msj Medicine & Science Journal

Medicine & Science Journal 2023; 1(1):e202334
https://doi.org./10.53150/msj.v1i1.34

CASE REPORT

Blunt chest trauma associated with bronchial rupture and cerebral air embolism. A case report.

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Keywords: pediatric blunt chest trauma, bronchial rupture, tracheo-bronchial injuries, cerebral air embolism

Abstract

Thoracic injuries following blunt chest trauma represent a significant cause of morbidity and mortality in the pediatric population. Airway injuries, such as tracheal and bronchial rupture are quite rare with an incidence of 1-3%. We present the case of a 17-year-old girl victim of major trauma after an intentional fall from a height of 12 meters who reported subcutaneous emphysema, bilateral pulmonary contusions, a slight apical left pneumothorax and massive pneumomediastinum. Following cardio-respiratory stabilization a flexible bronchoscopy was performed. The complete avulsion of the left superior bronchus was found. Urgent thoracic surgery was performed obtaining the complete pulmonary recovery. Subsequent total body Computed Tomography (CT) control documented a large area of cortical-subcortical ischemia in the left parieto-occipital lobe. Cerebral Magnetic Resonance Imaging (MRI), performed on day 6, confirmed the findings and therefore cerebral air embolism was hypothesized. Following surgery and lung recovery patient regained consciousness and consequently discharged without any neurological or respiratory sequelae. Systemic Air Embolism (SAE) should always be suspected in case of chest trauma, especially if pneumomediastinum or pneumothorax are present and associated with neurological signs or Cerebral CT scan abnormalities. Tracheal and bronchial lesions should always be investigated and treated surgically as soon as possible in case of airway instability and/or respiratory failure.

Received: March 19, 2023
Revised: March 24, 2023
Accepted: March 28, 2023
Published: May 03, 2023

Article information are listed at the end of this article.

1.Introduction

Thoracic injuries following blunt chest trauma (rib fractures, lung contusion, pneumothorax and hemothorax) represent a significant cause of morbidity and mortality in the adult and in the pediatric population [1]. Airway injuries as consequence of blunt thoracic trauma, such as tracheal and bronchial rupture are quite rare. In the adult population its incidence ranges from 1 to 3% while in the pediatric population the incidence does not reach the 1%. Scientific literature regarding pediatric airway injuries after blunt chest trauma is represented mainly by reports from clinical experience probably due to the event rarity. Unfortunately, this kind of traumatic lesion is accompanied with a very high mortality rate. It is estimated that only 30% of the patients are alive at the hospital arrival [2,3]. Clinical presentation of bronchial injury may range from clear manifestations as tension pneumothorax, massive subcutaneous emphysema to less obvious manifestations as pneumomediastinum [4]. Considering its lethality, early recognition and diagnosis of traumatic tracheobronchial injuries are crucial for the patient's care and survival.

2.1 Bronchial rupture in blunt chest trauma

We present the case of a 17-year-old girl victim of major trauma after an intentional fall from a height of 12 meters. In the pre-hospital phase, patient was found with a Glasgow Coma Scale of 9 (GCS: bilateral M5V3E1) and severe cardio-respiratory instability (Blood pressure <80/50; Heart rate >150, Oxygen saturation 75%). Clinical examination reported blunt thoracic trauma with evidence of left pneumothorax. Patient stabilization was performed through crystalloid administration, pelvic binder placement, percutaneous left pneumothorax decompression before sedation and endotracheal intubation. The patient arrived at the emergency department 30 minutes after the trauma under stable condition. Immediately after the hospital arrival the patient underwent a whole-body CT-scan that showed subcutaneous emphysema, bilateral pulmonary contusions, a slight apical left pneumothorax and pneumomediastinum, fracture of the right sacral wing. First head CT scan resulted negative (**Panel 1**).

