

Subarachnoid pneumorrhachis following blunt thoracic and spinal trauma

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Abstract

Subarachnoid pneumorrhachis is an increasingly identified entity in the setting of trauma. We report a case of this finding incidentally and of a positive outcome with conservative management following multi-speciality opinion. Our case-series review identifies an increasing num-

ber of cases in the literature due to improvements in computerised tomography resolution and explores traumatic and non-traumatic precipitants, suspected mechanisms of introduction of air into the spinal canal and ventricular systems and support for non-interventional management in uncomplicated pneumorrhachis.

Key words: Pneumorrhachis, pneumorrhachis, intraspinal air, epidural emphysema, pneumomyelogram, intraspinal-pneumocele.

Case report

We report a case of a 62-year-old male construction worker who fell through a skylight from an estimated height of 6 metres and landed on his left side onto concrete. His past medical history was unremarkable other than for being a smoker. On arrival of paramedics his respiratory rate was 24 breaths per minute with an SpO₂ of 80%. He was normotensive and had a Glasgow coma scale (GCS) of 15. He was transported to the local secondary-level hospital emergency department where he was found on primary survey to have a left-sided pneumothorax, which was decompressed with a pigtail drain.

A computed tomography (CT) trauma series revealed severe thoracic and spinal column trauma, with multiple bilateral rib fractures, a large left haemopneumothorax and moderate right pneumothorax, and extensive surgical emphysema. There were fractures of the thoracic vertebrae (T) 2, T3, and T5 transverse processes with a dural tear at the T2-T3 level, accompanied by a large volume of intraspinal air (pneumorrhachis) extending into the cranium (pneumocephaly), without radiological evidence of raised intracranial pressure. An unstable T6 Chance fracture, T9 vertebral body fracture, and left scapula fracture were also identified.

A large bore surgical chest drain was inserted on the left which promptly drained 1100 ml of blood. A right-sided chest drain was also inserted. Hypotension developed which was treated with administration of crystalloid (5 litres in total). Given the extent of his injuries, the patient was referred to the nearest tertiary centre with cardiothoracic, neurosurgical and intensive care services. He was intubated to facilitate safe and comfortable aeromedical transfer.

On day one of his intensive care unit (ICU) admission the patient underwent posterior stabilisation of T5-T7 for his unstable T6 fracture. The remainder of his spinal injuries were managed non-operatively. Neurosurgical opinion was sought regarding the pneumorrhachis and pneumocephaly; it

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was decided that no specific intervention was required.

The patient was treated for a ventilator-associated pneumonia and was extubated on day four of his admission, but subsequently developed respiratory failure requiring reintubation. A repeat CT chest demonstrated a persistent left-sided pneumothorax, extensive pneumomediastinum, and surgical emphysema of the entire chest wall, neck, abdominal wall, and scrotum. Multiple lung lacerations of the left upper lobe were also noted. Another left-sided surgical chest drain was inserted. Weaning from respiratory support was facilitated by a percutaneous tracheostomy, which was removed on day ten of his admission. The patient was discharged to the surgical ward and later transferred back to his local hospital for further rehabilitation. On outpatient review at two months following his accident, he was well with no significant functional impairment.

Discussion

Pneumorrhachis, the presence of air within the spinal canal in either the epidural or subarachnoid space, is a rare radiological finding in trauma. A literature search of the Medline and PubMed databases using the key words 'pneumorrhachis', 'pneumorrhachis', 'intraspinous air', 'epidural emphysema', 'pneumomyelogram', and 'intraspinous pneumocele' identified fifty case reports of pneumorrhachis (adult and paediatric) caused by blunt or penetrating trauma, excluding iatrogenic events. Causes of pneumorrhachis other than trauma include iatrogenic introduction of air into the spinal canal (most commonly following epidural anaesthesia or spinal surgery), (1) and a range of rare, non-traumatic causes described in case reports in the literature. Many in this latter group have mechanisms which may explain the entry of air into the spinal canal such as barotrauma in association with bullous or obstructive airways disease, or raised intrathoracic pressure secondary to exaggerated emesis. (2) A subset of pneumorrhachis cases have no identified precipitant. (3) Further subclassification can be made by division into the presence of extradural, or epidural, air versus intradural or subarachnoid air. (4-6) Distinguishing epidural pneumorrhachis from subarachnoid pneumorrhachis is important (though often difficult) because the two arise via different pathophysiologic mechanisms, and have different clinical implications and potential consequences. (1)

The first cases of pneumorrhachis in association with blunt thoracic trauma were described in the late 1980s (7,8) with case reports increasing since

then presumably due to the widespread availability and increasing resolution of computed tomography. (9,10) Katz et al postulated that in patients with dural tears secondary to vertebral fractures, air could enter the subarachnoid space via breached parietal pleura under the driving pressure of a pneumothorax. (9,11) This is the likely underlying mechanism in the case we have described here.

