Pneumorrhachis after Recreational Drug Use

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Radiology Case. 2018 Apr; 12(4):1-5 :: DOI: 10.3941/jrcr.v12i4.3103

ABSTRACT

Pneumorrhachis, the presence of air in the spinal canal, is an unusual and alarming radiographic finding. The etiology is most commonly traumatic or iatrogenic but it can occur as a spontaneous phenomenon in association with pneumomediastinum. We report the case of a 16 year old male who presented with throat discomfort and a feeling of altered voice after recreational drug use. Examination confirmed widespread subcutaneous emphysema above the clavicles and plain radiograph and computed tomography imaging confirmed the presence of extensive pneumomediastinum and pneumorrhachis. The patient was managed conservatively and made a full recovery. The clinical and imaging features of spontaneous pneumorrhachis are presented as well as a review of the literature with regard to pathogenesis, management and outcome. Knowledge and understanding of this unusual phenomenon is important to properly direct patient care.

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CASE REPORT

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A previously well 16 year old male presented to the Emergency Department (ED) in the evening with slowly progressive discomfort in the neck and throat, in association with concern that his voice had altered. He reported that he had alcohol followed by smoking a recreational substance which is believed to be cannabis. He denied 'huffing' but shortly after inhalation described becoming intensely nauseated and that he had forcefully vomited several times.

Initial ED assessment did not highlight any features of airway obstruction and vital signs were normal. Subcutaneous emphysema was evident on palpation of the neck and supraclavicular fossae bilaterally but respiratory examination was otherwise unremarkable. On pre-cordial auscultation a crunching sound was heard in time with the heart beat, indicative of Hamman's sign. Neurological examination was entirely normal.

A chest radiograph (Fig 1) was performed that demonstrated pneumomediastinum and extensive subcutaneous emphysema but no pneumothorax. Given the history of vomiting it was felt prudent to further investigate with computed tomography (CT) imaging of the neck and chest with oral contrast to assess for an esophageal leak. This confirmed extensive subcutaneous emphysema and pneumomediastinum but also revealed a large amount of air in the spinal canal (pneumorrhachis) extending up into the neck. (Figs 2, 3, 4 & 5). There was no evidence of an esophageal perforation but a small left sided pneumothorax was identified. Given that the proximal extent of the pneumorrhachis was not visible, a CT of the head was performed, which reassuringly did not demonstrate any pneumocephalus.

It was decided to manage the patient conservatively and he was admitted overnight for observation and to receive oxygen via facemask to facilitate nitrogen wash out. During this period he remained well, repeat chest radiograph the following day was unchanged and he was discharged at that time.

Despite reassurance, the patient remained very anxious about his symptoms and did re-present a couple of times to the ED over the next week with a variety of symptoms. However, examination and assessment on each occasion were reassuring, no complications were identified and he proceeded to make a full recovery with no intervention.

DISCUSSION

Etiology & Demographics:

Free air surrounding the spinal dura matter was first reported by Gordon et al. in 1977 [1] and has been variously described as an intraspinal pneumocele, spinal pneumatosis, spinal emphysema and pneumosaccus. The term pneumorrhachis itself was coined by Newbold et al. in 1987 [2] and represents an unusual and alarming phenomenon for clinicians and radiologists alike.

Most instances of pneumorrhachis (PR) are secondary to trauma or iatrogenic in origin but a review published in 2010 [3] identified 48 published cases of spontaneous PR in a 20 year period between 1989 and 2009. The majority were male (75%) and ages ranged from 4-72 years, though the median age was just 18 years, reflecting the fact that about 70% of cases occurred in patients less than 20 years of age. These are associated with maneuvers that raise intra-thoracic pressure such as a Valsalva, forceful vomiting or coughing and attempts to maximise inhaled drug absorption ('huffing'). [3,4]

The sudden increase in bronchoalveolar pressure can rupture distended alveoli and allow resultant free air to track to the perivascular interstitium following the path of least resistance along peribronchial vascular sheaths to the hilum of the lung, and hence into the mediastinum; a phenomenon known as the Macklin effect. [5] From there, air can move proximally within the mediastinum and via communicating fascial planes, to the submandibular space, the retropharyngeal space and the cervical vascular sheaths. Occasionally air will exit these spaces through neural foramina and appear in the spinal column as PR.

