Hemopneumothorax associated with pneumorrhachis following blunt chest trauma

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Abstract

Pneumorrhachis is a condition marked by the presence of air in the spinal canal. We present a rare case of pneumorrhachis of the cervical to thoracic canal associated with hemopneumothorax and flail chest with subcutaneous emphysema that recovered remarkably after shaft clipping surgery and chest tube insertion only. Pneumorrhachis can resolve by itself with conservative management. A 45-year-old woman suffered from chest pain and shortness of breath after fell at the hotel swimming pool. Further examination revealed rhonchi on left lung auscultation and asymmetry respiratory pattern. Computed tomography of the chest proved the presence of multiple rib fractures 4-9 left side, hemopneumothorax, subcutaneous emphysema. Accidentally, the CT showed intraspinal gas representing pneumorrhachis extending from C6-T3. No neurologic deficit was found. She was treated conservatively by supplemental oxygen only, no further neurological deterioration was detected. Follow up examination was uneventful and the symptoms resolved completely. Pneumorrhachis was mostly found accidentally with a variety of underlying diseases, especially in the case of traumatic pneumothorax and fracture of the skull base. Pneumorrhachis was managed conservatively and should be taken in attention in the presence of neurologic deficits.

Keywords: *ribs fracture, pneumothorax, pneumorrhachis*

Introduction

Pneumorrhachis is a condition marked by the presence of air in the spinal canal. It was Gordon *et al.*, in 1988, who stated clearly the term of pneumorrhachis as the presence of intraspinal air.¹ It can be associated with trauma or non-trauma cases.² Usually, it is not associated with neurological deficit and not dangerous for the patient. It is usually found accidentally during a radiological examination. There is no established guideline for its treatment yet.³

Hemopneumothorax is a relatively common complication of multiple ribs fracture because of blunt chest trauma. The fracture of ribs can tear several blood vessels and cause blood accumulation in intrathoracic cavity.^{4,5} However, blunt chest trauma associated with pneumorrhachis is a rare entity.¹⁻³ It is still unclear how free air can trap in the spinal canal because of chest injury.⁶⁻⁸ In this article, we present a rare case of pneumorrhachis of the cervical to thoracic vertebra canal, associated with hemopneumothorax and flail chest. We will discuss the possible mechanism of how free air can be trapped inside the spinal canal after blunt chest trauma. This case report is arranged based on the Surgical Case Report (SCARE) criteria.

Case Report

A 45-year-old woman with a history of left side multiple rib fractures with hemopneumothorax after fell at the hotel swimming pool. Vital sign examination found blood pressure 96/64 mmHg, respiratory rate 28 times/minute, heart rate 92 times per minute, O₂ saturation 98% on

Cite this article:

Mardhika PE, Mahadewa TGB, Aryanti C.
Hemopneumothorax associated with pneumorrhachis following blunt chest trauma.
Neurologico Spinale Medico Chirurgico.2019;2(2):
33-36. DOI:10.36444/nsmc.v2i2.10

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10 liters/minute on a non-rebreathing mask. General physical examination revealed rhonchi on auscultation of left lung and asymmetry respiratory pattern or flail chest. Neurologic examination was normal. There was no sign of lateralization with perfect motoric and sensory status.

Computed tomography of the chest showed multiple rib fractures of 4th to 9th costae of the left side, hemopneumothorax, subcutaneous emphysema and pneumorrhachis extending from C6 -T3 (Figure 1A, 1B, 2A). The patient undergone shaft clipped on 4th to 9th costae of left ribs and chest tube placement by a thoracic surgeon (Figure 2B). Pneumorrhachis was treated conservative by supplemental oxygen only, no further neurological deterioration was detected. The patient was discharged on day 14th with complete recovery.