Pneumorrhachis can also occur in trauma without meningeal tears, with air accumulating in the epidural space. (5) The first report of epidural pneumorrhachis caused by blunt thoracic trauma was of a patient with bronchial rupture and pneumomediastinum following a motor vehicle accident. (9) The authors hypothesised that air had gained access to the cervical epidural space by dissecting along the fascial planes of the mediastinum and neck, then entering through the neural intervertebral foramina. Again, the driving pressure of a pneumothorax or pneumomediastinum is required to force air along these planes into the epidural space. (5,12)

Whilst the presence of pneumorrhachis signifies potentially severe trauma, it does not usually require specific treatment beyond management of the precipitant pneumothorax. (1,6,13,14) The amount of air in epidural pneumorrhachis in particular is generally small, as the driving pressure of the pneumothorax or pneumomediastinum is not high enough to push large volumes into the epidural space. (1,5) Reabsorption in most instances occurs spontaneously. (2,4,12)

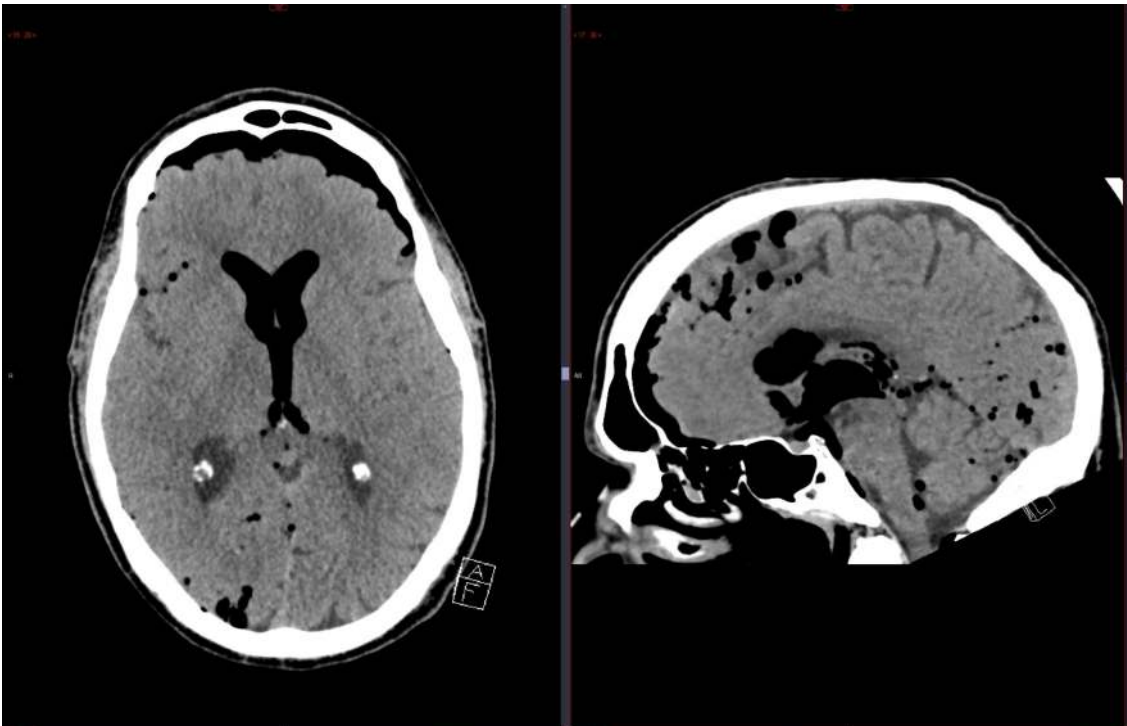
In contrast to epidural pneumorrhachis, traumatic subarachnoid pneumorrhachis is frequently associated with pneumocephalus (1) as in the case presented here. Complicated, or symptomatic, pneumorrhachis requires consideration of the risk of 'tensioning.' In such an instance, the volume of air might raise intraspinal and, by extension, intracranial pressure for which neurosurgical or interventional radiological treatment might be required to facilitate drainage or to repair the dural tear. (15,16) Symptoms might vary from explainable neurological deficits to the less readily explained, including that of tachycardia. (17,18) It is important to consider whether the pneumocephalus is due to an extension of intraspinal air or from the primary injury itself (i.e. open traumatic brain injury). (2,11) Subarachnoid pneumorrhachis secondary to dural tears can lead to other serious complications with the potential for meningitis, (1,16) and in extremely rare circumstances, pneumosyrinx. (19) Though the intraspinal space is sterile, antibiotics are typically not administered for the sole

