindication, the inability to distinguish anatomic structures for any reason increases the risk of complications and reduces the likelihood of success.

Neurolytic and Blocking Agents

Celiac plexus neurolysis is most commonly performed by injection of 50 to 100% ethanol or less likely 3 to 20% phenol. Ethanol causes irreversible neural damage by extracting cholesterol, phospholipids, and cerebroside from the neurolemma and inducing precipitation of lipoproteins and mucoproteins.^{17,18,22,23} Irreversible damage is achieved at concentrations over 50%; above this, neurolysis is more dependent on distribution than on concentration.^{17,18} Because injection of ethanol may cause temporary severe pain, addition of a long-acting anesthetic, such as bupivacaine, is recommended.^{17,18,24} Furthermore, to aid in visualization of distribution some authors advocate the addition of iodinated contrast, while others report satisfactory assessment in its absence.^{17,18} The most commonly utilized mixture consists of 95 to 100% ethanol, bupivacaine, and iodinated contrast in a 6:3:1 ratio.^{17,18,36}

Phenol has a similar mechanism of action to ethanol but causes an immediate anesthetic effect and is thereby painless when injected.^{17,24} However, phenol is viscous and thus harder to mix with contrast or inject.^{17,18,22,23} It is also believed to have a slower duration of onset, cause less neural

destruction, and produce a shorter duration of anesthesia.^{17,22–24} As such, ethanol is generally preferred as the first-line agent. However, a recent study comparing ethanol and phenol in splanchnic nerve neurolysis found no significant difference in pain reduction between the two neurolytics.³⁷

The recommended volume of injectate varies with technique (single or double needle) and tip position (retrocrucl or antecrucl). Injection of the antecrucl space using either a posterior or anterior approach is usually performed using volumes of 30 to 50 mL of absolute ethanol, either injected through one needle or split between two.^{17,22,23} Because the retrocrucl space is smaller than the antecrucl, the bilateral posterior retrocrucl technique is performed with a lower dose of neurolytic, on the order of 15 to 30 mL split bilaterally.^{18,23,35} Similarly, the single needle transaortic approach introduces the needle tip into close proximity to the plexus and thus requires only a small volume of 15 to 30 mL.^{17,22,23} A total of 25 to 30 mL is often recommended for a unilateral or bilateral transintervertebral disc approach; however, a recent direct comparison of injectate volume using a bilateral technique found 40 mL of 70% ethanol to be more effective in producing lasting anesthesia than either 20 or 30 mL.^{17,36}

At our institution, when performing celiac plexus neurolysis using a bilateral posterior antecrucl approach, we typically utilize a total of 40 mL of absolute ethanol (►Fig. 3). We stage the instillation of iodinated contrast, anesthetic, and ethanol, first confirming location with dilute iodinated contrast, then injecting a long-acting anesthetic, and finally performing the neurolysis with ethanol.

For patients with benign disease undergoing temporary celiac plexus block, a mixture of local anesthetic and corticosteroid may be administered.³⁸ One common mixture consists of 20 mL of bupivacaine 0.025% and 6 mL of triamcinolone 80 mg.³⁸

Patient Preparation

As part of a standard preprocedural evaluation and workup, all available imaging studies should be reviewed to determine optimal patient position, needle approach, and injection site.¹⁷ Bleeding time, clotting time, prothrombin time, and platelet count should be evaluated and optimized, and anticoagulants should be discontinued prior to the procedure in accordance with standard recommendations to reduce the risk of hemorrhage.^{17,18,23,35} Consent should include an explanation of the risks, benefits, and alternatives to the procedure, and patient's expectations regarding the outcome should be addressed. Patients undergoing neurolysis should be nil per os for 6 to 8 hours before the procedure to reduce the risk of aspiration during conscious sedation.^{17,24} By contrast, those undergoing celiac plexus block are not required to fast as sedation is minimized to better assess pain relief.

