Diagnostic celiac plexus block and outcome with neurolysis

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Pain is one of the most troubling symptoms for many of the over 10 million cancer patients in America. For many patients, traditional medications and treatments are not effective and they are severely debilitated by their pain, causing needless suffering at the end of life. Pancreatic cancer in particular is associated with severe, unrelenting pain that may not be responsive to opioids and other medication therapies. Celiac plexus neurolysis is a procedure with demonstrated efficacy for patients with visceral pain arising from an upper abdominal malignancy. Although a variety of techniques exist, efficacy is generally achieved in 70-90% of patients regardless of technique. Most providers will perform a diagnostic block of the celiac plexus to ensure benefit before proceeding to the neurolytic block; however, others advocate proceeding directly to the neurolytic block. In this article, we review the techniques for chemical neurolysis of the celiac plexus, discuss the literature supporting the different approaches, and discuss factors that may influence the decision to proceed with diagnostic block prior to the neurolytic procedure.
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The celiac plexus block is a technique described initially by Kappis[1] almost 100 years ago. It consists of blocking the sympathetic nerve fibers that pass through the celiac plexus and innervate the abdominal viscera. Now widely used to treat visceral pain in patients with intra-abdominal malignancies, it is most effective when used to treat pain that arises from abdominal organs that include the pancreas, liver, gallbladder, and digestive tract. Much less frequently it is used to treat chronic nonmalignant pain such as pancreatitis. Numerous techniques and radiologic modalities are now used to access the celiac plexus and perform the block. While celiac plexus nerve block typically consists of a diagnostic block with local anesthetic prior to neurolysis, some advocate directly proceeding to neurolytic celiac plexus block (NCPB).

Indications/patient selection

The primary indication for blocking the celiac plexus, or the nerves supplying the celiac plexus (splanchnic nerves), is to alleviate pain from the abdomen. Neurolysis is typically reserved for malignancies of the upper abdominal viscera (primarily pancreatic cancer), often for patients whose pain that is poorly controlled by opioid analgesics. Some advocate early intervention for those with aggressive disease before their pain becomes uncontrolled. Celiac plexus neurolysis can provide excellent pain relief and reduce the need for additional analgesics. Meta-analysis in 1995 by Eisenberg et al[2] showed long-lasting benefit for 70-90% of patients with intra-abdominal malignancy. Subsequent studies show similar benefit.[3-7]

Anatomy

There are 3 great plexuses of the chest and abdomen. These contain visceral afferent and efferent fibers as well as some parasympathetic fibers. The cardiac plexus innervates the

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thoracic structures. The celiac plexus provides innervation to most of the gut and is the largest of the 3 great plexuses. The hypogastric plexus supplies the pelvic organs.

The celiac plexus is located in the retroperitoneal space at the level of the T12 and L1 vertebrae. It lies in close proximity to numerous vascular structures including the celiac artery (plexus is anterolateral), the inferior vena cava (plexus is anterolateral on the right), and the aorta (plexus is anterior and midline).

The celiac plexus receives its primary innervation from the greater (T5-T9), lesser (T10-T11), and least splanchnic nerves (T12). These nerves, preganglionic in nature, traverse the posterior mediastinum and enter the abdomen through the crura of the diaphragm above L1. The plexus innervates most of the abdominal viscera, including the stomach, liver, biliary tract, pancreas, spleen, kidneys, adrenals, omentum, small bowel, and large bowel, to the level of the splenic flexure.

Approach

Although some may advocate 1 approach (transcrural vs retrocrural celiac plexus blockade) over the other, there is no evidence that either results in superior clinical outcomes. Decisions on which approach to take should be based on the patient's anatomical variations based on tumor burden and cancer treatments or surgeries and also the experience of the physician performing the procedure.

There are at least 2 different areas to target for the block. The first involves targeting the deep splanchnic nerves via a retrocrural approach (Fig 1). Traditionally, this involves a bilateral posterior approach, although a single-needle transdiscal approach has also been described.[5] The second involves placing the needle anterior to the aorta in the vicinity of the celiac plexus itself. This has typically involved a posterior approach, Placing the needle through 1 crus of the diaphragm, but the plexus can also be approached anteriorly under computed tomography (CT) or ultrasound guidance and may be targeted via an endoscopic, transgastric approach as well. Although landmark-based techniques have been described and operated with good success rates, most of these blocks are now performed under imaging guidance (fluoroscopy, CT, or ultrasound) as described below.[8-10]

For the posterior approaches described below (retrocrural or transcrural), the patient is placed prone with head turned to 1 side and pillows placed under the abdomen to reduce the lumbar lordosis. For both approaches, the fluoroscopic beam is rotated 20-30 degrees ipsilateral oblique, until the tip of the transverse process overlies the anterolateral margin of the vertebral body.