concern of pneumorrhachis unless there are signs of meningitis or sepsis and prophylactic antibiotics are generally not recommended. (2,15,16,20)

A significant differential to consider is that of free gas, rather than air, in the spinal column. This may arise from medical causes such as infection and gas forming organisms, malignancy, and fistulation. (9,21,22) Clinical correlation is an important tool here as CT imaging alone will not help differentiate within these causes.

The presence of air in these fixed volume tissues does raise important concerns regarding acute retrieval and anaesthesia care. Transport planning should account for the effect of gas expansion and a pressurised cabin should be utilised in aeromedical transfer. The anaesthetist also needs to be aware of avoiding agents that will promote gas bubble expansion via tissue diffusion such as nitrous oxide. (23)

Figure 1. Incidental air ventriculogram and pneumocephalus demonstrated on initial CT trauma series



Legend: CT=computed tomography.

Figure 2. Subcutaneous emphysema with retropharyngeal, epidural and intrathecal extension

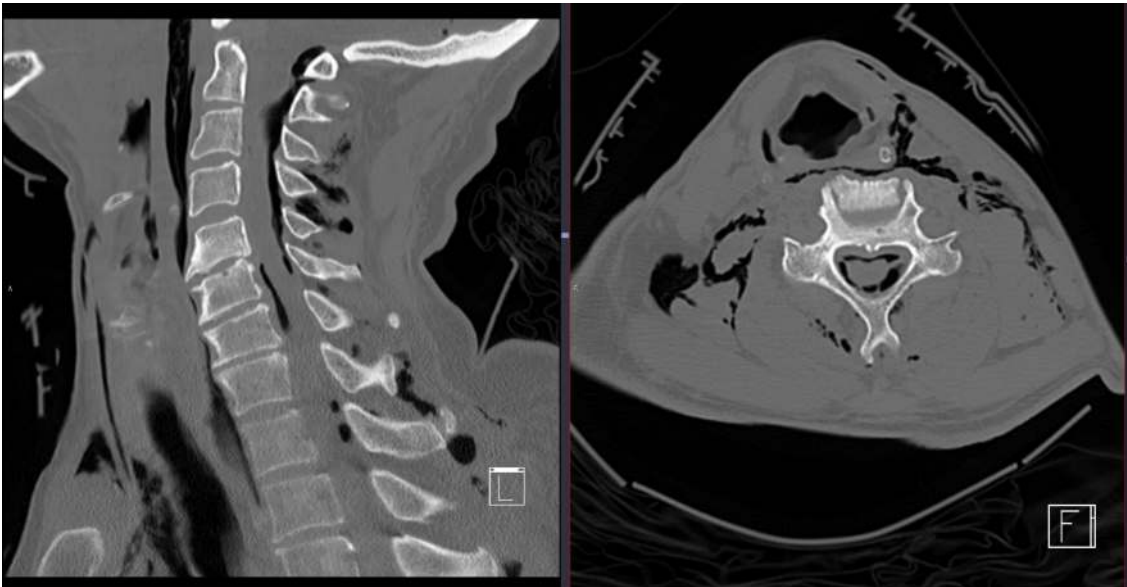


Figure 3. Sagittal CT section demonstrating a left sided anterior pneumothorax and associated driving pressure of the pneumothorax extending into the neuraxiom



Legend: CT=computed tomography.

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