Clinical & Imaging Findings:

Pneumorrhachis itself rarely causes clinical neurological manifestations such as sensory and motor deficits, and this is particularly the case in spontaneous instances. [6] Symptoms of discomfort and pain, as in our patient, may be due to air trapped in the subcutaneous tissues or elsewhere in the body; or due to other contributory pathology, but the diagnosis of PR is one largely made on imaging. In patients suspected of spontaneous pneumomediastinum a chest radiograph will usually be requested, but may miss the presence of PR in 30% cases [4] and further evaluation with contrast CT of the neck and chest is often required.

Pneumorrhachis is generally identified as intradural (usually secondary to significant injury) [7] or extradural, as in spontaneous cases, where it is relatively innocuous. This differentiation may be difficult but it is useful to note that extradural PR has a preference to collect in the posterior extradural space due to the reduced resistance of the connective tissues compared to the vascular network anteriorly. [6]

Differential Diagnoses:

Pneumorrhachis may also be considered as iatrogenic, for example after epidural anaesthesia or a lumbar puncture, non-traumatic or traumatic (table 1). Traumatic PR is almost always a result of major trauma [6,7] and diagnosis is usually self evident. In instances of non-traumatic PR pulmonary pathologies, such as asthma and bullous lung disease need to be considered. Further, the presence of intra-spinal gas should also prove one to think about oesophageal perforation and the possibility of malignant, inflammatory and infectious causes. In all cases discussion between the clinical staff and radiology is vital to get the correct diagnosis and direct treatment appropriately.

Treatment & Prognosis:

The treatment of secondary PR should be directed to the cause but established guidance regarding primary PR does not exist. A careful evaluation of each patient should be made individually but conservative management is generally the rule. Prophylactic antibiotics are not routinely indicated and the air typically reabsorbs without intervention. [6]

TEACHING POINT

Pneumorrhachis describes the presence of air in the spinal canal. It is a rare but important entity that clinicians and radiologists should be aware of. There are a few possible etiologies and close correlation of imaging with the history and clinical presentation is vital to facilitate optimal patient management.

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FIGURES

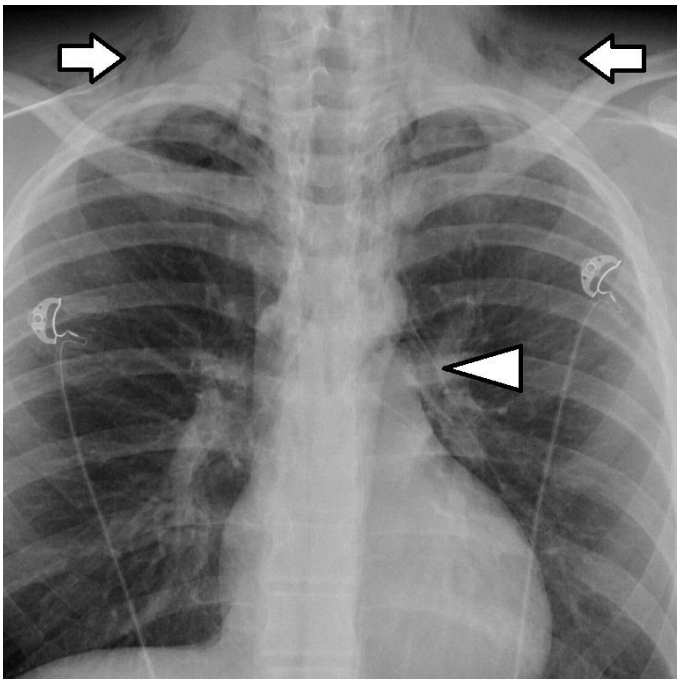

Figure 1: 16 year old male with subcutaneous emphysema and pneumomediastinum.
Technique: Plain posterioranterior (PA) chest radiograph.
Findings: Free gas in the soft tissues of the neck (white arrows). Sharp lucency adjacent to the left heart border (white arrowhead). Clear lungs with no visible pneumothorax.