Celiac plexus block: transcrural (anterocrural) technique

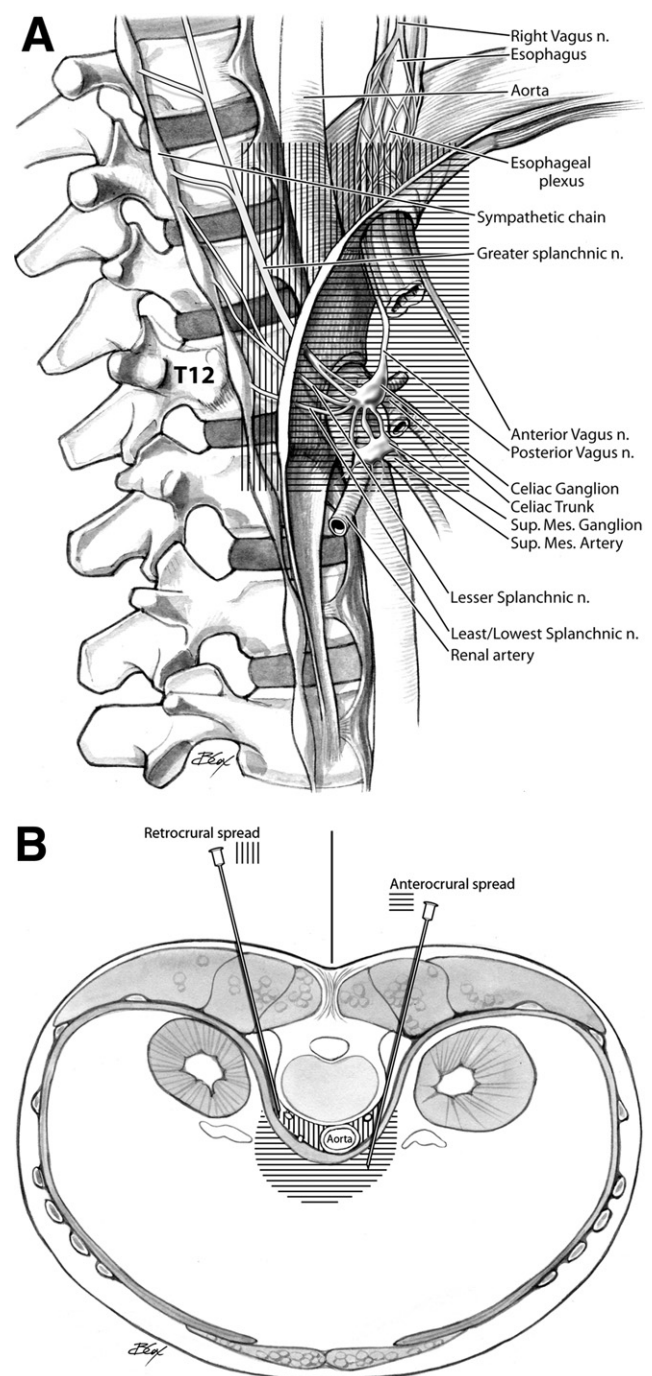The procedure is typically performed on the left due to positioning of the aorta. Skin and subcutaneous tissues over

Fig 1   Celiac plexus block—(A) parasagittal and (B) cross-sectional anatomy demonstrating placement for retrocrural and anterocrural block techniques (adapted from Brown[9]).

the superior margin of the L1 vertebral body are anesthetized. A 22-gauge, 5-inch spinal needle (or 8-inch for obese patients) is advanced toward a target just caudal to the margin of the 12th rib and cephalad to the transverse process of L1 with a coaxial technique under intermittent fluoroscopic guidance (every 1-2 cm). Once the periosteum is contacted at the anterolateral margin of L1, the c-arm is rotated to a lateral projection and the needle is advanced to lie 2-3 cm anterior to the anterior margin of L1 in the lateral

view. Aspiration should be done as the needle is advanced anterior to L1 and, if blood appears, the needle should be advanced through the anterior wall of the aorta until blood is no longer aspirated. The needle tip should be medial to the lateral edge of the L1 vertebral body on the anteroposterior view. Once the needle tip position is confirmed, then 1-2 mL of radiographic contrast (iohexol, 180 mg iodine mL^{-1}) should be injected under live fluoroscopy. The contrast should layer over the anterior surface of the aorta. If the contrast spreads to both sides of midline, then only a single needle is needed for the block. If the contrast remains to the left of midline over the anterolateral surface of the aorta, then a second needle is placed from the contralateral side using the same technique.

