

# CASE REPORT

## Pneumorrhachis complicating acute pain management using a thoracic epidural catheter

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### Abstract

The use of thoracic epidural catheters to infuse local anaesthetics and opioids is a common practice in acute pain management to attenuate the pain associated with thoracic and abdominal surgical procedures. The placement and maintenance of epidural analgesia is known to be associated with a variety of potential complications. A rare complication is the development of air within the spinal canal (pneumorrhachis). Although pneumorrhachis is typically asymptomatic and resolves spontaneously, it rarely can be associated with neurological dysfunction. Here we describe a case of pneumorrhachis that led to symptomatic acute spinal cord compression in a 27 year old man who had a thoracic epidural placed to help with pain management following laparotomy for the management of Crohn's disease. Postoperatively, the patient developed unilateral weakness in his upper and lower extremities and sensory dysfunction in the upper extremity. Urgent neuroimaging demonstrated epidural air causing mass effect on the cervical spinal cord. His symptoms resolved completely following conservative management. This rare presentation of pneumorrhachis highlights the need for close vigilance regarding neurological function in patients with epidural catheters for acute pain management. This presentation also promotes mitigation of factors that may be associated with the administration of air into the epidural space, such as changing epidural infusion solution bags and malfunction of epidural infusion pumps.

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### Introduction

Although the infusion of opioids and local anaesthetics via thoracic epidural catheters is known to help with pain management following abdominal and thoracic operations, catheter placement and use can be associated with a variety of complications. First described in 1977 by Gordon and Hardman in the context of head trauma with pneumocephalus and concomitant air in the cervical subarachnoid space, the development of pneumorrhachis, or air within the spinal canal, is one such rarely reported complication<sup>1</sup>. It is thought that pneumorrhachis is usually asymptomatic and found incidentally on imaging<sup>2</sup>. It has been reported to occur in the context of spinal trauma, conditions associated with increased intrathoracic pressure, infections of the spine or from contiguous areas, spinal surgery, and even spontaneously<sup>2</sup>. Iatrogenic anaesthesia-related pneumorrhachis cases are rare, especially those associated with neurological deficits, and these cases have occurred in the context of the administration of medications in the lumbar epidural space for the management of acute, chronic or labour pain<sup>3-7</sup>. We report a unique case in which pneumorrhachis devel-

oped following epidural placement at the thoracic level and for acute pain management and presented with signs and symptoms of acute spinal cord compression. Air within the spinal canal acted as a space-occupying lesion compressing neural structures. This case emphasizes the need to maintain vigilance for neurological dysfunction following thoracic epidural placement and discusses management options for symptomatic patients.

### Report

A 27 year old man with Crohn's disease, obesity (BMI 44), and obstructive sleep apnea (OSA) who was undergoing a small bowel resection with end ileostomy via laparotomy received a thoracic epidural catheter preoperatively. The catheter was inserted on a second attempt at the T8 / T9 level using a 17 g Tuohy needle and midline approach with loss of resistance to air (LORA) obtained at 10 cm needle depth. The catheter was secured at 13 cm to the patient's back. Pre-incision, 3mL of 0.25% bupivacaine (Marcaine) was administered via the catheter. Intraoperatively, the patient received fentanyl 50 mcg and 3 mL of 0.25% bupivacaine

(Marcaine) about 1.5 hours after surgery started and then another 4 mL of 0.25% bupivacaine (Marcaine) 2.5 hours later. The patient's operation proceeded with general anesthesia using sevoflurane. No intra-operative surgical complications were noted. Upon arrival to the Post-Anesthesia Care Unit 4.5 hours after surgery started, the patient complained of midline incisional and umbilical area pain. Neurological examination by the Acute Pain Service (APS) team was normal in terms of motor and sensory function in the upper and lower extremities. An infusion of hydromorphone (Dilaudid) 0.03 mg/mL with bupivacaine (Marcaine) 0.125% was started at 5 mL / hour after a 4 mL bolus, and the pain subsided. After about three hours in PACU, the infusion was changed to 0.125% bupivacaine (Marcaine) alone because of the OSA.

Approximately 5 hours post-operatively, the APS physician was informed by the ward nurse that the patient was experiencing new numbness and weakness in the left hand and arm and new weakness in the left leg in addition to increased incisional pain. Assessment revealed 60% decreased sensation to light touch in most of the left hand and arm and decreased sensation to ice from the left hand to elbow. There was normal sensation to the left abdomen and thoracic regions and legs. Motor examination showed normal strength on the right side but on the left side grade 4- finger flexion, extension, and abduction, grade 4+ elbow flexion and extension, and grade 4 hip flexion (Medical Research Council Scale). More distal left leg strength was normal. Constitutionally, the patient had hemodynamics within normal limits and was otherwise well with no evidence of sepsis.

The epidural infusion was stopped to determine if neurological function would improve and subcutaneous hydromorphone (Dilaudid) was ordered for pain management. When function had not improved after 2 hours, urgent neuroimaging was arranged since a space-occupying lesion (epidural hematoma) was at the top of the differential diagnosis of the clinical findings. Computed tomography (CT) showed epidural air extending from C5 to T12 and pushing the spinal cord anteriorly, extending around multiple nerve roots and also surrounding the right brachial plexus (Figure 1). Air was visualized along the paravertebral muscles and soft tissues from T11 to L2. There were no abnormal imaging findings in the cranium.

Conservative management was pursued after consultation with the Spine Service. The epidural catheter was removed with no complications and the catheter was not noted to have any new structural abnormalities. No steroid administration or surgical interventions were suggested by the Spine Service and the patient was treated with supplemental oxygen by face mask.