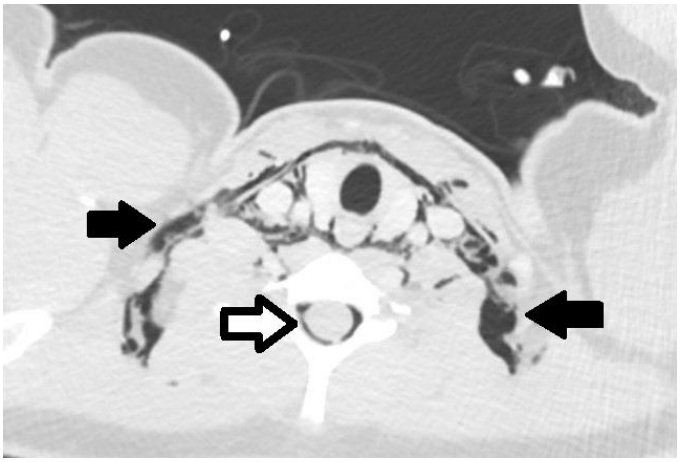

Figure 2: 16 year old male with subcutaneous emphysema and pneumorrhachis.
Technique: Contrast enhanced CT. Axial view through the upper thorax in lung windows.
Findings: Extensive free gas in the soft tissues (black arrows) as noted on the chest radiograph and free gas in the spinal canal (white arrow).

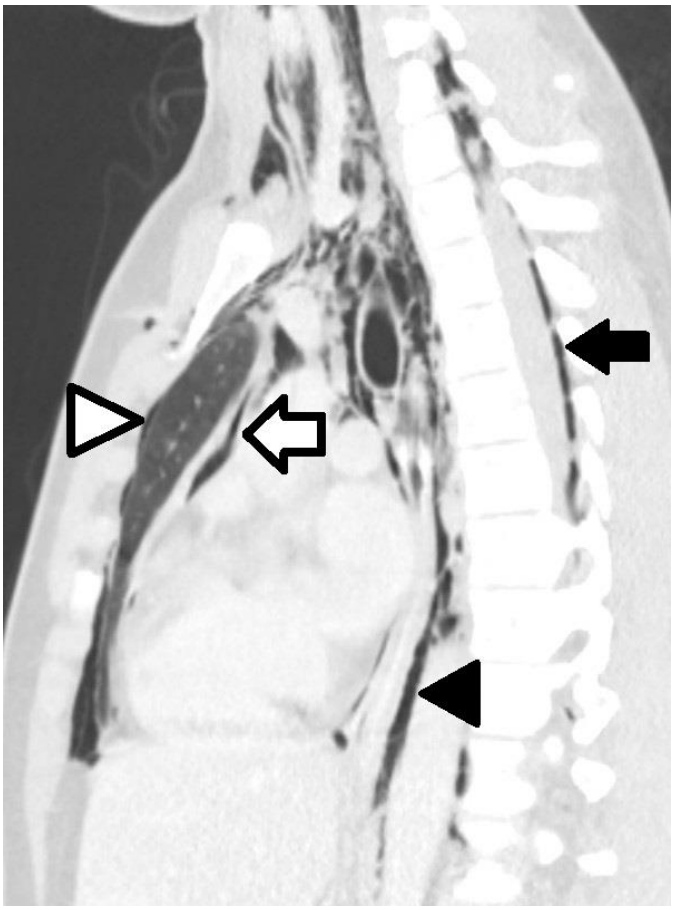

Figure 3: 16 year old male with pneumomediastinum, pneumorrhachis and pneumothorax.
Technique: Contrast enhanced CT. Sagittal multiplanar reformatted view of the thorax in lung windows.
Findings: Free gas tracking into the posterior mediastinum (black arrowhead) and free gas in the anterior mediastinum (white arrow). Free gas in the spinal canal (black arrow). Tiny free gas in the pleura (white arrowhead).