Diagnostic celiac plexus block prior to neurolysis is generally carried out with 20-30 mL of 0.25% bupivacaine (or 1% lidocaine). The dose should be given in increments of 5 mL, aspirating periodically to ensure that the needle has not moved into an intravascular location. If adequate spread is noted with fluoroscopic images, then a slightly smaller volume may be used (15-20 mL). The same volumes of 10-12% phenol (in iohexol, 180 mg mL^{-1}) or 50-100% ethyl alcohol should be injected for neurolysis. Phenol has a direct local anesthetic effect and is associated with minimal pain on injection, whereas alcohol causes intense burning pain on injection and is best diluted with local anesthetic prior to injection or injected after placing a small volume of local anesthetic. If the neurolytic solution begins to spread posteriorly toward the intervertebral foramen, the injection should be halted to avoid nerve root injury. The needle should be flushed with local anesthetic or saline before being removed to avoid neurolytic agent in the needle tract.

Splanchnic nerve block: retrocrural technique

The same 20- to 30-degree oblique is used, but now a 20- to 30-degree cephalad tilt is added to bring the inferior margin of the 12th rib cephalad to the T12 vertebral body. Next, the skin and subcutaneous tissue are anesthetized. For splanchnic nerve block and neurolysis, needles must be placed on both sides. The needle is advanced to the caudal margin of the 12th rib and cephalad to the transverse process of L1 until the periosteum is contacted at the anterolateral margin of T12. The needle should remain coaxial with intermittent fluoroscopic guidance every 1-2 cm. Next, a lateral projection is used for the c-arm and the needle is advanced 1-2 cm in the lateral view to align with the anterior one third of the T12 vertebral body. On the anteroposterior view, the needle tip should be just medial to the lateral border of the T12 vertebral body. Injection of 1-2 mL of radiographic contrast using live fluoroscopy should reveal a layer over the anterolateral surface of the T12 vertebral body (Fig 2). A second needle is placed on the contralateral side using an identical technique. Diagnostic splanchnic nerve block (retrocrural celiac plexus block) is carried out using 10-15 mL of 0.25% bupivacaine (5-8 mL per side). The dose should be given in increments of 5 mL
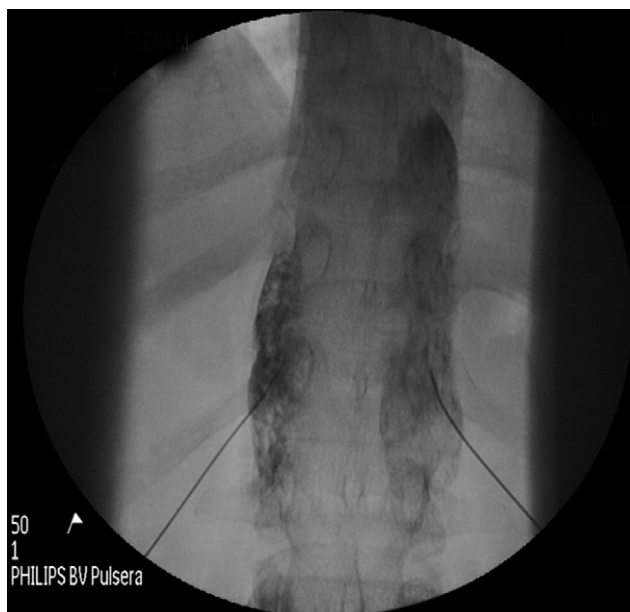

Fig 2 Anteroposterior fluoroscopic view of final bilateral needle placement for splanchnic nerve neurolysis (retrocrural approach to the celiac plexus).

or less, aspirating periodically to ensure the needle has not moved to an intravascular location. Similar volumes should be used for neurolysis as outlined above.

Complications

The most common side effects related to celiac plexus block are diarrhea and orthostatic hypotension, which are almost[11] invariably transient, but should be discussed with the patient. Sudden diarrhea is related to blockade of the sympathetic innervation to the abdominal viscera and results from unopposed parasympathetic stimulation. It is important to ensure that the patient does not have bowel obstruction as the increased motility could potentially result in perforation if a complete obstruction exists. Orthostatic hypotension results from dilation of the splanchnic vasculature, but rarely requires treatment other than intravenous hydration.

Other complications of splanchnic nerve and celiac plexus blockade include hematuria due to the position of the kidneys, which extend between T12 and L3 with the left 1 being slightly more cephalad than the right. Intravascular injection is also of concern as the celiac plexus lies in close proximity to numerous major vessels described above. Additionally, there is risk of pneumothorax given the medial pleural reflection, which extends inferomedially as low as the T12 to L1 level. CT allows visualization of the structures that lie adjacent to the celiac ganglion and may decrease the likelihood of inadvertent needle puncture; however, it does not readily allow for live injection of contrast.

