Traumatic Pneumorrhachis

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Abstract

Pneumorrhachis or intraspinal air is an increasingly encountered phenomenon in the management of severe trauma. The case of a 23-year-old soldier, who sustained a gunshot wound to the chest, is presented and the subsequent discussion illustrates that while often benign this phenomenon may indicate serious occult injury.

Introduction

Pneumorrhachis is the presence of air in the spinal canal. This rare phenomenon has numerous aetiologies. It is a radiological diagnosis that, dependent on the location of the air, may be of varying significance.

Case History

A 23-year-old United States Marine Corps soldier was admitted to the Joint Force Medical Group (R2E) facility at Camp Bastion in September 2009. He had sustained a gunshot wound to the left chest.

Pre-hospital management had included high flow oxygen, a chest-seal dressing placed over the chest wound and vascular access with a 16G cannula in the left antecubital fossa. At the primary survey on arrival in the emergency department he was alert and orientated and maintaining his own airway. Initial observations were: respiratory rate 16 breaths per minute, reduced air entry noted on the left, SpO_2 97%, pulse 78 beats per minute and blood pressure 110/60 mmHg. No abdominal, pelvic or long bone injuries were identified. On examination of the back a single gunshot entry wound was identified in the left chest with an associated soft tissue injury to the left triceps.

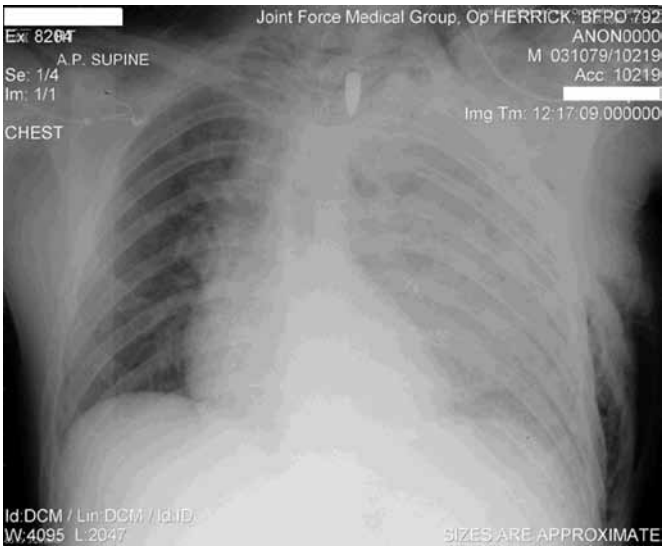

Figure 1 – Chest radiograph showing injury to left chest and retained round.

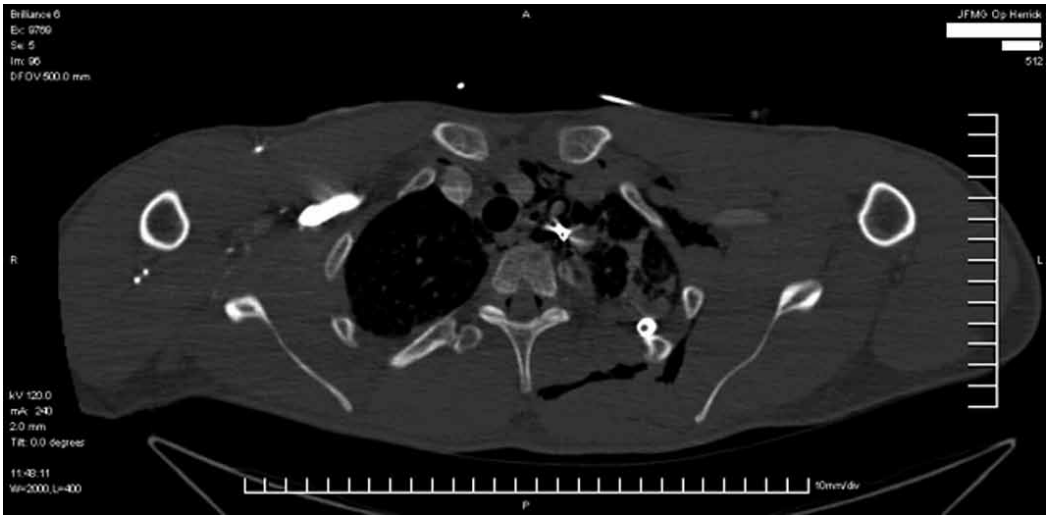

Figure 2 – CT Scan of upper chest showing spinal air and retained round.

Chest radiograph taken as part of the primary survey showed mediastinal shift and a large left sided haemo-pneumothorax. The penetrating round was seen clearly in the left upper zone (Figure 1). A thoracostomy tube was inserted and initially drained 300ml of fresh blood and a further 100ml over the next 15 minutes. The patient remained haemodynamically stable throughout. No neurological deficit was detected.

The patient was subsequently transferred for computerised tomography (CT) scanning and images of the thorax and abdomen were obtained. The CT images confirmed the haemo-pneumothorax, and also indicated large amounts of subcutaneous emphysema with air extending into the spinal canal from above C5 to T7. The bullet was found to be lying between the left carotid and subclavian arteries (Figure 2). No bony injuries were identified.

The patient remained stable and was admitted to the intensive care unit for observation. Initial debridement of his wounds was undertaken later that day. Post-operatively the patient underwent insertion of a thoracic epidural for analgesia at 24 hours post-

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injury. Delayed primary closure of the extremity soft tissue injury was undertaken at 48 hours.

