Case study

Post-traumatic pulmonary pneumatoceles, a case report

ABSTRACT

Road accidents are the leading cause of serious injuries worldwide, accounting for more than 10% of trauma cases resulting in death or significant physical impairment. Thoracic injuries are responsible for a quarter of all trauma-related deaths, and two-thirds of these deaths occur after the patient has been admitted to the hospital. Management depends on the nature of the injuries, their mechanism, their size, and the patient's hemodynamic stability.

Recognizing these injuries quickly can save lives, whether the patient is outside or in a modern intensive care unit.

The reported case is an 8-year-old female child with no particular medical history, no delayed growth or development, who was involved in a public road accident with a thoracic impact. She presented with hemoptysis and chest pain, and a thoracic CT scan revealed bilateral pulmonary parenchymal contusions predominantly on the right, with post-traumatic pneumatoceles on the right side and a right pneumothorax blade, with good progress under surveillance, oxygen therapy, and prophylactic antibiotic treatment.

Keywords: pneumothorax, pneumatocele, pulmonary contusion, pulmonary laceration.

1. INTRODUCTION:

Blunt thoracic trauma usually occurs as part of polytrauma resulting from a road accident, and thoraco-pulmonary injuries are a major cause of trauma-related deaths, responsible for 25% of all post-traumatic fatalities. The accumulation of air in the pleural cavity (pneumothorax) is the most common potentially life-threatening injury in cases of blunt thoracic trauma [1].
The correct diagnosis of post-traumatic injuries relies on a comprehensive understanding of the various clinical and radiological manifestations [2]. While the low sensitivity and specificity of chest radiography compared to CT scan are well known, a chest X-ray in dorsal decubitus position is still systematically performed upon patient admission to urgently identify any pleural or air effusion that requires drainage.

2. PRESENTATION OF CASE:

We present a clinical case with the written consent of the patient. The patient is an 8-year-old female child, with no consanguinity or significant medical history, who was the victim of a road traffic accident with thoracic impact (pedestrian hit by a vehicle).
The clinical examination revealed a conscious and well-oriented child, afebrile, with normal conjunctivas, tachypneic at 52 cycles per minute, tachycardic at 122 beats per minute, and a

saturation of 91% on room air, with thoracic asymmetry due to right hemothorax distension, decreased right thoracic expansion, decreased transmission of vocal vibrations and vesicular murmurs on the same side, and tympany on percussion, while the rest of the examination was unremarkable.
The chest X-ray showed interstitial syndrome predominantly on the right side [Fig. 1], while the thoracic CT scan revealed bilateral pulmonary parenchymal contusions predominantly on the right side, with post-traumatic pneumatoceles on the right side and a right pneumothorax blade [Fig. 2].

The cerebral, thoracic, and abdomino-pelvic scan did not find any other lesions.

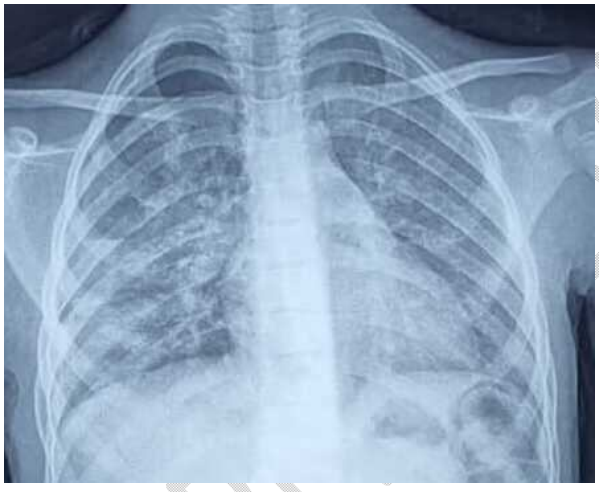

Fig. 1. The chest X-ray showed interstitial syndrome predominantly on the right side.

