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Anterior Spinal Artery Syndrome following Splanchnic Nerve Cryoablation for Oncological Pain: A Case Report

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Background: Anterior spinal artery syndrome is a diagnosis associated with high morbidity, mortality, and long-term disability. It is a known complication following conventional celiac plexus and splanchnic nerve blocks. The popularity of minimally invasive pain procedures is growing, especially in the domain of oncology, and the interventions are being performed by specialists with varying backgrounds. Complications such as anterior spinal artery syndrome need to be at the forefront of specialists' minds whenever there is manipulation of the celiac plexus or splanchnic nerves. These structures play an integral role in maintaining circulatory perfusion. The earlier hypoperfusion is suspected or confirmed, the better the prognosis, as steps can be taken to immediately correct this deficit.

Case Report: We present a case of a 65-year-old man with a history of poorly differentiated metastatic pancreatic adenocarcinoma who suffered a thoracic anterior spinal artery infarction following a splanchnic nerve cryoablation. Noninvasive methods to control pain prior to the procedure were unsuccessful. Prior to becoming a paraplegic this patient was independent in all activities of daily living and ambulation.

Conclusions: This case report aims to prove the importance of being familiar with the early signs associated with spinal cord infarction and the importance of completing a thorough, transparent informed consent process when manipulating the celiac plexus or splanchnic nerves. Cryoablation procedures of such structures remain relatively novel compared to conventional blocks. Few case reports have documented anterior spinal artery syndrome following cryoablation. This unfortunate complication results in permanent, life-altering damage. We also propose steps that can be taken to minimize this risk.

Key words: Splanchnic nerve cryoablation, anterior spinal artery syndrome, pancreatic adenocarcinoma

BACKGROUND

Anterior spinal cord infarction has an overall mortality rate of 9% to 23% (1). It is essential that physicians are aware of this condition and promptly begin diagnostic work-up if this diagnosis is suspected. In this example, a 65-year-old man underwent a splanchnic nerve cryoablation in hopes of improving his abdominal pain related to metastatic pancreatic adenocarcinoma. An interventional pain procedure is not an uncommon treatment for abdominal tumors and is offered to a patient if titration of opioids is not sufficient (2).

Pain related to abdominal tumors has 3 components: visceral, somatic, and neuropathic (2). Visceral pain is a result of nociceptive influxes from abdominal ductal obstruction or dilatation and inflammation within the

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abdominal cavity. Somatic pain is a result of malignant invasion into the peritoneum and bones. Signals of pain within the abdominal cavity travel via the sympathetic nervous system to the celiac plexus at T12-L1. The neurotransmitters substance P and glutamate are released in the dorsal horn of the spinal cord and then act on synapses within the dorsal root ganglia of the splanchnic nerves from T5-T12. Signals then travel to the central nervous system for the body to perceive pain. Specifically with pancreatic adenocarcinoma, one of the first routes of metastasis is to the surrounding nerve plexi, contributing to neuropathic pain. Neuronal cells and cells of pancreatic adenocarcinoma have the same surface growth factor and surface adhesion molecules, thus allowing malignant cells to spread along the dorsal root ganglia (2).

One of the more progressive ways to target these nerves is through cryoablation. This method introduces pressurized gas into tissues through a cryoprobe causing intracellular freezing. Decreased pain is a result of damage to vasa vasorum, edema of the endoneurium, Wallerian degeneration, and direct damage to neurons and microtubules (3). Cryoablation has shown promise in alleviating pain related to abdominal cancer. Other options include conventional radiofrequency ablation, cooled radiofrequency ablation, phenol neurolysis, and alcohol neurolysis.

There are several complications that have been documented in the literature following a splanchnic nerve cryoablation including orthostatic hypotension, diarrhea, gastric or intestinal perforation, pneumothorax, vessel injury, and hematoma (4,5). Side effects may be related to disruption of sympathetic activity or direct injury to anatomical structures. A well-documented complication of a celiac plexus nerve block and neurolysis is transient or permanent paraplegia. The accepted etiology is vasospasm of the anterior spinal artery leading to infarct. Few cases of such injury are reported with cryoablation of these same structures.

This case report aims to emphasize the importance of informing the patient of the risk of spinal cord infarct when cryoablation is being considered. In addition, it is important to administer intravenous fluids before the procedure is commenced. Lastly, one may consider conducting celiac plexus and splanchnic nerve procedures in a setting where there is an anesthesiologist who can conduct intraoperative blood pressure monitoring and respond immediately to decreases in sympathetic tone and blood pressure.

CASE PRESENTATION

A 65-year-old man with an extensive past medical history including hypertension and polysubstance use disorder presented for a computed tomography (CT)-guided celiac/splanchnic plexus nerve block with cryoablation due to abdominal pain related to a poorly differentiated pancreatic adenocarcinoma. At the time of diagnosis, he had encasement of the superior mesenteric artery and metastases to the lung and adrenal gland. He underwent one year of chemoradiation therapy with minimal improvement. His pharmacologic pain regiment included: methadone 10/5/10 mg, hydrocodone-acetaminophen 10/325 mg, and duloxetine 60 mg. He was independent with activities of daily living and ambulated with a rollator.

The day of the procedure, the patient was placed in a prone position. Focus-limited noncontrast CT images identified entry sites. Due to the positioning and body habitus the celiac plexus was unable to be safely identified. A decision was made to forgo the celiac plexus cryoablation and only perform a splanchnic nerve cryoablation. Under general anesthesia, 2% lidocaine was injected into the subcutaneous and deep tissues. Several 24-V cryoablation probes were inserted using a retrocrural approach and needle positioning was confirmed with imaging. The patient underwent bilateral cryoablations of the splanchnic nerves along the anterolateral border of the T12 vertebral body for 10 minutes. Post-ablation CT images demonstrated successful hypoattenuating ablation zones.