Discussion

Air within the spinal canal is termed pneumorrhachis, first described by Newbold in 1971 [1]. Other terms include: aerorachia, intraspinal pneumocele, epidural pneumatosis, pneumosaccus, and traumatic pneumomyelogram. It is a rare but increasingly recognised epiphenomenon [2]. The air can be within the epidural or subarachnoid spaces. While it can be difficult for clinicians to distinguish between these two anatomical locations, varying distribution of air seen on CT may indicate its location. Air within the subarachnoid space may be located both anterior and posterior to the spinal cord. Air confined to the epidural space may be seen to have a predominantly posterior and/or lateral distribution [3, 4]. This differentiation is important as the mechanism and causes of air entry are different and have different clinical implications [5]. Air in the epidural space is usually benign, while its presence in the subarachnoid space is commonly found in association with air within the cranial vault, basal skull fracture and dural tear, and is a marker of severe trauma.

Epidural pneumorrhachis

Epidural pneumorrhachis has numerous causes and these can be broadly divided into iatrogenic, non-traumatic and traumatic. Iatrogenic causes include the administration of epidural analgesia. Non-traumatic cases have been reported in association with degenerative disc disease, epidural abscess, synovial cysts and following spontaneous pneumomediastinum and pneumothorax. In traumatic cases pneumorrhachis is most commonly seen in association with pneumomediastium and/or pneumothorax but has also been reported secondary to pelvic and vertebral fractures and dural-enteric fistulae [6].

The mechanism whereby air enters the epidural space is a result of the fact that there is no true fascial envelope protecting the space [7]. Air may dissect along fascial planes from either the posterior mediastinum or retropharyngeal space, through the neural foramina and into the epidural space; this movement of air occurs down the pressure gradient caused by a pneumothorax or pneumomediastinum. This continuous pathway between the intervertebral foramina and the epidural space was first demonstrated in 1973 [8]. It has also been established that air may track along fascial planes between the retroperitoneum and mediastinum and thus the epidural space [9]. Therefore injury to abdominal viscera may also result in pneumorrhachis [10].

Epidural pneumorrhachis is usually benign. Identification of the underlying cause is important as its treatment will result in resolution of the intraspinal air. Criteria have been described that allow pneumorrhachis to be classified as benign, including: 1) major thoracic trauma, 2) substantial pneumomediastinum with extensive subcutaneous emphysema, 3) a small amount of epidural air, 4) air demonstrable only by CT scan, and 5) the air was an incidental finding on CT scan performed for an indication unrelated to the spine [11].

It is rare for epidural pneumorrhachis to cause neurological symptoms; the few reported cases are most often in the context of the administration of epidural analgesia. The volumes of air injected during the "loss of resistance technique" are much larger than those likely to enter the spinal canal as a result of a traumatic injury [5]. Clinicians should rule out other possible causes of neurological symptoms before attributing them to intraspinal air.

In cases of severe trauma consideration must be given that air may actually be present within the subarachnoid space.

Subarachnoid pneumorrhachis

Traumatic subarachnoid pneumorrhachis is a marker of severe injury. The most common reported causes are skull fractures and thoracic spine fractures and subarachnoid pneumorrhachis is almost always associated with pneumocephalus.

In the case of skull fracture air enters the subarachnoid space either directly from the atmosphere in the case of a fracture of the cranial vault or from an air containing cavity or sinus. Once inside the intracranial subarachnoid space the air is free to migrate to the spine through the foramen magnum, this usually occurs when the patient has been in the head or face down position [5].

Pneumocephalus may cause both general and focal neurological symptoms as a result of intracranial hypertension [12]. In addition there is the risk of meningitis as a breach in the dura may act as a portal of entry for bacteria.

Thoracic spine fractures may be associated with the formation of dural and pleural tears that may join to form a fistula. In penetrating trauma the missile may cause these tears directly; fistula formation has been reported in a case of gunshot injury to the chest [13]. In blunt trauma extreme flexion and compression of the thoracic spinal nerve roots and thoracic cage is felt sufficient to allow the formation of a fistula [14].

As with epidural air there is no specific treatment for subarachnoid pneumorrhachis and therapy is aimed at identifying and treating the underlying cause. Focussed investigation of the spinal column and base of skull should be considered. Consideration should also be given to closure of defects in the dura if such are present.

Anaesthetic considerations

Severely injured patients who are due to undergo surgery should not be exposed to anaesthetic techniques likely to increase the pressure or volume of intraspinal gas collections. Therefore the use of nitrous oxide should be avoided [15]. A high inspired fraction of oxygen may help to speed resolution of air pockets.

Air in the epidural space has been shown to cause the failure of attempted epidural analgesia [16]. There are no reports of the use of epidural anaesthesia in the provision of analgesia for injuries associated with pneumorrhachis however we found that good analgesia was obtained from a thoracic epidural inserted 24 hours after injury despite the initial presence of intraspinal air. It would, however, seem prudent to use a "loss of resistance to saline" rather than a "loss of resistance to air" technique.

Aeromedical evacuation considerations

The aeromedical transfer of patients with pneumocephalus has always caused some concern. Pneumorrhachis may not always be associated with pneumocephalus. In the case of intracranial air a recent study concluded that the mechanism causing pneumocephalus, its time course, progression, and the rate of altitude change are likely more important factors in determining its clinical significance [17], and this probably holds true for intraspinal air. Advice should be sought from those who will be responsible for the patient's in-flight care.

Conclusion

Pneumorrhachis, or intraspinal air, is a rare phenomenon. However with the early use of CT in the assessment of the

severely injured patient it is likely to be increasingly encountered. The early management of the precipitating cause underpins the management of pneumorrhachis. While in the majority of cases intraspinal air is benign and of little significance efforts must be made to identify those situations where the underlying cause may dictate that morbidity may be high.

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