Fig 1. (A) Cervical CT Scan (axial view) and (B) coronal view showing subcutaneous emphysema on the left side and pneumorrhachis intracanal of C7-T1

Fig 2. (A) Sagittal view showing pneumorrhachis extending from C6 - T3. (B) Post shaft clipping surgery of left 4 - 9 ribs and chest tube insertion

Discussion

Pneumorrhachis is defined as free air in the spinal canal, resulting from chest trauma, head trauma, epidural injections, spinal surgery, endoscopic retrograde cholangiopancreatography (ERCP) and/or occurred iatrogenically. Pneumorrhachis had several definitions (pneumocoele, pneumatosis, emphysema, aerorachia, pneumosaccus, air myelogram) before Gordon and Hardman (1977) describe the fixed term “pneumorrhachis”.¹ About less than 80 case reports have been published worldwide, while many articles are not available online and not all were caused by traumatic pneumothorax (Table 1).^{1,3,7-19}

Pneumorrhachis can be classified into internal and external. The internal pneumorrhachis is defined as the finding of air in the intradural space (subdural or subarachnoid), while the external pneumorrhachis

is defined as the finding of air in the extradural space (intraspinal and epidural).^{2,13} In the extradural type, the absence of fascial barrier between the posterior mediastinum and neck causes migration of air from intervertebral foramina into the spinal canal.²⁰⁻²² In intradural type, air dissects the interstitial space which surrounding the nerves and vessels through neural foramina or neurovascular sheaths.²³ Specifically in pneumothorax, the marked increase in intra-alveolar pressure could cause alveolar rupture, which allows the air to pass along the bronchovascular axis up to the mediastinum.¹⁶ The air then travelled along mediastinal pleura, then intervertebral foramina, and enter the dural space.²⁴ The leakage of gas to the spinal canal can result in the negative pressure intradiscal, which could lead to further recruitment of gas in the disc space.²⁵ Moreover, presented air in the spinal canal can move to the cranium, thus leading to pneumocephalus.²⁶

The most common location for pneumorrhachis to occur was at cervical, followed by thoracic, lumbar, then sacral.⁹ However, the location of air accumulation in spinal canal depends on the site, rate, and volume of air dissection, also the positioning of the patient. If free air was found at intradural, the pathomechanism usually was more severe, while if the air was only located extradural, the patient was usually better preserved clinically, and was usually not associated with pneumocephalus. The extradural air was often reabsorbed to the deeper structure.²⁷ The symptomatic case could cause spinal cord compression, mostly in trauma cases.

Pneumorrhachis is primarily a radiographic diagnosis since it usually provide no specific clinical symptoms. The standardized treatment guideline was not existed until now. Patients with pneumorrhachis are usually managed conservative with cervical collar and supplemental oxygen showed promising results, even in the case with complication.¹¹ Oxygen therapy was used with the concept that oxygen induces air absorption, as previously reported.²⁸ The presence of intracranial injuries was suggested to have antibiotics prescription to prevent secondary infection.³ In fact, the treatment was primarily aimed at addressing the primary disease.²

Based on our analysis, the presence of pneumorrhachis usually accompanied by calvaria or skull base fracture. As we can see in Table 1, all the reported pneumorrhachis case were accompany by pneumocephalus. The etiology of all case were either calvaria, skull base, sinus fracture, or combination of them. The fracture line may provide entry point for free air and manifest as pneumocephalus. The pneumocephalus somehow make their way into the spinal canal and manifest as pneumorrhachis. However, in this case, the patient had blunt chest injury and accidentally we found pneumorrhachis from CT scan examination. Several authors have reported 6 similar case of pneumorrhachis following blunt chest trauma but there is no further explanation about it.¹⁹ There were others 5 cases about pneumorrhachis with pneumothorax as its underlying cause, however, no full text was available online. The intraspinal gas has the same low CT scan density with other gases must be clearly differentiated from gas

Table 1. Published case reports of pneumorrhachis occurred due to a traumatic fracture of brain skull and traumatic pneumothorax