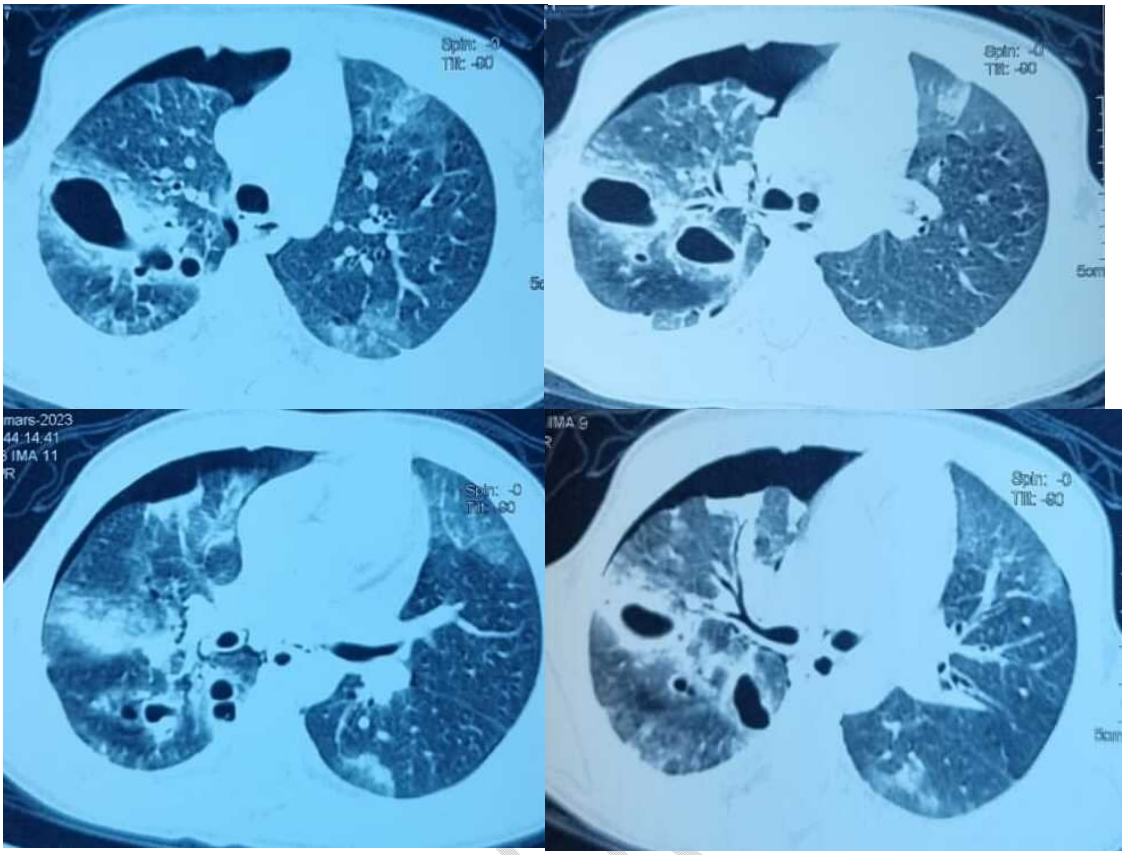

Fig. 2. (a.b.c.d). The thoracic CT scan revealed bilateral pulmonary parenchymal contusions predominantly on the right side, with post-traumatic pneumatoceles on the right side and a right pneumothorax blade .

The patient was put on oxygen therapy with preventive antibiotic treatment to avoid infection (amoxicillin protected for 10 days). After 72 hours of hospitalization, the patient's condition improved. A follow-up chest x-ray [Fig. 3] and CT scan [Fig. 4] conducted one month after the accident showed radiological improvement with the dissipation of lung lesions.