Loss of sympathetic tone to the vessels innervated by the celiac plexus may result in postprocedural hypotension. As such, outpatients should be admitted overnight and intravenous fluids administered as needed while vitals are closely monitored; some authors additionally recommend a preprocedural²² fluid bolus in those deemed to be at elevated risk of hypotension,

Fig. 3 Bilateral posterior antecrural approach celiac plexus neurolysis performed in a 66-year-old female patient with locally advanced pancreatic adenocarcinoma and intractable abdominal pain. (a) Needle tips (arrows) were positioned immediately anterolateral to the aorta in the region of celiac trunk. (b) A small amount of dilute contrast (arrows) was injected through each needle to confirm position. (c) 5 mL of mepivacaine was injected into each needle followed by 100% ethanol, 35 mL on the right and 25 mL on the left. The needles were then flushed with 5 mL mepivacaine before removal.

as well as 12 hours of bedrest following the procedure.^{17,18,22,23} Despite this risk, antihypertensives should be continued to prevent rebound hypertension or myocardial ischemia.²³

Technique

Celiac plexus block/neurolysis may be performed from either a posterior or anterior approach based on patient's position and site of needle introduction. Posterior approaches are more commonly performed and multiple variants have been reported; the techniques discussed here include antecrural, retrocrural, transintervertebral disc, and transaortic.^{17,18,22–24,35} Direct tumor infiltration has also been described but will not be discussed in depth in this review.^{17,18} Because results have not been proven to differ between the various techniques, selection should be individualized based on operator's preference, patient's anatomy and comorbidities, and extent of disease (–Fig. 4).^{22–24,31} Specific considerations include a lower risk of damage to visceral organs with the posterior approach, and a decreased incidence of neurologic complications resulting from either needle passage or inadvertent retrocrural spread of neurolytic with the anterior approach.^{17,22,35,39}

Of note, in patients undergoing celiac plexus neurolysis, some authors recommend injecting a test dose of local

anesthetic such as 2% lidocaine or 0.25% bupivacaine immediately before neurolytic injection as a way of predicting efficacy and anticipating and correcting technical problems that could occur.^{22,40} However, this diagnostic block may be misleading, as in up to 28% of cases a successful diagnostic block does not predict the outcome of neurolysis.⁴⁰ As such, it is not often performed.

Posterior Approaches

Retrocrural

The posterior retrocrural approach is the traditional technique for performing celiac plexus neurolysis.^{22,24} Despite this, the actual target for neurolysis is not the celiac plexus itself but rather the splanchnic nerves which supply it.^{22,23} As such, it is commonly performed concurrently with an anterior approach which directly treats the plexus, thereby producing multicentric denervation and enhancing the analgesic effect.^{17,18}

To perform this technique, the patient is positioned either prone with a pillow under the abdomen or alternatively lateral decubitus depending on tolerance, and a preliminary non-enhanced CT scan is obtained to confirm anatomy, localize the plexus, and plan the approach.^{17,18} After widely prepping the skin and anesthetizing the soft tissue subjacent the

Fig. 4 Unilateral posterior antecrural approach celiac plexus neurolysis performed in an 83-year-old female patient with chronic abdominal pain secondary to pancreatic adenocarcinoma. Severe scoliosis and kyphosis precluded a bilateral posterior approach, so unilateral neurolysis using a left posterior paravertebral route was performed. (a) Left-sided needle tip (arrow) was positioned anterolateral to the aorta in the region of celiac trunk. (b) A small amount of dilute contrast (arrow) was injected to confirm position. (c) The following medications were then injected in order: 10 mL of mepivacaine, 40 mL 100% ethanol, and an additional 10 mL of mepivacaine.