Author	MOI	Etiology	Location	Symptoms	Treatment	Outcome
Associated with traumatic fracture of brain skull						
Gordon et al. (1977) ¹	Motor vehicle accident	Open skull fracture	Pneumocephalus and pneumorrhachis of the cervical region	Decerebrate	Details not available	Death
Yip, et al. (1990) ⁷	Motor vehicle accident	Bifrontal and frontal sinus fractures	Pneumocephalus and pneumorrhachis of the cervical	None	Antibiotics	Resolution
Sinha and Mantle (2000) ⁸	Motor vehicle accident	Multiple skull base fractures, intracerebral hemorrhage, otorrhea	Pneumocephalus and pneumorrhachis of the cervical	Coma	Ventilator support	Death
Inamasu, et al. (2002) ⁹	Motor vehicle accident	Temporal bone fracture and dural tear	Pneumocephalus and pneumorrhachis of the cervical	None	CSF lumbar drainage	Resolution
Çaylı, et al. (2003) ¹⁰	Fall/Trauma	Mastoid fracture with otorrhea	Pneumocephalus and pneumorrhachis of the cervical	None	Antibiotics and lumbar drainage	Resolution
Yousaf, et al. (2003) ¹¹	Fall	Temporal bone fracture and epidural hematoma	Pneumocephalus and pneumorrhachis of the cervical	Radicular pain	Collar brace	Resolution
Chibbaro, et al. (2005) ¹²	Motor vehicle accident	Mastoid cavity fracture	Pneumocephalus and pneumorrhachis of the cervical	None	None	Resolution
Chaichana, et al. (2010) ³	Motor vehicle accident	Bilateral mastoid and sphenoid wing fractures	Pneumocephalus and pneumorrhachis of the cervical region (C2-7)	None	Antibiotics and oxygen	Resolution
Arora, et al. (2011) ¹³	Assault	Fracture of the cribriform plate of ethmoid bone	Pneumocephalus and pneumorrhachis of the cervical region and emphysema	None	Antibiotics and oxygen	Resolution
Associated with pneumothorax						
Yanagawa et al. (2007) ¹⁴	Automobile accident	Ribs fracture, extremities bone fractures, cervical root avulsion injury, pneumomediastinum	Pneumorrhachis of C5-T1	Loss of consciousness	Artificial ventilation (intubation)	Resolution
Pangtey et al. (2008) ¹⁵	Barotrauma	Spontaneous pneumothorax and pneumomediastinum	Pneumocephalus and pneumorrhachis of the lumbar (L2-3)	Chest tightness and shortness of breath	None	Resolution
Ould-Slimane et al. (2010) ¹⁶	Motor vehicle accident	Pneumothorax, pneumomediastinum, T7-8 transverse process fracture	Pneumocephalus and pneumorrhachis of the thoracic region T7-8	Vertebral pain, neurological deficits	Spinal osteosynthesis and oxygen	Resolution
Botchu et al. (2012) ¹⁷	Automobile accident	Pneumothorax	Pneumorrhachis of the cervicothoracic region	None	None	Resolution
Ghafarzad et al. (2014) ¹⁸	Motor vehicle accident	Ribs fracture, hemothorax, pneumothorax, lumbar vertebra fracture in L2-4	Pneumocephalus and pneumorrhachis of the lumbar region L2-L4	Low back pain and dyspnea	Laminectomy and cord compression Oxygen	Resolution
Kaloregrakos et al. (2017) ¹⁹	Motor vehicle accident	Ribs fracture, hemothorax, T10 vertebral body fracture	Pneumorrhachis of the thoracolumbar region	Right-sided chest pain	Therapeutic tube insertion	Resolution
Present case	Fall	Rib fractures 4-9 left side	Subcutaneous Emphysema and Pneumorrhachis C6-T3	None	Shaft Clipping and chest tube	Resolution

due to infective, degenerative, malignancy, and inflammation.²⁹ The management of this case was done conservatively while the treatment was focused on correcting the underlying or primary cause, thus the ribs fracture with shaft clipping. Other studies also reported that pneumorrhachis could be managed conservatively. In concordance with this study, pneumorrhachis will resolve spontaneously by diffusion.³⁰ In most cases, air tends to reabsorb completely into the blood without significant recurrence.

