Case reports

Abnormal motor blockade after epidural analgesia caused by pneumorrhachis and the role of hyperbaric oxygen treatment: a case report

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Abstract
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Introduction: Pneumorrhachis is a rare clinical entity that is usually asymptomatic. Previous reports have associated such events with epidural insertion using a loss of resistance (LOR) to air technique. This report describes a case of symptomatic epidural pneumorrhachis following epidural anaesthesia using LOR to saline.
Case report: A 32-year-old American Society of Anesthesiologists (ASA) Classification II female patient was admitted for unplanned caesarean section. Epidural anaesthesia was performed at the L3-4 space using LOR to saline. The procedure, including delivery of the neonate, was uneventful. In the recovery room, a local anaesthetic infusion via an elastomeric pump (infusion 'balloon') was started. Two hours after initiation of the infusion the patient complained of motor blockade, so it was stopped. Two hours later she remained paraparetic, and a neurologist assessment was required. A computed tomography scan showed epidural pneumorrhachis at the L2-3 level. The patient was referred for emergent hyperbaric oxygen treatment (US Navy Treatment Table 5) and following one session the patient recovered completely.
Discussion: Anaesthetists should be aware of this rare complication, which is easily overlooked. Hyperbaric oxygen treatment is a first line treatment for gas-associated lesions with neurological impairment. Timely referral is essential to prevent irreversible deficits.

Introduction

The rate of caesarean sections has increased with a similarly increasing trend to performing them under neuraxial anaesthesia.[1,2] Although there are specific advantages of this approach, a range of complications can occur and knowledge of these is essential to an early diagnosis. These complications include mechanical injuries, vascular complications, drug-related complications or technique-related injuries. Mechanical injuries can be subdivided in direct lesions to the spinal cord or nerve roots or compressive lesions such as haematoma, pneumorrhachis or epidural abscess.

Pneumorrhachis, the presence of gas within the spinal canal, is a rare imaging finding arising from various aetiologies, mainly traumatic and iatrogenic. As imaging techniques improve, this pathologic entity has become somewhat more often diagnosed.[3,4] Computed tomography (CT) is the most reliable method of diagnosing this complication.[3,5–7]

As a result of the rareness of this complication, there are no empiric guidelines for the treatment and standards of care.[4,7] Various treatment options have been described, such as non-surgical treatment with dexamethasone, decompression and aspiration by needle, high inspired concentrations of oxygen, and hyperbaric oxygen treatment (HBOT).[5,8] In fact, the management of this condition should be based on a multidisciplinary approach contributing to an individualised plan.

In this report, we describe a case of abnormal motor blockade due to pneumorrhachis after epidural analgesia, and its successful treatment with HBOT.

Case report

The patient gave consent for the publication of her case. A healthy 32-year-old pregnant woman (G2P1) at term gestation was admitted for vaginal delivery. Her anaesthetic history included a caesarean section under spinal anaesthesia complicated by post-dural puncture headache. There was no relevant past medical history except sporadic right sciatica pain during pregnancy.

During labour, because of suspicion of cephalopelvic disproportion, it was decided to perform an unplanned caesarean section. Following a full explanation of the risks and benefits and taking account of the prior history of post-dural puncture headache, an epidural catheter was placed at L3-4 using a Tuohy 18G needle in a midline approach with loss of resistance (LOR) to saline. On the first pass the catheter was advanced 4 cm into the epidural space. Neither cerebrospinal fluid nor blood could be aspirated from the epidural catheter. Ropivacaine 0.75% 75 mg plus 10 µg sufentanil were administered. The surgery progressed uneventfully and a healthy baby was delivered.

In the recovery room, adequate motor blockade reversion was observed. Thirty minutes after the procedure, at 5 pm, a ropivacaine 0.2% infusion at 2.7 $mL \cdot h^{-1}$ was initiated using an elastomeric drug infusion 'balloon' (DIB). The patient was transferred to the ward without complaints.

Two hours after initiation of the ropivacaine infusion, the anaesthesiologist was called because the patient was hypotensive (systolic blood pressure 80–90 mmHg) and exhibiting bilateral motor blockade. The hypotension was treated with crystalloids and the infusion was stopped. At 8pm, although the motor blockade started to reverse on the left side she continued to exhibit right motor blockade. Therefore, urgent neurology consultation was obtained at 9 pm, two hours after the DIB had been stopped. This confirmed a patchy sensory blockade (L4 level), with an asymmetric right paraparesis grade 2/5 (hip and knee flexion, knee extension, dorsiflexion and plantar flexion of foot) without any signs of more proximal neurologic dysfunction. No headache or neck stiffness were present and she did not have any signs of dyscoordination with a negative finger-to-nose test. A cervicothoracolumbar CT scan was obtained which revealed a single bubble of epidural air (6 x 6 x 17 mm) at the L2-3 level on the right side of the rachis without significant mass effect (Figure 1). No other lesions were seen. Pneumorrhachis was assumed as the most likely cause of the paraparesis. After consultation with the hyperbaric medicine physician, a decision was made to initiate urgent HBOT and the patient was transferred with oxygen inhalation via a non-rebreather mask.