puncture site, 20 to 24 gauge bevel-tipped needles are introduced bilaterally at the lower borders of the 12th ribs angled approximately 45 degrees medially and 15 degrees cephalad.^{17,23,24,35} The classic needle entry site is 5 to 7 cm from the midline at the level of the L1 vertebral body, with the right-sided entry point often slightly more lateral than the left.^{23,24} As the needle is advanced, care is taken to avoid the transverse processes, kidneys, and vascular structures.⁴¹ The needles may contact the lateral aspect of L1 vertebral body, in which case they may be slightly withdrawn and laterally redirected to “walk” along the bone.^{23,35} In general, the right-sided needle will require advancement 2 cm further than the left.²³ The tips should ultimately be positioned lateral to the L1 vertebral body immediately posterior to the diaphragmatic crura.²²

After radiologic confirmation of tip position, the needle should be aspirated to ensure no blood is present; if it is, an intravascular location is assumed and the needle repositioned.^{17,23} Once aspiration yields no blood, tip position is further verified via injection of a small volume of contrast material.^{17,23} For this purpose, most authors advocate 3 to 5 mL of dilute iodinated contrast on each side (potentially with added local anesthetic), while others report adequate visualization with injection of air alone.^{17,18,23,35,41} The contrast should be seen spreading along the anterolateral aspects of the lower thoracic and upper lumbar vertebral bodies into the retrocrural and retroaortic spaces.^{23,24}

Once free diffusion is confirmed, 7.5 to 15 mL of neurolytic is injected on each side. There should be no resistance to flow, and contrast should be observed spreading freely in the retroperitoneal space.^{17,18,22} Confirmation of spread is the key determining factor that adequate destruction has occurred.^{17,42,43} Once the procedure has been completed on one side, it is performed on the other. As the final step before needle withdrawal, the needle should be flushed with approximately 2 to 5 mL of normal saline to prevent inadvertent retrograde tracking of neurolytic along the needle path, which may be painful.^{17,18,23,35} Of note, though this technique is generally performed with a bilateral approach given the anatomic separation of the splanchnic nerves, a single needle retroaortic approach has recently been reported; further investigation will be needed to determine its safety and efficacy.⁴⁴

Antecrural

The posterior antecrural approach is purported to be the most commonly utilized of the various techniques.^{17,18,22} The goal is direct ablation of the celiac plexus via injection of neurolytic into the antecrural space using a posterior transcral paravertebral route.²² The positioning and initial steps are identical to that for the posterior retrocrural technique, except the needles are advanced an additional 1 to 2 cm on each side.^{23,35} A loss of resistance is felt upon piercing the crus of the diaphragm, but no resistance to flow should be present

with injection.²³ The ideal tip position is immediately anterolateral to the aorta at the level of the space between the celiac trunk and SMA, anterior to the diaphragmatic crus and posterior to the pancreas.^{17,18,23,41} As before, correct position is confirmed by visualization of free contrast diffusion, this time in the antecrural space along the anterolateral wall of the aorta; in comparison with retrocrural injection, a greater volume of neurolytic (30–50 mL) should be used given the larger size of the space.^{17,23}

Unlike the retrocrural approach which mandates bilateral injections due to the anatomic separation of the splanchnic nerves, this technique can initially be attempted with a single needle, usually introduced on the left, with addition of a second needle if bilateral contrast spread is not initially visualized.²⁴

Transintervertebral Disc

The transintervertebral disc approach is an alternative technique which can be used when the paravertebral route is obstructed, usually by the transverse processes, ribs, or abnormal retroperitoneal anatomy.^{17,18} It provides increased access to the anterolateral wall of the aorta while avoiding the risks of visceral injury that accompany an anterior approach.^{17,22,45} The technique may be performed with unilateral or bilateral needle placement.¹⁷ As before, patients are positioned prone or lateral decubitus and the level of the T12–L1 or L1–L2 disc space determined with imaging.^{22,35,45} A puncture site is then selected, and the needle advanced through the disc until the tip is anterior to the aorta at the level of the celiac axis; a midline position is sufficient for a single needle approach, whereas an anterolateral position is preferred with use of bilateral needles.^{17,22,24,45} As the tip traverses the anterior longitudinal ligament, a sense of breakthrough can often be felt.^{17,18,22,45} Given the proximity of the needle tip to the celiac plexus, a relatively small volume of neurolytic (25–30 mL) is usually adequate for induction of anesthesia.^{17,45}