In the postanesthesia care unit, the patient complained of worsening abdominal and back pain. Palliative care, who was managing his opioids, was consulted after the patient had missed 4 methadone doses preoperatively. They attributed the increased pain to methadone withdrawal. He was admitted for further observation.

On postprocedure day 2, he started to endorse numbness, tingling, and weakness in his bilateral lower extremities. On postprocedure day 3, physical examination was significant for 0 of 5 strength and areflexia of the bilateral lower extremities with preserved light touch and temperature sensation. Initial differential diagnosis included spinal cord hemorrhage with cord compression.

Thoracic and lumbar magnetic resonance imaging (MRI) with and without contrast revealed a T2-weighted hyperintensity within the spinal cord from T10-T12 without signs of cord compression or metastatic disease

to the spine. These findings were supportive of spinal cord infarction vs transverse myelitis.

The patient was transferred to the intensive care unit for close monitoring of blood pressure, and a brief norepinephrine infusion was initiated to maintain a mean arterial pressure (MAP) greater than 85 mmHg. At this time, there was trace movement in his distal right lower extremity while the left lower extremity remained paretic. Subjectively, the patient stated several days after the procedure that cryoablation had improved his abdominal pain and ability to tolerate oral intake.

On postprocedure day 13 he was transferred to a multidisciplinary spinal cord injury team. The patient remained areflexic with improving less-than-antigravity lower extremity strength. Rectal exam revealed intact deep anal pressure sensation and rectal tone without voluntary anal contraction.

The patient's clinical status slowly declined due to severe pain, significantly limiting his ability to engage in therapy. On postprocedure day 43, the patient passed away. Subacute infarction of the thoracic anterior spinal artery with involvement of the anterior horns and corticospinal tracts was reported on autopsy.

DISCUSSION

This patient reported sharp abdominal and back pain immediately following the procedure. This pain was initially attributed to methadone withdrawal. However, the long half-life of methadone makes this less likely as most withdrawal symptoms would present 60 hours after the last dose. Following a splanchnic nerve cryoablation, abdominal pain with concurrent back pain should prompt investigation. In anterior spinal artery syndrome, acute back pain at the level of injury and bilateral flaccid paraplegia are cardinal findings (1). The proceduralist should be contacted immediately to ensure early cohesive communication between the patient and multidisciplinary team.

Understanding the blood supply of the spinal cord is essential. The anterior spinal artery originates from the union of the 2 vertebral arteries. The single artery descends through the anterior median sulcus. It supplies the anterior two-thirds of the spinal cord. The anterior spinal artery is smallest in diameter throughout the thoracic region, making this region most susceptible to ischemia (1). The aorta gives off segmental arteries which then split into the anterior and posterior radiculomedullary artery. The anterior radiculomedullary artery joins the anterior spinal artery. When targeting the celiac plexus and splanchnic nerves through a retrocrural approach, literature supports a safe zone. This zone is described as the upper one-third of the vertebral body at the anterolateral position. In theory, this should avoid direct disruption of the segmental arteries (6). The sympathetic ganglions are immediately lateral to the vertebral bodies. The splanchnic nerves and celiac plexus are branches of the sympathetic chain providing innervation to the abdomen, thus playing an integral role in blood pressure control.

Transient, self-resolving hypotension can occur immediately following manipulation of the celiac plexus and splanchnic nerves. One study reported 20% to 42% of patients with celiac blocks had this complication (7). However, this hypotension, if prolonged, can result in frank infarction when performing cryoablation of these same structures. This is due to a sudden decrease in sympathetic input to the arterioles innervated by the greater, lesser, and least splanchnic nerves. Preloading patients with intravenous fluids and providing maintenance fluid following the procedure is a common practice. Most interventionists will provide a 500-mL preprocedural intravenous fluid bolus. The patient's transfer to the intensive care unit and use of a pressor was warranted to ensure MAPs remained greater than 85 mmHg, decreasing the likelihood of further spinal cord ischemia.

Lastly, the informed consent of the splanchnic nerve cryoablation was examined. Under the risks associated with cryoablation, there was no mention of spinal cord injury. Only for the celiac plexus block was a risk of spinal cord injury disclosed. Although spinal cord infarct is rare, given the labile medical status in oncological patients, the risk of spinal cord injury should be discussed.

CONCLUSION

In summary, we recommend that prophylactic spinal cord injury precautions for infarction be immediately initiated in the postoperative phase of splanchnic nerve manipulation. These precautions include monitoring and correcting for hypotension, maintaining eunatremia, obtaining immediate postoperative hemoglobin for comparison to preoperative levels to rule out active bleed or anemia, and frequent blood sugar monitoring to ensure the patient remains euglycemic. Additionally, patients should be placed in a position to avoid hyperextension of the neck. These steps will not reverse any ischemia that occurred during the procedure, but they are essential in preventing further damage in the postoperative period.

Manipulation of the celiac plexus and splanchnic nerves must be done with meticulous caution and care. These structures are integral parts of maintaining our sympathetic tone. We especially want to emphasize the age-old paradigm of the importance of communication in patient care, especially with respect to the potential complications of an intervention. Whether it be in the informed consent process, with consulting teams, or in face-to-face interaction after a major procedural complication, it is crucial that the patient knows that the proceduralist is concerned for their well-being. It is important to endorse a holistic approach to patient care, one that is guided by genuine vigilance, empathy, and compassion from consult to discharge. With the goal of many pain procedures being to enhance function and quality of life, the small potential of paralysis needs to be weighed against the benefit of pain relief by the patient. This may be especially true when working with a patient who has an underlying terminal diagnosis.

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