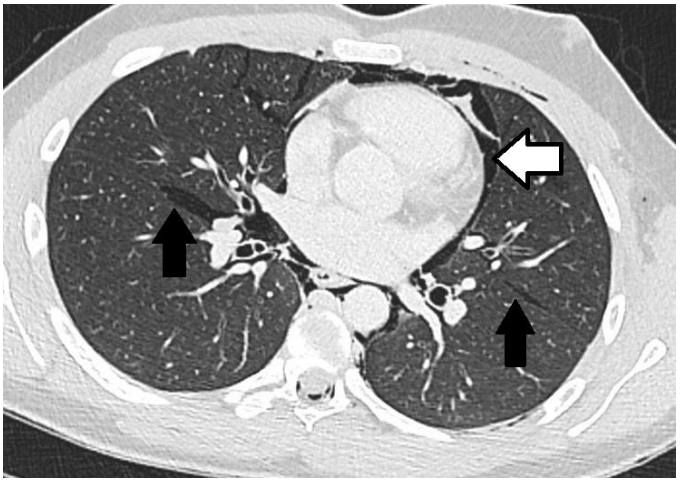

Figure 4: 16 year old male with pneumomediastinum
Technique: Contrast enhanced CT. Axial view through the mid thorax in lung windows.
Findings: Free gas in the mediastinum (white arrow). Intrapleural gas along the lung fissures (black arrows).

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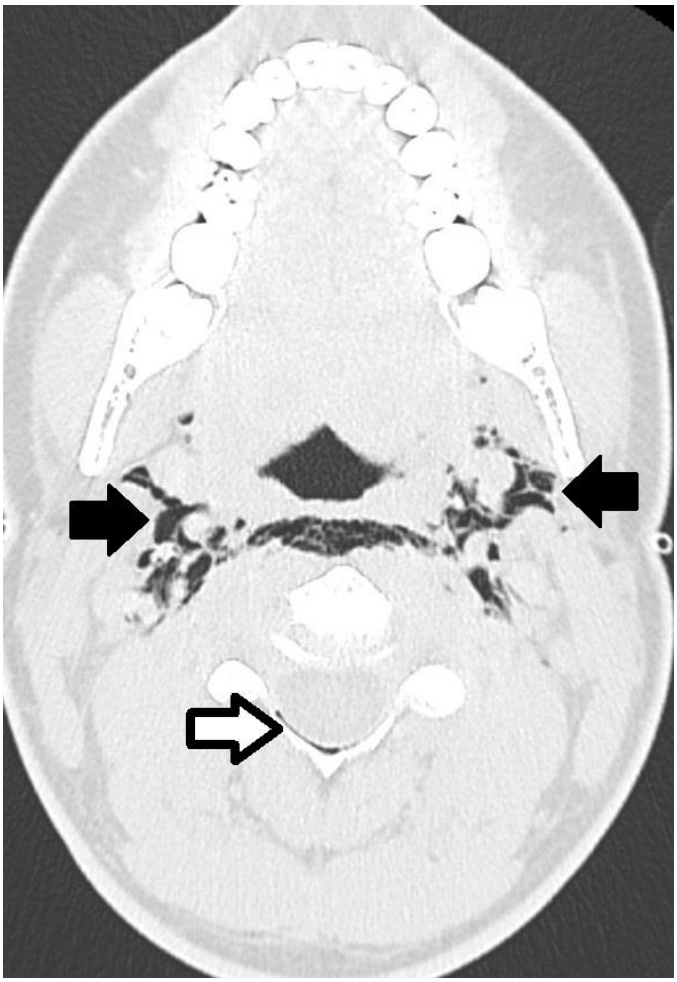

Figure 5: 16 year old male with subcutaneous emphysema and pneumorrhachis.
Technique: Contrast enhanced CT. Axial view through the mid thorax in lung windows.
Findings: Free gas is seen tracking up to involve the fascial spaces of the suprahyoid neck (black arrows). Free gas in the cervical spinal canal (white arrow).

