Pneumocephalus following gunshot injury to the thoracic vertebral column: a case report

Torasik vertebra bölgesi ateşli silah yaralanmasından sonra oluşan pnömosefalus: Olgu sunumu

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Subarachnoid pleural fistula (SPF) following injury to the vertebral column is an extremely rare complication and is usually described after blunt trauma. We report the first case of SPF with pneumocephalus due to a gunshot wound to the spine.

Key Words: Gunshot; pneumocephalus; spine.

Vertebral kolon travmasını takiben subaraknoid plevral fistül (SAPF) oluşması ender görülen bir komplikasyondur ve genellikle künt travmadan sonra bildirilmiştir. Biz, ateşli silahla gerçekleşen bir omurga yarası nedeniyle oluşan pnömosefalusu bulunan ilk SAPF olgusunu sunuyoruz.

Anahtar Sözcükler: Ateşli silah; pnömosefalus; omurga.

The occurrence of a subarachnoid pleural fistula (SPF) following injury to the vertebral column with dural breach is an extremely rare complication, with a recent review article identifying only 40 such cases.[1] The authors of that review divided SPFs into two groups: SPF I (no pneumorachis or pneumocephalus) and SPF II (pneumorachis or pneumocephalus present). The latter group is rare and comprised only seven patients, only four of which had concomitant pneumocephalus. The common factor seen in that group was that they were all secondary to blunt trauma.

We report the first case of SPF with pneumocephalus due to penetrating chest trauma, and we propose an additional category to the aforementioned classification.

CASE REPORT

A 21-year-old man was admitted to the Trauma Center, Groote Schuur Hospital, Cape Town, having sustained multiple gunshot wounds. He had tangential entry and exit wounds over his left parietal area, two entry wounds on his back (on either side of the seventh thoracic vertebra) and one exit wound over his right anterior chest wall; the other bullet lodged in the subcutaneous tissues of his right chest. Three additional gunshots had made insignificant wounds to his upper and lower limbs. He was in shock with a systolic blood pressure of 90 mmHg and pulse rate of 110/min. His Glasgow Coma Scale score was 14. A thoracostomy tube was inserted for a large right-sided hemopneumothorax. There were no signs of tension pneumothorax prior to the placement of the thoracostomy tube. Peripheral neurological examination revealed a complete motor-sensory deficit distal to the fifth thoracic segment. A chest radiograph showed the intercostal drain with surgical emphysema and a resolving hemopneumothorax. Three hours post-injury, a computerized tomography (CT) of the brain was obtained, which revealed extensive pneumocephalus, despite an intact cranial vault (Fig. 1). CT imaging of the thoracic spine demonstrated the tract of the bullet as it traversed and shattered the seventh thoracic vertebra (Fig. 2). He developed a SPF with persistent cerebrospinal fluid (CSF) drainage though his thoracostomy tube. As the daily drainage was gradually decreasing, it was elected to treat the fistula conservatively. After three weeks,

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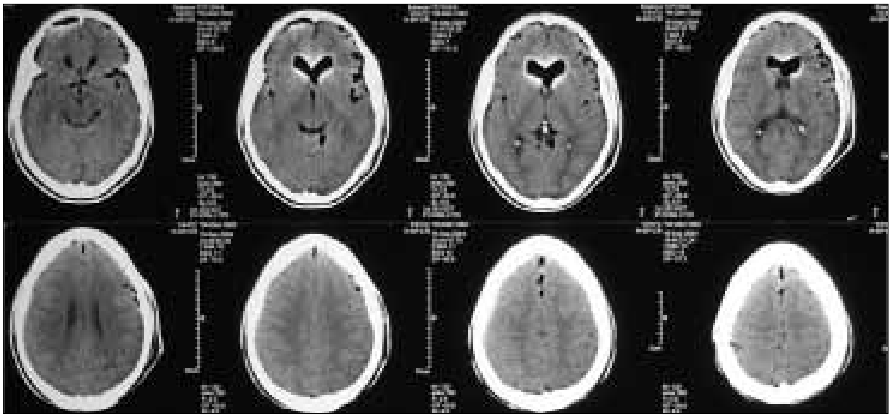

Fig. 1. CT scan of brain showing extensive pneumocephalus. Parietal slice (lower left) reveals extensive soft tissue swelling and break in the skin where the bullet tangentially traversed the soft tissue, without underlying bony fracture.

the drainage had reduced to less than 100 ml per day and the thoracostomy tube was removed without a dural repair being performed. CSF reaccumulated and partially filled his right hemithorax, but did not cause any symptoms. Weekly chest radiographs demonstrated that the fluid gradually resorbed over the following two months without reaccumulation. His bony vertebral injury was not repaired. He was eventually discharged to a chronic rehabilitation center after three months.