This technique is precluded in patients with extensive degenerative disease of the thoracolumbar spine, and is not considered first line given its associated risks, including disc trauma (i.e., discitis or herniation), spinal cord injury, and aortic puncture with resulting retroperitoneal hematoma.^{17,18,22,45}

Transaortic

Despite traversing two walls of the abdominal aorta, the transaortic approach has a low complication rate and is capable of producing bilateral celiac plexus blocks with a single puncture.^{18,46,47} With the patient prone, a preliminary scan is obtained and scrutinized for the presence of an aortic aneurysm, extensive mural calcification, or mural thrombus, the presence of any one of which would preclude use of this approach.^{23,47} A puncture site is then selected 7 cm left of the midline inferior to the 12th rib at approximately the level of the celiac axis; the craniocaudal level need not be exact because the injectate will diffuse widely in the preaortic space.^{23,46,47} The needle is advanced toward the aorta using a left posterior paravertebral approach. Proximity to the aorta will result in a characteristic pulsation in the needle, and a pop will be felt as

the posterior aortic wall is punctured; a second breakthrough with subsequent loss of resistance indicates traversal of the anterior wall.^{18,23,47} Once the tip is thought to have entered the preaortic space, aspiration must be performed to ensure an extravascular position and prevent systemic administration of neurolytic.^{17,23,47} Further confirmation of tip position is then obtained by injecting 3 to 4 mL of iodinated contrast, which should diffuse through the preaortic space.^{17,18,23,46,47} Once diffusion is confirmed, the neurolytic may be administered; because of the proximity of the needle tip to the plexus, a comparatively low volume (15–30 mL) is required.^{17,22,23}

A theoretical advantage of the transaortic approach is minimization of the risk of neurologic complications resulting from spread of the neurolytic to the lumbar plexus or spinal cord.^{17,18} The primary disadvantage is the increased risk of retroperitoneal hemorrhage accompanying iatrogenic aortic puncture, which may occur in up to 0.5% of patients, particularly those with hypertension or coagulopathy.^{17,22}

Anterior Approach

Though initially reported as early as 1918, the anterior approach to celiac plexus block/neurolysis has gained acceptance only in recent years, as concerns about its safety have been assuaged.^{17,23,35,39,48} Despite this, it generally remains second line given the higher risk of visceral organ injury compared with the posterior approach.^{17,18} The procedure is comparatively technically simple to perform and, as with the posterior antecrural approach, one or two needles may be used.^{17,22,39} Patients are positioned supine and a scan obtained to determine the entry site.^{18,39,48} It should be selected such that the needle can be introduced nearly vertically with the tip ultimately positioned at the level of the space between the celiac artery and SMA, either in the midline with a single needle approach or anterior to the diaphragmatic crura with bilateral needles.^{17,18,23,48} As before, tip position is confirmed via injection of a contrast agent which should be seen tracking around the aorta and anterior to the diaphragmatic crura.³⁹ Once tip position is assured, 30 to 50 mL of neurolytic is injected.^{17,18,35,48} Of note, the anterior approach may also be performed under ultrasound guidance.³⁵

This approach almost invariably involves traversal of visceral organs, most commonly the liver and stomach.^{17,22,35} Care should be taken to minimize damage to these structures by selecting the shortest overall route through them, avoiding major vessels and dilated biliary ducts, and minimizing needle repositioning; the pancreas should be avoided if possible given the risk of inducing pancreatitis, and while the stomach and small bowel may be safely traversed, stool-filled colon loops should not be punctured.^{17,49,50} Advantages to the anterior approach include overall ease and speed, improved patient comfort particularly in those with abdominal pain or ostomy, and a lower probability of neurologic injury.^{17,18,22,23,35} Risks are largely secondary to visceral organ damage and include infection, hemorrhage, fistula formation, liver hematoma, and gastric perforation.^{17,18,23,35}