Panel 1

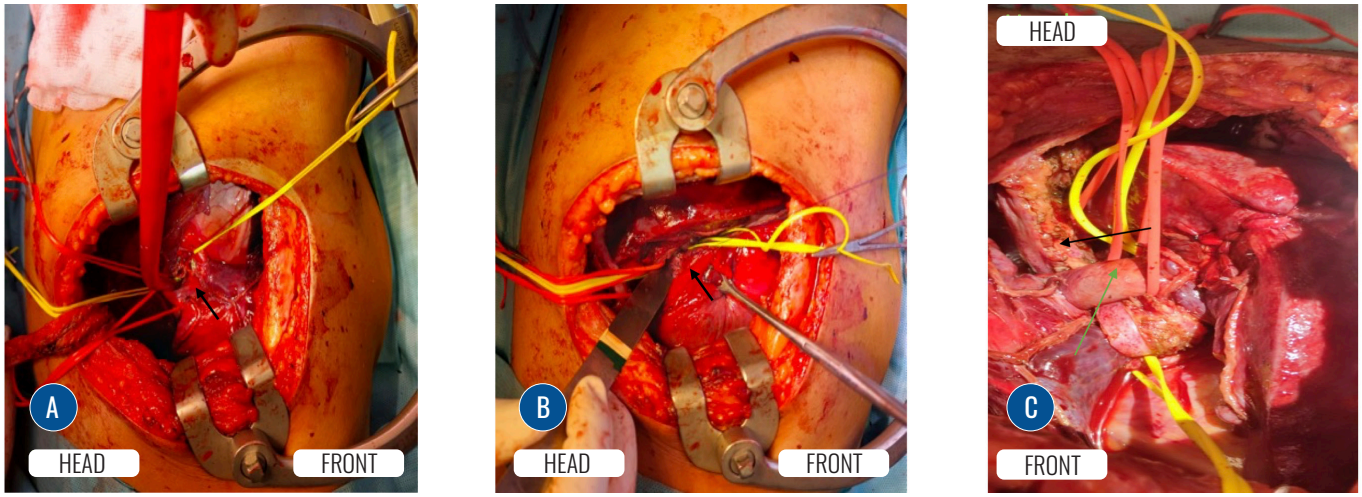
In Panel 1 Figure A and B we report the CT scan collected at the hospital arrival. As shown subcutaneous emphysema, bilateral pulmonary contusions, apical left pneumothorax and pneumomediastinum were present. In Panel 1 figure C we report the first bronchoscopy collected. As shown the rupture of the left superior bronchus was located distal to the lower bronchus division (yellow arrow). Pulsating left pulmonary artery was identifiable through the superior bronchial rupture (red arrow).

At end of the CT scan the patient was admitted in the ICU. A thoracic drainage was then placed to drain the left pneumothorax. Flexible bronchoscopy was subsequently performed to exclude or confirm airway injuries as cause of the massive pneumomediastinum. A complete rupture of the left superior bronchus was found immediately distal to the lower bronchus division. Pulsating left pulmonary artery was identifiable through the superior bronchial rupture without signs of active bleeding. The patient underwent urgent thoracic surgery within 4 hours. Right lung selective ventilation was performed

https://doi.org./10.53150/msj.v1i1.34

using a right double lumen endotracheal tube. After mediastinal and fissure dissection the left superior bronchus was visualized. A double running suture end-to-end anastomosis with 3-0 polydioxanone sutures (PDS) was performed. The sutures were covered with an intercostal muscle flap. The water test showed no air leakage. Two 28 French chest tubes were placed (**Panel 2**).