DISCUSSION

The imaging of choice for SPF is a CT myelogram, as it not only demonstrates the fistula but delineates it anatomically. It was not considered essential in this case because the CT of the thoracic spine and head performed in the trauma department, combined with the clinical findings, implied the diagnosis. Other techniques include myelography, magnetic resonance imaging and radioisotope imaging.

Although there is no one correct method of treatment, modalities can generally be classified as "expectant" or "operative". "Expectant" implies that the fistula itself is not surgically addressed and is allowed to seal spontaneously. Examples of this management would include no intervention, thoracostomy tube or thoracostomy tube with associated lumbar CSF tapping. This management is generally continued for three weeks and if the fistula does not appear to be resolving, the operative route is chosen. Operative treatments include primary repair of the dura, fascial

Fig. 2. CT scan of the shattered seventh thoracic vertebra, indicating tract of the bullet from the left to the right.

grafts, various types of flaps, and synthetic patches. Some surgeons may choose the operative route from the beginning but, due to the invasiveness of the procedure, the patient should be adequately informed regarding the choices of available treatment.

The causes of traumatic SPF broadly fall into two categories as blunt and penetrating. The predominant causes of blunt and penetrating injuries are motor vehicle accidents and gunshot injuries, respectively.[1] Other causes include iatrogenic and pathological causes. Common to all are three basic prerequisites for the formation of a traumatic pneumocephalus: There must be a breach in the dural membrane; the breach must be in contact with air, albeit temporarily; and lastly, the pressure gradient between the air and the CSF must favor the movement of air into the subdural space. The latter is extremely rare, as the pleural cavity pressure is usually subatmospheric, unless there is a tension pneumothorax.

Another factor decreasing the likelihood of this occurring is that the intra-thecal fluid is hyperbaric, varying between 60 to 250 mm of water.[2] This pressure does vary, however, depending on the level that the measurement is taken and the position of the patient. In the supine position of most trauma patients, the intra-thecal pressure at the level of the thoracic vertebrae is likely to be much lower. Furthermore, shock patients have a relatively lower intra-thecal pressure,[3] as CSF production drops by about 30% after sympathetic stimulation.[4]

Should the dural breach be large, as in a gunshot injury, it could be expected that the pressure of the CSF drops to zero, as it flows out of the defect. If the defect is in communication with air, even in the case of a simple pneumothorax, it can be seen that the above-mentioned factors could collectively contribute to the development of a pneumocephalus. With gunshot injuries in particular, however, the projectile itself can forcefully introduce air into the subdural space, especially if the shot was at close range. Furthermore, the shock wave that high energy projectiles are known to create is likely to cause a temporary hyperbaric situation when entering the thoracic cavity, which will further drive air into the subdural space.

Certain symptoms have been described (headache, nausea, vomiting, dyspnea and chest pain),[5] which should alert a clinician to the possibility of a traumatic pneumocephalus. These are often difficult to assess in acutely ill patients who are often intubated. It is proposed that any fractured thoracic vertebra associated with a pneumothorax should raise the level of suspicion to the possibility of this condition. This is particularly true if there is a tension pneumothorax or if the injury is secondary to a projectile.

There are currently no clear guidelines for the management of SPF. Liang et al.[1] proposed a classification that assists in the diagnosis and management of SPF. The classification, which defines two subgroups based on the absence (SPF I) or presence (SPF II) of concomitant subarachnoid air, may be useful, since the diagnosis, treatment and mortality of the two groups is different. Their literature review of all patients with SPF, however, demonstrated that the mechanism of injury in all SPF II cases was blunt trauma. The large amount of energy required to extend the thoracic vertebral column to the extent that dural and pleural tears occur may explain the high mortality rate in this group. Being a closed injury may also explain the higher incidence of tension pneumothorax (a proposed mechanism for the subarachnoid air). However, the unique case presented here does not fit in any of these categories. Although, by definition, it belongs in the SPF II group, the mechanism of injury is not blunt and as a consequence the mortality rate is likely to be similar to that of the SPF I group. Furthermore, there is no requirement for a tension pneumothorax to facilitate subarachnoid air in the case of a high energy projectile, as mentioned earlier in the discussion. We therefore propose that SPF II be subdivided into SPF IIa, in which the mechanism is blunt, and SPF IIb, in which the mechanism is penetrating. The latter is likely to have a mortality rate and demographics similar to SPF I and not necessarily require the presence of a tension pneumothorax for diagnosis.

Although this is the only reported case of pneumocephalus following a thoracic gunshot injury known to the authors, surgeons should be aware of this condition, particularly with the increasing incidence of gunshot injuries worldwide.

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