Endoscopic Ultrasound-Guided Celiac Plexus Block and Neurolysis

EUS-guided celiac plexus block/neurolysis is an alternative approach to accessing the plexus that is usually employed by gastroenterologists. It was made possible by the advent of the linear array ultrasound which allows real-time tracking of a needle into a target, and was first described in 1996.^{51,52} The technique is performed under conscious sedation or general anesthesia with the patient in the left lateral decubitus position; because the procedure is not sterile, antibiotics are generally indicated at the outset.^{53–55} A therapeutic linear-array echo-endoscope is advanced down the esophagus and into the stomach, tracing the aorta until the celiac artery is visualized.^{51,53–55} Previously, the artery was used as a marker for injection as the plexus itself was not visible on EUS; however, it has recently been demonstrated that the celiac ganglia are in fact discernable in approximately 81% of patients as discrete oblong or lobulated hypoechoic structures with irregular edges and internal hyperechoic foci.^{51,53–57} Once the celiac artery or plexus has been identified, a needle is advanced through the gastric wall and the neurolytic injected.^{51,53,54} It is essential to confirm tip position prior to injection as neurolytic administration will immediately obscure the needle with a “white-out” or “snowstorm” effect.^{53,54} The procedure is reported to take 15 to 20 minutes to perform.⁵¹

EUS-guided celiac plexus block is generally believed to have a lower complication rate than percutaneous approaches, likely due both to the use of an anterior approach which avoids the neural structures of the back, and to the short distance between the puncture site and plexus.^{51,53,55,58} Of note, a single study directly comparing CT-guided and EUS-guided celiac plexus blocks found EUS-guided blocks to be more effective, preferable to patients, and less costly compared with blocks performed under CT guidance; further studies are needed to confirm this finding.²⁸

Complications

Celiac plexus neurolysis is generally considered to be a low-risk procedure; most adverse effects are transient and serious complications occur in less than 2% of cases.^{17,23,59} The most common adverse effect is local back pain, which is experienced by up to 96% of patients, although more recent reports suggest a lower incidence.^{59,60} The pain routinely lasts less than 72 hours, and may radiate to the shoulder when it results from diaphragmatic irritation.^{17,23} Pain also accompanies ethanol injection at the time of neurolysis, and may be reduced both by addition of a long-acting anesthetic and by flushing the injection needle before removal to prevent tracking of neurolytic into the soft tissues of the back. Most postprocedure pain will be modest and adequately managed with oral analgesics.¹⁸

Postprocedural diarrhea and transient hypotension are the next most common complications, occurring in 44 to 60% and 10 to 52% of patients, respectively.^{17,23,24,59,60} Unopposed parasympathetic activity results in bowel hypermobility, hypersecretion, and diarrhea, and underscores why existing bowel obstruction is a contraindication to neurolysis. Though

generally lasting no more than 48 hours, in rare cases diarrhea can be severe and persistent.^{17,22–24,59} This is thought to be secondary to continuous nerve injury from the neurolytic, and may relate to the volume of agent injected.^{17,18,61,62} Though difficult to manage, a few cases have reported benefit from administration of octreotide and atropine.^{17,18,63,64} Transient hypotension results from loss of sympathetic tone to the splanchnic vasculature with resulting vasodilation.^{17,18,22,59} Compensatory reflexes usually manifest within 48 hours, but in the immediate postprocedure period precautionary measures should be taken, including overnight admission of outpatients, close monitoring of vitals, 12 hours of recumbence, and fluid administration as needed to maintain adequate cardiac output.^{17,22–24}