**Figure 1.** Representative coronal CT image through the upper thoracic spine demonstrating pneumorrhachis pushing the spinal cord anteriorly.

His symptoms improved by the first post-operative day and completely resolved by post-operative day 2.

## Discussion

Acute spinal cord compression causing neurological dysfunction secondary to pneumorrhachis associated with thoracic epidural catheter placement has hitherto not been reported. Other cases have presented with radicular pain, radicular sensory and motor deficits, cauda equina syndrome and even cardiac arrest<sup>4,5,7-10</sup>. Most other reported cases have involved epidural-related procedures at the lumbar level with only one other case involving placement of an epidural in the thoracic spine<sup>3-10</sup>. In that case, the epidural catheter was placed at T4 in order to administer opioids for metastatic cancer-related pain in the cervicothoracic and interscapular areas<sup>9</sup>. Only one other report involving the use of an epidural catheter describes spinal cord compression occurring in the context of medication infusion<sup>3</sup>. In that case, a lumbar epidural catheter was placed to manage recurrent unilateral lumbar radicular pain via the administration of local anesthetic and steroid<sup>3</sup>. The catheter was replaced twice when it became occluded and ultimately removed after the patient developed headaches and upper extremity weakness and numbness<sup>3</sup>. Imaging demonstrated pneumorrhachis in the cervical, thoracic, and lumbar spine<sup>3</sup>. Other than cancer-related pain, which was the reason for epidural catheter placement in only one other case report, other cases involving pneumorrhachis were seen in the context of the administration of medications epidurally for chronic back or radicular pain, labour pain or as the intended method of anaesthesia for a lower extremity vascular operation<sup>3-8,10</sup>. Other rare, concerning complications of epidural anesthesia causing neurological

deficits include formation of epidural abscess or hematoma. However, with such complications their presentation is often delayed and the deficits are expected to be at or near the level of the epidural placement.

The introduction of air into the epidural space could have occurred in a variety of ways. Although the LORA technique is well-recognized manner of identifying the epidural space, some have argued that epidural air could lead to patchy or incomplete analgesia<sup>2</sup>. It is not known what volume of air can be safely injected without causing harm<sup>6</sup>. Presumably the greater the number of attempts using LORA, the increased amount of air that could be administered and so it would seem prudent to limit the amount of air used during LORA techniques<sup>4</sup>. In our case, although two attempts were required in order to identify the epidural space, it is unlikely that any pneumorrhachis thus created caused any neurological deficits since the patient was neurologically intact for several hours post-operatively. Clinically significant pneumorrhachis may have developed when the infusion solutions were changed and then run through an infusion pump. This was the suspected etiology in a case in which air was inadvertently introduced by the patient into the epidural catheter medication bags<sup>10</sup>. In our case, once a critical volume of air was present within the cervicothoracic epidural space, the air likely acted as a space-occupying lesion manifesting with signs and symptoms of cord compression<sup>2,6</sup>. That the patient did not have any symptoms attributable to air around the right brachial plexus suggests that no mass effect was exerted by that collection of air on those nerves, perhaps because the soft tissues surrounding the plexus were better able to accommodate pressure from the air collection than the rigid confines of the cervicothoracic spinal canal. The injection of autologous blood into the epidural space is an established therapy for the treatment of post-dural puncture headache, with volumes of blood of 16 to 20 millilitres being common<sup>11</sup>. Endpoints to injection can include back pain or pressure<sup>12</sup>. It is unusual, however, for patients to develop signs and symptoms of acute spinal cord compression despite this, although such cases have been reported<sup>12,13</sup>. It has been suggested that factors such as spinal stenosis, obesity, and decreased compliance of the epidural compartment may be risk factors for the development of spinal compression symptoms with epidural blood patch procedures<sup>13,14</sup>. In our case, obesity may have been the risk factor associated with the spinal compression symptoms. We cannot be certain as to why there was air found in the paravertebral space and muscles in addition to within the spinal column. We hypothesize that this may have been introduced during the process to place the catheter. The patient was obese and this can increase the technical challenges associat-

ed with catheter placement. However not enough details were provided in the anesthetic record to let us know exactly how much air was used during catheter placement attempts.

Reports indicate that CT is the modality of choice to diagnose pneumorrhachis<sup>2,6</sup>. It has been acknowledged, however, that the resolution of CT is such that it will not necessarily allow discrimination between intradural and extradural air and magnetic resonance imaging would be more sensitive to provide that information<sup>2</sup>.

The management of pneumorrhachis in our case is consistent with that provided in other iatrogenic anaesthesia-related cases. Over time, air within the epidural space is reabsorbed and associated with improvement of symptoms<sup>3,4,7-10</sup>. Because pneumorrhachis with neurological dysfunction is such a rare entity, there are no established management guidelines<sup>2</sup>. Most other cases have used conservative management including the provision of supplemental oxygen to hasten the reabsorption of air<sup>3-5,7-9</sup>. Other treatments that have been used include the administration of steroids<sup>2</sup>. Rarely have more aggressive interventions, such as hyperbaric oxygen therapy or percutaneous aspiration of epidural air been necessary<sup>2,5,10</sup>.

This case highlights the need for vigilance to neurological dysfunction when managing patients' acute pain with thoracic epidural catheters. Lack of resolution of neurological symptoms with cessation of administration of epidural medications should prompt investigation of potential causes of neural compression to rule out the need for urgent surgical intervention. If pneumorrhachis is found, conservative management is usually sufficient.

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