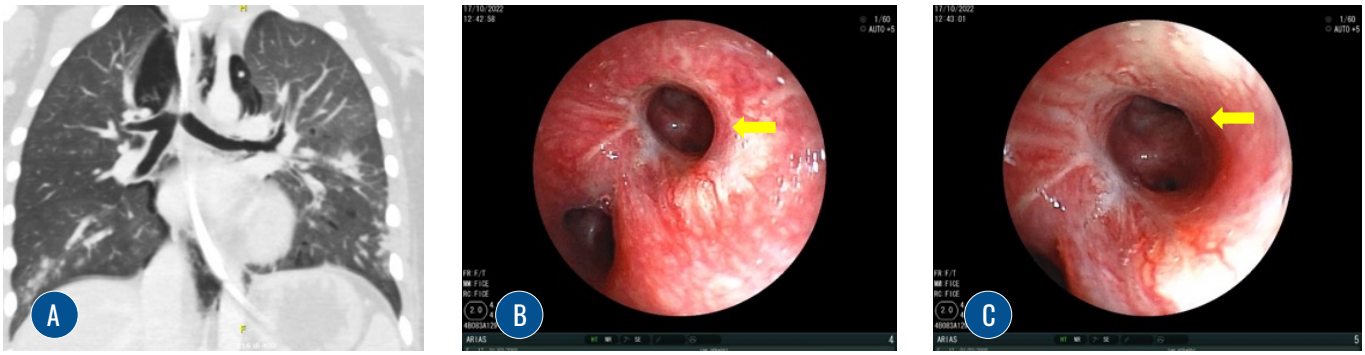
Panel 2



In panel 2 we report the three main intra-operatory phases. In Figure A the left superior bronchus (black arrow) is exposed after mediastinal and fissure dissection. In Figure B a double running suture is performed to obtain an end-to-end anastomosis of the left superior bronchus (Black arrow). In Figure C the Intercostal muscle flap (Black arrow) is placed to cover and protect the bronchial anastomosis, final view of the result with the pulmonary artery dissection in between the lobes (Green arrow).

At the end of the surgery, the double lumen endotracheal tube was then substituted with a normal single lumen endotracheal tube. Patient was ventilated under low PEEP (6 cmH2O) controlled protective ventilation for the first 48 hours of ICU stay. Chest X-rays controls performed in the first three days of ICU stay have shown left superior lobe contusion while flexible bronchoscopy controls revealed a normal transit through the left superior main bronchus. No signs of air leakage were present after surgery. Left superior lobe contusion spontaneously recovered within 4 days. Patient was then gradually weaned from mechanical ventilation (**Panel 3**).

Panel 3



In Panel 3 Figure A we report the CT scan collected after urgent thoracic surgery (left superior bronchial suture).
In Panel 3 figure B and C we report the bronchoscopy collected after thoracic surgery. As shown normal anatomy was restored, no signs of bronchial stenosis were found.

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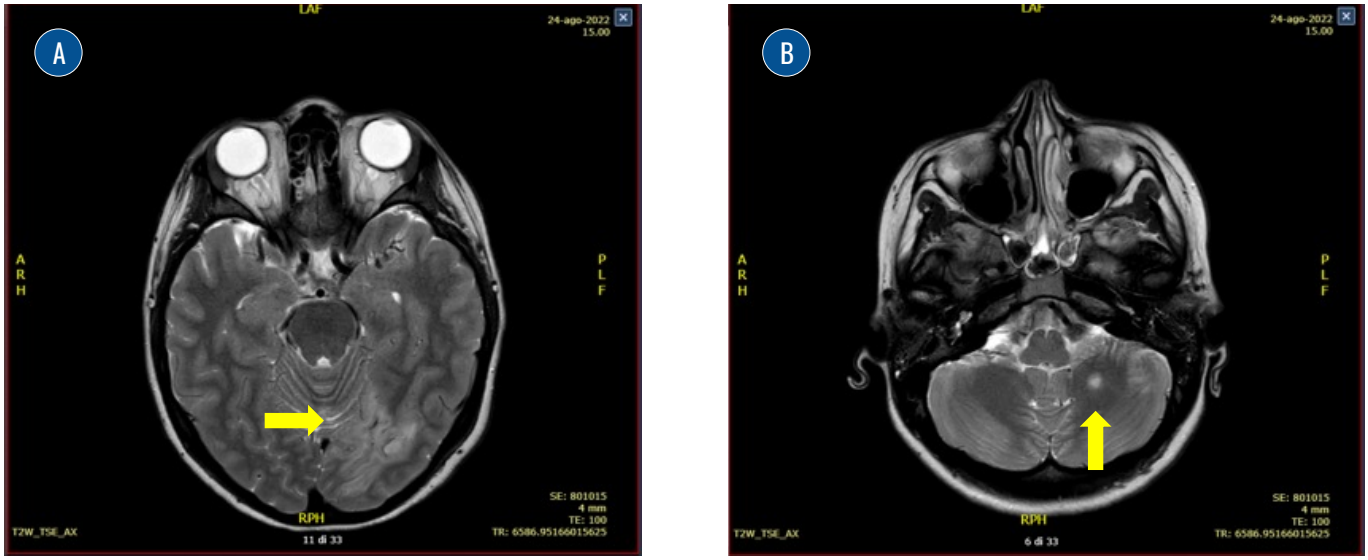
2.2 Cerebral air embolism after traumatic bronchial rupture