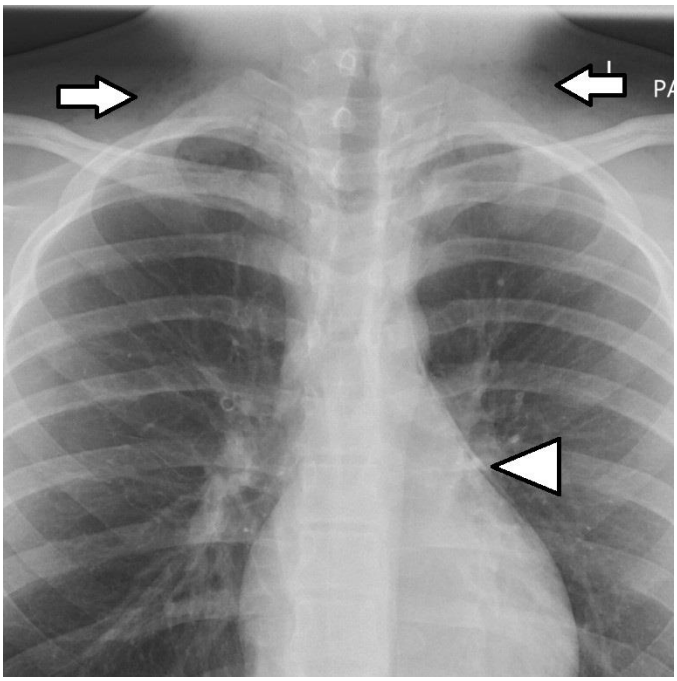

Figure 6: 16 year old male with pneumomediastinum and subcutaneous emphysema.
Technique: Plain posterioranterior (PA) chest radiograph (4 days after initial presentation).
Findings: Reduction in the amount of free gas adjacent to the left heart border (white arrowhead) and in soft tissues of the neck (white arrows) compared to previous chest radiograph.

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Etiology	- Iatrogenic (epidural analgesia, lumbar puncture). - Non-traumatic (SPM, pneumothorax, degenerative disc disease, epidural abscess vertebral metastases) - Traumatic (road traffic accidents, fall from heights)
Incidence	Rare
Gender ratio	No formal data but literature mentions female: male ratio of 1:3
Age predilection	No formal data but in literature majority of patients 20 years or younger.
Risk factors	Predisposing lung disease (asthma, pulmonary bullae), manoeuvres that raise intra-thoracic pressure (Valsalva, vomiting, coughing, illicit drug inhalation).
Treatment	Treatment usually aimed at underlying cause, but conservative management is usually sufficient in majority of primary cases.
Prognosis	Usually benign and self-limiting course with full recovery.
Findings on imaging	Air in various compartments and cavities - pleura, mediastinum, spinal canal. In cases of underlying contributing pathology fractures (trauma) and bony destruction (infection, neoplastic) may be present.

Table 1: Summary table for pneumorrhachis.

Radiographs	Features associated with PR like spontaneous pneumomediastinum, pneumothorax and subcutaneous emphysema usually picked up incidentally on radiographs. PR itself cannot be diagnosed on radiographs.
Ultrasound (US)	Suboptimal imaging in diagnosing PR or its underlying cause.
Computed Tomography (CT)	Can positively demonstrate the presence and extent of free gas in the spinal canal and extra-spinal compartments. Additionally, CT can help identify any underlying aetiology.
Magnetic Resonance Imaging (MRI)	Suboptimal imaging for diagnosing PR itself, but can be of value in diagnosing an underlying cause e.g., epidural abscess, vertebral infection or metastases.
Pattern of contrast enhancement	PR itself will not demonstrate any enhancement but underlying inflammatory, infectious or neoplastic process will avidly enhance.
Scintigraphy	Suboptimal imaging for this condition.
Positron Emission Tomography (PET)	Suboptimal imaging for this condition.

Table 2: Imaging Modalities in the diagnoses of pneumorrhachis.

ABBREVIATIONS

CT - Computed Tomography
ED - Emergency Department
LP - Lumbar puncture
MRI - Magnetic Resonance Imaging
PR - Pneumorrhachis
SPM - Spontaneous Pneumomediastinum
US - Ultrasound

KEYWORDS

Pneumorrhachis; intraspinal air; spinal pneumatosis; diagnosis; imaging; computed tomography

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