Neurolytic block (NCPB) carries significant additional risk. Intravascular injection of 30 mL of 100% alcohol

results in a blood–alcohol level well above the legal limit but below danger of severe alcohol toxicity. Intravascular injection of phenol results in clinical manifestations similar to local anesthetic toxicity: CNS excitation, followed by seizures, and potentially cardiovascular collapse. The most devastating and worrisome complication of celiac plexus block is paraplegia. The incidence of this complication is unknown, but believed to be less than 1:1000. The mechanism is theoretically related to spread of the neurolytic solution toward the spinal segmental arteries, namely the artery of Adamkiewicz at the level of T12 or L1. This single dominant segmental artery may provide the dominant arterial supply to the anterior two thirds of the spinal cord in the low thoracic region. Neurolytic solutions may cause spasm or even necrosis and occlusion of the artery of Adamkiewicz, leading to infarction of the cord and paraplegia.

Diagnostic blocks as a predictor of successful neurolytic block

The purpose of the diagnostic block is to determine efficacy prior to neurolysis. Given the potential difficulty of performing the block with aggressive tumor burden, and the number of serious associated complications, many feel more comfortable performing a block with local anesthetic before committing to alcohol or phenol.

Despite being the accepted practice by most physicians who perform celiac plexus blocks, many have questioned the need for and efficacy of diagnostic block prior to neurolysis. In 2002, Yuen et al[7] addressed this question with a retrospective analysis of 59 patients. Diagnostic block was performed on 32 patients prior to the decision for subsequent neurolytic block, while 27 patients (1 patient had the block performed twice; n = 28) were directly treated with a neurolytic celiac plexus block. This reflected their clinical practice shift away from performing the diagnostic block, to a paradigm of proceeding directly to the neurolytic block without prior diagnostic testing. In their study, 28 of 32 patients had a positive response to diagnostic block, with 85% (n = 26) having good response to the neurolytic block. In the second group of patients who proceeded directly to NCPB, 79% (n = 28) had a good response. From these group II data, the authors project "expected" responses onto the group I patients to create the following calculations. Comparison of the 2 groups showed diagnostic celiac plexus block predicted a positive response with a sensitivity of 93% and a specificity of 37%. The positive-predictive value was 85% and the negative-predictive value was 58%. Therefore, a positive response to diagnostic block correlates positively with neurolytic celiac plexus block for abdominal visceral pain due to malignancy. However, diagnostic block is a poor predictor when the response is negative. The study indicates a number needed to test of 16.7, meaning that 16-17 patients must undergo diagnostic block to avoid 1

unnecessary neurolytic block. Hence, the authors conclude that the clinical role of diagnostic celiac plexus blockade "is questionable and may not be warranted for patients with terminal malignancy."

Ischia et al[4] described reasons for failure of neurolytic block after positive diagnostic block may relate to a number of patient and technical factors. These may include (1) a placebo effect with the diagnostic block that is not sustained; (2) differences in local diffusion and mechanisms of action of the neurolytic compared with the local anesthetic; (3) systemic absorption of local anesthetic; (4) the spread of the neurolytic may differ from the local anesthetic; and (5) technical problems resulting in difficulty or differences in location with needle tip placement and medication spread. These factors may be even more common if a significantly larger volume of medication is used for the diagnostic block compared with the NCPB. Erdek et al[3] reported a positive trend toward success with NCPB in patients who received <20 mL of local anesthetic for their diagnostic block, although some authors (including Yuen et al) propose using as much as 40 mL for the diagnostic injection. Other factors for consideration when deciding to omit the diagnostic block include the patient being exposed to the doubled procedure-related risk (including the procedure itself and other factors such as stopping anticoagulants), evolving medical problems/contraindications that may preclude the patient from the subsequent neurolytic block, possible false negative block due to various technical problems, and doubling the health care cost.

A simple but effective study could be performed to determine the need for diagnostic block prior to neurolysis. Patients who were candidates for NCPB would receive a diagnostic block with local anesthetic. All patients, regardless of response to diagnostic block, would then proceed to neurolytic block. With this information sensitivity, specificity, positive-predictive value, and negative-predictive value could be calculated to help answer the question for the need for continuing diagnostic blocks.

Conclusions

Neurolytic celiac plexus block to relieve intractable pain caused by upper abdominal malignancies is a well-established treatment. Although a variety of techniques and imaging modalities are used, no single technique has proven superior and all demonstrate 70-90% efficacy. Many practitioners advocate a diagnostic block prior to NCPB, although evidence to date does not necessarily support this approach. Given the significant complications reported with NCPB, it may be warranted to first perform the diagnostic block with <20 mL of local anesthetic if the expected risk of performing 2 procedures is low. However, if comorbidities or other factors exist that make a second procedure more risky or burdensome for the patient, it appears appropriate to proceed directly to NCPB. Further studies are

needed to better elicit what benefit is gained by doing the diagnostic block prior to chemical neurolysis of the celiac plexus (or splanchnic nerves).

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