The first total body CT scan was performed at the patient's hospital arrival. No cerebral abnormalities were found. A second total body CT control was performed 10 hours and 24 hours later. Both controls documented a large area of cortico-subcortical ischemia in the left temporo-occipital lobe. The neurological examination was possible only 48 hours after surgery due to the respiratory problem which required deep sedation and controlled protective mechanical ventilation. Patient appeared conscious, oriented and without any focal abnormalities in the first examination and during the following ones. Cerebral MRI, performed on day 6, showed a hyperintensity in the left mesial temporo-occipital and left mesial parietal cortex, in addition to some focal hyperintense areas in the left cortical-subcortical cerebellar hemisphere and in the left medulla compatible with multiple ischemic lesions (**Panel 4**).

Panel 4



In panel 4 we report the cerebral MRI collected on day 6 after finding an ischemic area in the left parieto-occipital lobe during the control CT scan. As shown the lesion appears in the MRI as an hyperintensity lesion in the left mesial temporo-occipital lobe (yellow arrow figure A). A further focal hyperintense lesion was found in the left cerebellar hemisphere (yellow arrow figure B)

Hypothesizing a paradoxical embolism, we performed a compressive ultrasound sonography. No signs of deep venous thrombosis were found. Dimer dosage was elevated on the day of arrival (8130 ng/mL), and it progressively lowered to 2500 ng/mL. Transesophageal echocardiography (TEE) did not find any sign of interatrial or interventricular defect (color-doppler and positive pressure bubble test). No clinical sign or risk factors for fat embolism were present (long bone fracture, low platelet count, sub cutaneous or sub conjunctival petechiae) as well as fat embolism MRI signs. After the resolution of the respiratory failure, the patient was completely weaned from intravenous sedation and mechanical ventilation. Endotracheal tube was successfully removed on day 11. Patient was discharged to the thoracic surgery ward on day 16 after trauma. Patient was discharged to the child neuropsychiatry ward and finally to rehabilitation without any respiratory or neurologic sequelae. Follow up bronchoscopy was performed immediately before the hospital discharge two months after the trauma, no abnormalities were found.

3. Discussion

Tracheo-bronchial injuries (TBI) due to blunt chest trauma are a rare in the pediatric population. These injuries represent only 1-3% of pediatric blunt chest trauma, however, more than the 70% of the patients