The present report aimed to increase awareness about the possi-

bility of pneumorrhachis occurrence, especially in traumatic pneumothorax. Although it was asymptomatic and self-limiting, the presence should alert the attending physician to pay more attention, by treating the underlying cause before it leads to neurologic deficits.

Conclusion

Pneumorrhachis was mostly found accidentally with variety of underlying disease, especially in the case traumatic pneumothorax and fracture of skull base. Pneumorrhachis was managed conservatively

and should be taken in attention in the presence of neurologic deficits.

Acknowledgement

None.

References

- Gordon IJ, Hardman DR. The traumatic pneumomyelogram. A previously undescribed entity. *Neuroradiology*. 1977;13(2):107-8. DOI: 10.1007/BF00339843.
- Oertel MF, Korinth MC, Reinges MHT, et al. Pathogenesis, diagnosis and management of pneumorrhachis. *Eur Spine J*. 2006;15(5):636-43. DOI: 10.1007/s00586-006-0160-6.
- Chaichana KL, Pradilla G, Witham TF, et al. The clinical significance of pneumorrhachis: a case report and review of the literature. *J Trauma*. 2010;68(3):736-44. DOI: 10.1097/TA.0b013e3181c46dd3.
- Belotti EA, Rizzi M, Rodoni-Cassis P, et al. Air within the spinal canal in spontaneous pneumomediastinum. *Chest*. 2010;137(5):1197-200. DOI: 10.1378/chest.09-0514.
- Charlotte G, Chah'era K, Jean-François C, et al. Spontaneous Pneumomediastinum Associated with Pneumorrhachis. *Am J Respir Crit Care Med*. 2014;189:11-9. DOI: 10.1164/rccm.201305-0900IM.
- Newbold RG, Wiener MD, Vogler JB, et al. Traumatic pneumorrhachis. *AJR Am J Roentgenol*. 1987;148:615-6. DOI: 10.2214/ajr.148.3.615.
- Yip L, Sweeny PJ, Mccarroll KA. The traumatic air myelogram. *Am J Emerg Med*. 1990;8(4):332-4. DOI: 10.1016/0735-6757(90)90089-I.
- Sinha PA, Mantle M. Cervical pneumorrhachis. *Clin Radiol*. 2000;55:569-70. DOI: 10.1053/crad.1999.0099.
- Inamasu J, Nakamura Y, Saito R, et al. Air in the spinal canal after skull base fracture. *Am J Emerg Med*. 2002;20(1):64-5. DOI: 10.1053/ajem.2001.29554.
- Cayli SR, Koçak A, Kutlu R, et al. Spinal pneumorrhachis. *Br J Neurosurg*. 2003;17(1):72-4. DOI: 10.3109/02688690309177976.
- Yousaf I, Flynn P, McConnell R. Symptomatic intraspinal pneumocele resulting from closed head injury. *Br J Neurosurg*. 2003;17(3):248-9. DOI: 10.1080/0268869031000153143.
- Chibbaro S, Selem M, Tacconi L. Cervicothoracolumbar pneumorrhachis. Case report and review of the literature. *Surg Neurol*. 2005;64(1):80-2. DOI: 10.1016/j.surneu.2004.09.047.
- Arora S, Aggarwal P, Cheema GS, et al. Pneumorrhachis of the cervical spine with associated pneumocephalus and subcutaneous emphysema. *Indian J Orthop*. 2011;45(4): 372-5. DOI: 10.4103/0019-5413.82346.
- Yanagawa Y, Takasu A, Sugura T, et al. A case of cervical pneumorrhachis induced by the combination of pneumomediastinum and root avulsion injuries. *Eur Spine J*. 2007;16(4): 573-4. DOI: 10.1007/s00586-006-0236-3.