Upon arrival at the hyperbaric medicine unit at 1:15 am, she had some improvement of motor deficits but maintained altered temperature sensitivity and muscular weakness 3/5 on hip flexion and 4/5 on knee extension on the right. At 1:37 am the patient was compressed according to the US Navy Treatment Table 5 protocol (145 minutes, maximum 284 kPa [2.8 atmospheres absolute], 100% oxygen), administered in a multiplace chamber with an attending nurse and continuous clinical and vital signs monitoring. There was significant neurological improvement after the first oxygen period at 284 kPa and after the treatment she had no motor weakness though she continued to exhibit distal symmetric hyposensitivity.

Figure 1
CT scan at the L2-3 level showing a single bubble of epidural air which measured 6 x 6 x 17 mm on the right side of the rachis without significant mass effect

A re-evaluation CT was obtained showing a reduction of the epidural air. As she also had no significant clinical manifestations, she was transferred back to the referring hospital with continuous neurological monitoring.

At the time of discharge, four days later, her neurologic examination was unremarkable, and she had full strength in all extremities and an intact sensation to light touch without pain.

Discussion

Pneumorrhachis is defined as the presence of air within the epidural or subarachnoid space.[9,10] As the condition is rare, few reports are available. The causes of epidural air can be iatrogenic, spontaneous, or traumatic. Iatrogenic causes are the most common, usually after epidural injection or epidural analgesia.[5,10,11] In fact, there are some case reports of epidural, subdural or subarachnoid air after techniques with LOR to air, however none following LOR to saline (as was used in the present case).[8,9,12–16]

In this case, there is not a clear reason for prolonged motor blockade. Our first hypothesis was intrathecal instead of epidural administration of ropivacaine. However, as the right motor blockade persisted more than two hours after the discontinuation of local anesthetic perfusion, the second hypothesis was a local compressive event as the most probable cause. There are some cases reported in the literature of neurological deficits and pain thought to be complications associated with the application of intraspinal air, with descriptions of accidentally injected air into the epidural space via an epidural catheter for continuous epidural anaesthesia.[4]

The CT imaging showed epidural air (pneumorrhachis) on the side of motor blockade without evidence of compression or ischemia of the spinal cord, but with possible compression of the spinal roots near the emergence from the vertebral canal.

Another hypothesis was that air could also have been entrapped in the DIB and since the flow was slow (2.7 $mL \cdot h^{-1}$), the air did not move and became a single gaseous mass contained in the right epidural side.

Although pneumorrhachis is usually asymptomatic, reabsorbs spontaneously and the majority of patients are commonly managed conservatively, in this case the patient exhibited a persistent asymmetric right paraparesis. She had complete resolution of motor blockade after initiation of HBOT which would have immediately reduced the gas volume and then accelerated diffusion of nitrogen away from the gas mass under hyperoxic conditions. The CT imaging after treatment showed a reduction in epidural air as has been previously reported. The application of HBOT in pneumorrhachis is not well established and, to our knowledge, there are only two case reports describing its utilisation for epidural air.[12,17]

On first contact, the hyperbaric medicine physician considered this injury as the possible cause for the neurological deficits and accepted the patient for HBOT, in spite of the limited evidence available, after taking into consideration the limited improvement after stopping the local anaesthetic infusion, the exclusion of other possible causes, the severity of the neurological deficits with a risk of sequelae and the lack of therapeutic alternatives at the referring hospital.

The location and the relatively small volume of air (with no signs of compression) made it difficult to extrapolate experience in treating decompression sickness (where a US Navy Treatment Table 6 would typically be used as first-line recompression therapy) to making management decisions in this case. A shorter HBOT table was chosen since there was clinical improvement between the first neurological examination and arrival at the hyperbaric center, and the patient demonstrated fatigue in excess of what was expected in the postoperative period, attributed to the diagnostic procedures and transport to the hyperbaric center. Therefore, a US Navy Treatment Table 5 was deemed acceptable treatment, improving the patient's tolerance of the recompression treatment and permitting continuous neurological evaluation with optional extensions.

Conclusions

Despite the numerous advantages of epidural anaesthesia and analgesia, it is crucial to have a complete knowledge of the different complications and side effects that may arise from this technique. This case highlights the possibility of pneumorrhachis that, although rare, is one of the reported complications of neuraxial techniques. It is essential to ensure adequate monitoring of patients, since the key for successful management of all such complications is prompt diagnosis followed by multidisciplinary management.[18] The contributing factors for this complication have to be evaluated and appropriate interventions should be implemented.

In conclusion, when pneumorrhachis is documented, a decision to treat conservatively or surgically should be made, and consideration should be given to HBOT as a first line treatment for gas-associated lesions with neurological impairment, in addition to its established role as a complementary/synergistic or first-line treatment for other conditions.[19]

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