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die before the hospital arrival [5-8]. Tracheo-bronchial injuries are usually associated with life threatening co-existing conditions which are responsible for the outcome like hemopneumothorax in 30% of cases, esophageal injuries (10%), major vascular injuries (20%), cardiac injuries (5%), spinal cord damages (5%) and abdominal injuries (20%). Early recognition and diagnosis are cornerstones in this type of trauma. The presence of pneumomediastinum and/or subcutaneous emphysema strongly suggests an airway injury. Flexible bronchoscopy is the gold standard for rapid recognition and fine characterization of these lesions [3,5]. Management of these patients range from conservative treatment if a condition of hemodynamic stability is resumed, to emergent surgical approach [3,7,8]. Thoracotomy is the option and end-to-end anastomosis represents the standard treatment. Running suture is indicated for the linear section of the bronchus. On the other hand, interrupted sutures seem to achieve better results when the bronchial tissues are traumatically damaged and/or the anastomosis needs more tension [9]. Airways anastomosis have always been considered at high risk for the several complications, dehiscence with consequent infection and erosion of the adjacent vessels representing the main ones. Covering and protecting the sutures may lead to better outcomes. The possible options include intercostal muscle flap, pericardial or pleural flap, omentum, pericardiophrenic pedicled graft (when pneumonectomy is performed) [10].

As far as the cerebral ischemia is concerned, this cannot be justified by a paradoxical thromboembolic event, given the absence of deep venous thrombosis and intracardiac shunt, while the absence of long bone fractures and the MRI findings do not support the hypothesis of a fat embolic event. We have hypothesized a cerebral air embolism as cause of the brain lesion given the context of chest trauma complicated by the rupture of a main bronchus. Systemic Air Embolism (SAE) represents a rare but potentially life-threatening complication of thoracic trauma with a mortality rate of 80% for blunt forms and 45% for penetrating forms in adult population [11]. Data about SAE in pediatric population after blunt chest trauma are missing. SAE after trauma can occur when gas penetrates in the venous system after veins disruption. Normally air embolies reaching the pulmonary filter pass to the peripheral tissues passing from the venous to the arterial circulation through cardiac shunt (inter-ventricular defects or inter-atrial defects). The consequent ischemia is caused by the vessel occlusion [12]. In the described case, thoracic trauma caused the complete avulsion of the left superior bronchus, and it could have involved minor pulmonary arteries and veins leading to a direct communication between the airway and the pulmonary veins (left circulation). During positive pressure ventilation the airway pressure easily overcomes the pulmonary vein pressure (left atrial or wedge pressure) generating the pressure gradient necessary to the direct gas entry in the arterial circulation [12,13]. This hypothesis could justify systemic embolism in the absence of intracardiac shunt. To corroborate the diagnosis no new cerebral ischemic lesions were found after the total restoration of the normal bronchial anatomy. It is finally necessary to underline that no stringent criteria or specific exams are available for the diagnosis of cerebral air embolism. Its diagnosis, necessarily obtained by exclusion criteria, still remains in the hypothetic field. In this case cerebral air embolism sings were detected incidentally and already after surgery. However, it is worth to underline that a rapid recognition of air embolism as consequence of traumatic tracheobronchial injury may represent a further indication for reparative approach. Its presence could suggest the need of an urgent etiological cause resolution.

4. Conclusion

Tracheo-bronchial injuries represent a serious possible complication in blunt chest trauma and its rapid recognition and treatment are crucial for patient survival. Fibro-bronchoscopy represents the gold standard for a clear characterization of the injury. In patient with unstable airway or severe respiratory conditions surgery should be performed as soon as possible. End-to-end anastomosis seems to achieve the best results. We strongly recommend to protect the anastomosis with a peduncled, well-perfused tissue.
SAE should always be suspected in case of chest trauma, especially if pneumomediastinum and/or subcutaneous emphysema are present. Tracheal and/or bronchial lesions should always be investigated.

https://doi.org./10.53150/msj.v1i1.34

If possible, a neurological examination should be performed as soon as possible or, if discontinuing sedation is not possible, a cerebral CT scan should be considered. Rapid recognition of the bronchial rupture and consequent urgent surgery were crucial in this case. Rapid removal of the cerebral embolism cause avoided further brain damage.

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Abbreviations:

Computed Tomography (CT), Magnetic Resonance Imaging (MRI), polydioxanone sutures (PDS), Systemic Air Embolism (SAE), Glasgow Coma Scale (GCS), Intensive Care Unit (ICU), transesophageal echocardiography (TEE)

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