- Pangtey GS, Das CJ, Javan N. Airlessness in airspace. Simultaneous occurrence of spontaneous pneumothorax with pneumomediastinum. *Surg Today*. 2008;38(1):49-51. DOI: 10.1007/s00595-007-3556-y.
- Ould-Slimane M, Etori A, Lazennec JY, et al. Pneumorrhachis: a possible source of traumatic cord compression. *Orthopaedics & Traumatology: Surgery & Research*. 2010;96(7): 825-8. DOI: 10.1016/j.otsr.2010.03.024.
- Botchu R, Shah R, Burli P. Epidural emphysema following blunt trauma: A case report and review of literature. *Iowa Orthop J*. 2012; 32: 224-6. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3565407/pdf/IOJ_2012_224.pdf
- Ghafarzad A, Tagizadieh A, Moharamzadeh P, et al. Thoracic Pneumorrhachis in Patient with Lumbar Fractures; a Case Report. *Emerg*. 2014 Spring;2(2):98-100. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4614588/pdf/emerg-2-098.pdf>
- Kalgoreakos PD, Lazopoulos G, Palioudakis S, et al. Pneumorrhachis associated with persistent tachycardia after blunt thoracic trauma. *Asian Cardiovascular & Thoracic Annals*. 2017;0(0):1-3. DOI: 10.1177/0218492317717421.
- Gonzales GR, Payne R, Portenoy RK. Epidural air from a bronchopleural-epidural-cutaneous fistula producing reversible myelopathy and radiculopathy symptoms. *Neurology*. 1994;44:2409-10. DOI: 10.1212/wnl.44.12.2409.
- Goh BK, Yeo AW. Traumatic pneumorrhachis. *J Trauma*. 2005;58:875-9. DOI: 10.1097/01.TA.0000158249.77176.9A.
- Dwarkanath S, Banerji A, Chandramouli BA. Post-traumatic intradural pneumorrhachis: A rare entity. *Indian J Neurotrauma* 2009;6:151-2. DOI: 10.1016/S0973-0508(09)80012-9.
- Manden PK, Siddiqui AH. Pneumorrhachis, pneumomediastinum, pneumopericardium and subcutaneous emphysema as complications of bronchial asthma. *Ann Thorac Med*. 2009;4:143-8. DOI: 10.4103/1817-1737.53352.
- Krasoudakis A, Marathianos S, Tsiminikakis N, et al. Intraspinal air after blunt thoracic trauma. *J Indian Assoc Pediatr Surg*. 2006;11:248-9. DOI: 10.4103/0971-9261.29612.
- Al-Mufarrej F, Gharagozloo F, Tempesta B, et al. Spontaneous cervicothoracolumbar pneumorrhachis, and pneumoperitoneum. *Clin Respir J*. 2009;3(4):239-43. DOI: 10.1111/j.1752-699X.2008.00116.x.
- Ristagno RL, Hiratzka LF, Rost RC Jr. An unusual case of pneumorrhachis following resection of lung carcinoma. *Chest*. 2002;121:1712-4. DOI: 10.1111/j.1752-699X.2008.00116.x.
- Lerner DJ, Potturi N, Beteselassie N, et al. Pneumorrhachis. *Kansas Journal of Medicine*. 2014;171-5. DOI: 10.17161/kjm.v7i4.11508.
- Prabhakar H, Bithal PK, Ghosh I, et al. Pneumorrhachis presenting as quadriplegia following surgery in the prone position. *Br J Anaesth*. 2006;97:901-3. DOI: 10.1093/bja/ael305.
- Adams MT, Nadalo L, Dunn EL. Air in the spinal canal following blunt thoracic trauma. *J Trauma*. 2003;55(2):386. DOI: 10.1097/01.TA.0000037744.83060.51.
- Aribas OK, Gormus N, Kiresi DA. Epidural emphysema associated with primary spontaneous pneumothorax. *Eur J Cardiothorac Surg*. 2001;20:645-6. DOI: 10.1016/S1010-7940(01)00851-X.

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