Neurologic complications including paraplegia, lower extremity weakness, sensory deficits, and paresthesias are the most severe but occur in only 1% of cases.²² Paralysis, the most dreaded complication, has been reported in only 0.15% of cases.⁶⁵ Paraplegia may result from injury to the spinal cord due to direct needle puncture or misadministration of neurolytic, or may alternatively be caused by injection into or damage to the anterior spinal artery.^{18,22,23} Less severe complications include numbness and dysesthesia in the groin resulting from spread of neurolytic to the lumbar roots, as well as unilateral lower extremity paresis from injection of the psoas muscle or lysis of lumbar somatic nerves.²³

Numerous additional, though infrequent, complications have also been reported. Arterial injury may occur as a result of migration of the needle tip with resulting dissection or retroperitoneal hematoma.¹⁸ Chemical peritonitis can occur from neurolytic leakage as a result of improper needle tip location; if the patient experiences sudden severe pain during neurolytic instillation, the injection should be stopped and needle position confirmed before continuing.¹⁸ Other complications include local hematoma, pneumothorax, chylothorax, chemical pericarditis, gastroparesis, superior mesenteric vein thrombosis, hematuria, impotence, aortic pseudoaneurysm, aortic dissection, and retroperitoneal fibrosis.^{17,18,22–24}

Efficacy

Celiac plexus neurolysis has repeatedly been demonstrated to reliably produce effective long-term reduction in chronic pain, narcotic administration, and frequency of opioid-related side effects in patients with malignant disease regardless of technique.^{31,63,66–71} A meta-analysis of 24 articles concluded that in patients with upper abdominal malignancy, good to excellent pain relief was achieved in 89% of patients at 2 weeks, and partial to complete relief was maintained in 90% of patients at 3 months and 70 to 90% at death.⁵⁹ Similarly, a Cochrane review including six studies concluded that, although the statistical evidence is minimal for the superiority of neurolysis versus standard analgesic administration for pain relief, patients undergoing neurolysis had significantly lower opioid consumption and rates of opioid-related side effects.⁷² Thus, it is the reduction in opioid dosing and side effects that produces the major benefit to most patients.^{17,69,72} Neurolysis has also been suggested to improve both longevity and quality of life,

probably as a result of decreased opiate-related side effects and increased functionality, though this remains unproven.^{17,70,73}

In general, the probability of remaining pain free after neurolysis decreases with survival time, usually as a consequence of disease progression and development of somatic pain which is not transmitted through the celiac plexus.³¹ In patients who initially achieve a good response but subsequently develop recurrent pain, repeat neurolysis may be performed, though with a lower likelihood of success.⁷⁴

Numerous specific contributors to the rate of neurolytic success have been identified. In patients with pancreatic cancer, neurolysis may be more effective in cases of pancreatic head tumors compared with those centered in the body and tail.⁷⁵ In patients with upper abdominal malignancy, the likelihood of success is correlated both with lower preprocedural opioid dose and performance of neurolysis without procedural sedation, and has also been suggested to increase with the use of CT guidance (as compared with fluoroscopy) and injection of <20 mL of local anesthetic at the time of diagnostic block.⁷⁶

Celiac plexus block has also been reported to be of benefit in managing pain resulting from chronic pancreatitis.^{28,77,78} While neurolysis using ethanol is generally performed for pain with a malignant etiology, a shorter-acting block using bupivacaine and triamcinolone is usually performed for pain resulting from chronic pancreatitis. There are limited data on the efficacy of percutaneous approaches; however, the available literature suggests a lower response rate compared with that traditionally observed in pancreatic cancer, a similar finding has also been reported with the use of EUS guidance.^{27,28,30}

Conclusion

Celiac plexus block and neurolysis are safe and effective procedures for managing chronic upper abdominal pain resulting from both malignant and benign disease, and should be offered early in the disease course to patients as part of a multidisciplinary approach to pain management. Familiarity with the various approaches and techniques allows the interventional radiologist to optimize the approach for each patient and thereby maximize the chance of success while minimizing complications.

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