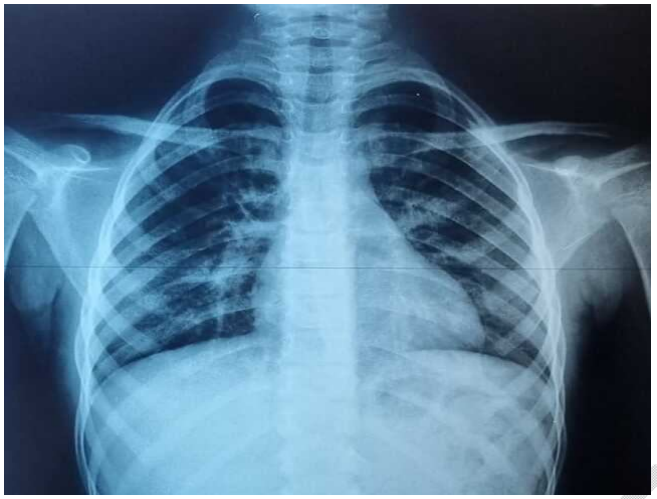

Fig. 3. The chest X-ray conducted one month after the accident showed radiological improvement.

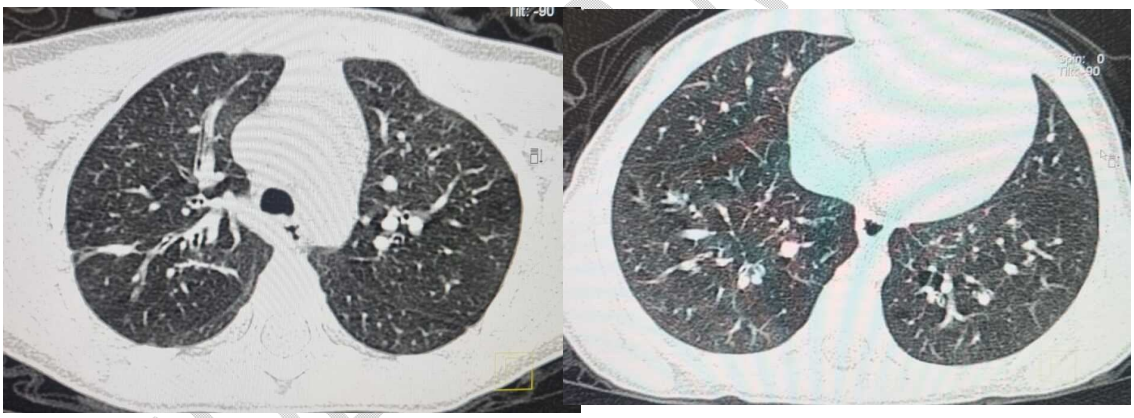

Fig. 4. (a.b). The chest CT scan performed one month after the accident showing the disappearance of pneumothorax and pneumatoceles.

3. DISCUSSION:

Most thoracic traumas are related to road accidents. These injuries are closed in 90% of cases and are mainly related to deceleration forces during impact [3]. There is no correlation between the severity of parietal and visceral injuries [4], and age plays a special role in the transmission of forces after trauma. The thoracic skeleton is flexible and deformable in children and young adults, so rib fractures are less common, with a higher frequency of associated visceral injuries [5]. In contrast, in elderly people, rib fractures are frequent and absorb part of the energy of the trauma.

A chest X-ray in the dorsal decubitus position remains a routine procedure upon admission of the patient to look for any urgent need to drain air or pleural effusion. Thoracic computed tomography is indicated for a stable or stabilized patient because 30-50% of small pneumothoraces in traumatized patients are missed on a frontal radiographic image, and it is by far the most sensitive technique for detecting low-volume pneumothoraces.

After thoracic trauma, several parenchymal injuries are possible, ranging from contusion, pulmonary laceration, pneumothorax, or post-traumatic pneumatocele.

A pneumothorax occurs in 30-40% of patients with thoracic trauma. It occurs twice as often in closed traumas as in penetrating traumas. It is frequently associated with severe extra-thoracic injuries and can be related to alveolar compression in crush injuries, pulmonary lacerations, or barotrauma.

Hemorrhagic pulmonary contusions are the most common lung injuries in closed traumas. They are found in 17-70% of patients with severe trauma. They are one of the main factors of morbidity and mortality in thoracic trauma. The incidence of mortality varies from 14 to 40%, depending on the severity of the lesions and the presence of associated injuries. Clinical signs are variable, sometimes minimal, with classic initial underestimation of the injury. Abnormalities appear 4-6 hours after trauma in over 70% of cases [6-7], and always within 24 hours. The rupture or injury of small vessels and the alveolocapillary membrane leads to extravasation of blood and edema in the interstitium and alveolar spaces. The extent of parenchymal damage depends on the severity of the trauma.

Contusions are frequently masked by atelectasis, inhalation phenomena, or hemothorax on standard radiographs. The lesion can be unifocal, multifocal, or diffuse in one or both lungs. The appearance is that of homogeneous, non-segmental opacities, preferably located near fractured or non-fractured rib and vertebral structures. An air bronchogram is rare due to bronchial obstruction caused by secretions or blood. A contusion can favor the occurrence of lobar torsion during pleural drainage. Differential diagnosis of contusions is only considered in diffuse forms. It can be pulmonary edema of overload, inhalation of blood from the ORL sphere or gastric fluid, or neurogenic pulmonary edema after head trauma. In this latter case, the apical predominance of opacities should be emphasized [8]. The resolution of uncomplicated contusions is rapid, superior to 72 hours in most cases, with restitution after 1-2 weeks. The absence of progressive regression after 7-8 days, or even worsening of the lesion, should suggest a co-associated pathology such as infection, pulmonary edema, or acute respiratory distress syndrome.

The presence of air or aero-fluid cavities in the lung parenchyma indicates lung laceration. Lung lacerations are a consequence of more severe closed traumas. They are the result of tearing and can be caused by pleural or pulmonary perforation, rib fractures, or deceleration. They are generally associated with hemoptysis and hemothorax. Often associated with pulmonary contusions, they are often not recognized in the initial X-rays due to perilesional bleeding. Lung lacerations are generally benign and resolve in 3 to 5 weeks. However, in case of mechanical ventilation, a post-traumatic pneumatocele may quickly become larger and persist for months. A direct connection of the laceration with a bronchus or pleura determines a bronchopleural fistula with a pneumothorax or hemothorax. Limited thoracic expansion with reduced pulmonary compliance and possible intubation also favors the onset of infection or abscess.

Several diagnostic hypotheses exist regarding the mechanisms that create this laceration:

The first hypothesis [9] postulates that a shock wave in the lung parenchyma generates shear forces. This wave is caused by the transmission of trauma through the thoracic wall, which explains the higher frequency of this type of injury in young subjects and its lower frequency at the top of the lung where the thoracic cage is less flexible.

The second hypothesis [10] suggests that the compression of a lung segment, as well as the compression of the corresponding segmental bronchus, can lead to increased alveolar pressure and subsequent rupture of interalveolar septa.

Finally, the third hypothesis [11] suggests that chest compression with a closed glottis can create increased pressure in the tracheobronchial tree.

Pneumatoceles are rare lesions but are increasingly detected after thoracic trauma thanks to thoracic CT scan. They are characterized by a round or oval shape, a thin and regular wall, and a preference for paramediastinal and laterovertebral locations [12].

The violence of the trauma and the delay in the appearance of the lesions are very variable, which can make diagnosis difficult [13]. Pneumatoceles mostly affect children and young adults. Clinical symptoms are poor and nonspecific, with hemoptysis being the most frequently encountered sign, followed by chest pain, dyspnea, cyanosis, or cough. The most likely etiopathogenesis in the traumatic context would be that of bronchiolar rupture during direct chest wall impact on lung parenchyma (crushing forces) [14], on the one hand, and during sudden lung decompression on a soft and elastic chest (young patient ++) with bronchiolar tears (shearing forces), on the other hand. Chest X-ray may show a pseudo-cystic image, single or multiple, located within an alveolar condensation zone related to lung contusion. The presence of other traumatic lesions (rib fractures, hemothorax, and pneumothorax) helps to orient the diagnosis. CT scan remains the reference examination for the detection of these lung lacerations and the assessment of lesion extension (bones, parenchyma, and cardio-mediastinal structures).

Hemato-pneumatocoele is characterized by oval hydro-aerous lesions with thick walls, more or less confluent, surrounded by areas of ground-glass opacity (intra-alveolar hemorrhage) due to hemorrhagic lung lacerations. The evolution of pneumatocele is usually favorable with symptomatic treatment between four to twelve weeks, with a return to the previous parenchymal state. Simple radiological monitoring is sufficient in the absence of complications [15], which are dominated by superinfection. Systematic antibiotic prophylaxis has been discussed [17] but appears to be ineffective. Treatment by CT-guided drainage is indicated in the case of a single infected pseudocyst, while surgical excision is to be considered if the pseudocysts are multiple or not drainable [18].

Understanding the diagnostic hypotheses of the various possible pulmonary lesions is critical in the evaluation of patients with thoracic trauma, as an accurate diagnosis can help guide appropriate treatment and improve outcomes.

4. CONCLUSION:

Thoracic trauma accounts for approximately 25% of post-traumatic deaths, with many thoracic injuries causing death within the first few minutes or hours after trauma. However, many of these injuries can be treated at the patient's bedside with definitive or temporary measures that do not require advanced surgical training. The CT management of thoracic trauma is part of a broader approach to polytrauma. A technical and interpretive rigor ensures a comprehensive study, preventing potentially serious injuries from being overlooked in this context.

5. REFERENCES:

1- H. Wilson, J. Ellsmere, J. Tallon, A. Kirkpatrick ,Occult pneumothorax in the blunt trauma patient: tube thoracostomy or observation , Injury, 40 (2009), pp. 928-931.
2- Zinck SE, Primack SL. Radiographic and CT findings in blunt chest trauma. J Thorac Imaging 2000;15:87-96.
3- Groskin SA. Selected topics in Chest trauma. Radiology 1992; 183: 605-17.
4- Bléry M, Lacombe P, Jachenod P et al. Traumatismes fermés de la paroi thoracique. In: Editions techniques. Encycl. Méd. Chir. Elsevier. Paris; Radiodiagnostic, II 31035 A10, 1987: 1-7.
5- Balci AE, Kazez A, Eren S, Ayan E, Ozalp K, Eren MN. Blunt thoracic trauma in children: review of 137 cases. Eur J Cardiothorac Surg 2004;26:387-92.
6- Erickson DR, Shinozaki T, Beekman E, Davis JH. Relationship of arterial blood gases and pulmonary radiographs to the degree of pulmonary damage in experimental pulmonary contusion. J Trauma 1971;11:689-94.
7- Stevens E, Templeton AW. Traumatic nonpenetrating lung contusion. Radiology 1965;85:247-52.
8- Lacombe P, El Hajjam M, Beigelman-Aubry C, Pelage JP, Giron J, Schnyder P. Traumatismes fermés du thorax. Pathologie traumatique et iatrogène. In : Grenier P, editor. Imagerie thoracique de l'adulte. 3e éd. Paris : Flammarion ; 2006. Chapitre 26.
9- Kato R, Horinouchi H, Maenaka Y. Traumatic pulmonary pseudocyst. J Thorac Cardiovasc Surg 1989; 97:309—12.
10- Fagan CJ. Traumatic lung cyst. AJR 1966; 97:186—94.
11- Nielsen G, Gronmark T. Traumatic cyst of the lung injury. Injury 1975;6:241—3.
12- Roux P, Fisher RM. Chest injuries in children: an analysis of 100 cases of blunt chest trauma from motor vehicle accidents. J Pediatr Surg 1992; 27:551—5.
13- Desrues B, Delaval P, Motreff C, et al. Pneumatoce`les et he´mato-pneumatoce`les post-traumatiques du poumon. Rev Mal Respir 1998;5:67–70.
14- Quigley MJ, Fraser RS. Pulmonary pneumatocele: pathology and pathogenesis. AJR 1988;150:1275–375.
15- Ayuso JR, Ares J, Vilana R, Salvador A. Traumatic lung cyst. Can Assoc Radiol J 1989;40:147–55.
16- Moore FA, Morre EE, Haenel JB, et al. Post traumatic pulmonary pseudocyst in the adult: pathophysiology, recognition and selective management. J Trauma 1989; 29: 1380–5.
17- Schimpl G, Schneider U. Traumatic pneumatoceles in an infant: case report and review of the literature. Eur J Pediatr Surg 1996;6:104–6.