

Sygnatura: Pol J Radiol, 2007; 72(1): 15-19

Otrzymano: 2005.01.03
 Zaakceptowano: 2006.03.20

Injuries of diaphragm in children – diagnostic problems

Agnieszka Biejat¹, Tomasz Zieliński¹, Michał Brzewski¹, Anna Jakubowska¹,
 Zofia Majkowska¹, Krystyna Iwaszkiewicz², Dariusz Piotrowski²

¹ Department of Pediatric Radiology, Medical University, Warsaw, Poland

² Department Pediatric Surgery, Medical University, Warsaw, Poland

Author's address: Agnieszka Biejat, Department of Pediatric Radiology, Medical University, Marszałkowska 24, 00-576 Warsaw, e-mail: abiejat@wp.pl

Summary

Background:

Nine children with blunt trauma were hospitalized in our hospital from September 2000 to July 2005. The group consisted of 7 boys and 2 girls from 2 to 15 years old.

Material/Methods:

The object of our article is to present problems in diagnosis of diaphragmatic injuries and compare the possibilities of diagnosis among different methods. We observed 3 children with trauma of diaphragm: in two of them the injury was on left side of diaphragm, and in one- on the right side.

Results:

Results of our examinations allowed us only to suspect a trauma of the right side of diaphragm, and in one patient correct diagnosis was established based on autopsy. The left side diaphragmatic injury was diagnosed by means of the CT abdominal scan after the extubations.

Conclusions:

Although various diagnostic methods were applied, diaphragmatic injuries constitute a serious problem in the diagnosis. Chest X-ray is still an important part of diagnosis in patients with diaphragmatic trauma.

Key words:

traumatic diaphragmatic rupture • blunt abdominal trauma • pediatrics

PDF file:

<http://www.polradiol.com/fulltxt.php?ICID=468210>

Background

Injuries of the diaphragm are rarely observed in children – only in 1–7% of patients with multiorgan injuries [1–4]. They are often undiagnosed as in this group of injuries the most common are those affecting spleen, kidneys, liver, lungs and bones [4].

Materials and methods

The aim of his study was to compare diagnostic possibilities of various imaging techniques in recognition of the consequences of multiorgan injuries, in order to evaluate their usefulness, particularly in case of a diaphragm injury.

Within the last 5 years – from September 2000 until July 2005 – 9 children were admitted to our hospital for multiorgan injuries sustained in traffic accidents (6 children) or fall from a height (3 children). The group consisted of 7 boys and 2 girls aged 2–15 years.

The recognition of consequences of multiorgan injuries was based on ultrasonography examination, computed tomography and plain film examination of the thorax, as well as on the images of osseous system.

Ultrasonography was performed as a foreground examination in 6 children, while computed tomography – in 3 children. All patients had the thoracic plain film examinations performed during their hospitalization. Images of bones (upper and lower limbs, clavicle, ribs, pelvis, spine) were made for 8 patients.

Results

The diaphragm injuries were stated in 3 children out of 9 in the examined group. In two cases the injury concerned the right diaphragmatic dome, and in one case – the left dome. The diaphragm injuries resulted from traffic accidents in all cases and were accompanied by many other injuries such as lung contusion in all three patients, limbs, clavicle,

Table 1. Consequences of blunt trauma in 9 children.

| No./patient's age | Location of changes | | | | | |
|-------------------|---------------------|-------|--------|-----------|-------|------------|
| | lungs | liver | spleen | diaphragm | bones | intestines |
| 1. *2 yr | X | X | X | X | X | |
| 2. 8 yr | X | X | X | X | X | |
| 3. 7 yr | | X | X | X | X | |
| 4. 3 yr | | X | X | | | |
| 5. 8 yr | | | | | X | X |
| 6. 8 yr | X | | | | X | |
| 7. 15 yr | X | | X | | X | |
| 8. 6 yr | | | X | | X | |
| 9. 6 yr | | | X | | X | |

* – death

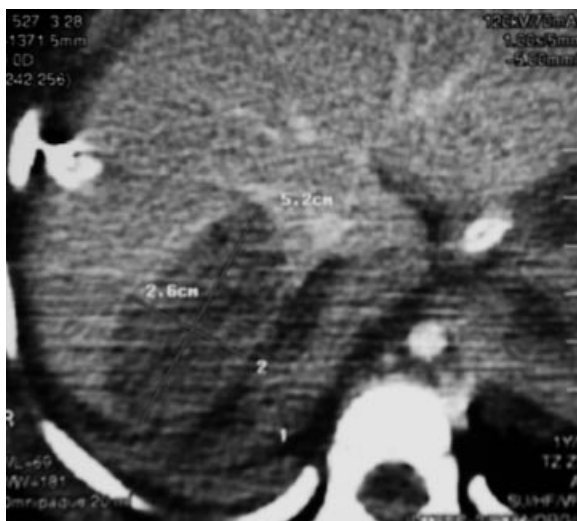
pelvis bone fractures in an eight-year-old boy, spinal body fracture in a 2-year-old boy and head injury with left temporal bone fracture in a 7-year-old boy. Two of these patients were also diagnosed with liver injuries, fractures with haematoma and spleen injuries (boys aged 2 and 8). A 2-year old patient from the described group died on the 12th day of hospitalization in consequence of multiorgan injury (table 1).

All three patients had thoracic plain films done in the first place, followed by abdominal ultrasonography and thoracoabdominal CT scan.

As for the first patient (table – patient no. 1), a 2-year-old boy – the multiorgan injury was a result of traffic accident. At the time of admission, the plain film showed emphysema with liquid in both pleural cavities. The thoracic CT was performed after intubation on the next day of hospitalization at the intensive care unit. Vesicular lesions were seen at the base of both lungs and were interpreted as posttraumatic changes. Th6 body fraction

with indentation of bone element into the spinal canal was also stated. The thoracoabdominal CT examination revealed focus of contusion in the upper splenic pole, free liquid in the visceral cavity and both pleural cavities. CT exam of the abdomen revealed liver contusion focus in its right lobe (fig. 1), disordered area within the spleen, contusion of its parenchyma (fig. 2) and presence of higher density liquid (haemorrhagic exudate) around the liver, right kidney and between the intestinal loops. CT examination of the head showed brain edema with no traces of hemorrhage. Very serious condition of the patient remained unchanged all through the hospitalization and in consequence of severe multiorgan injury followed by spinal cord injury the child died on the 12th day of hospitalization. Autopsy revealed interruption of the right diaphragmatic dome, which was not diagnosed based on imaging examinations.

The second patient (table – patient no. 2), an 8-year-old boy, was admitted to hospital in consequence of getting under a farming machine. The thoracic CT examination performed

**Figure 1.** Abdominal CT: contusion of the right hepatic lobe.**Figure 2.** Abdominal CT: contusion of the spleen.

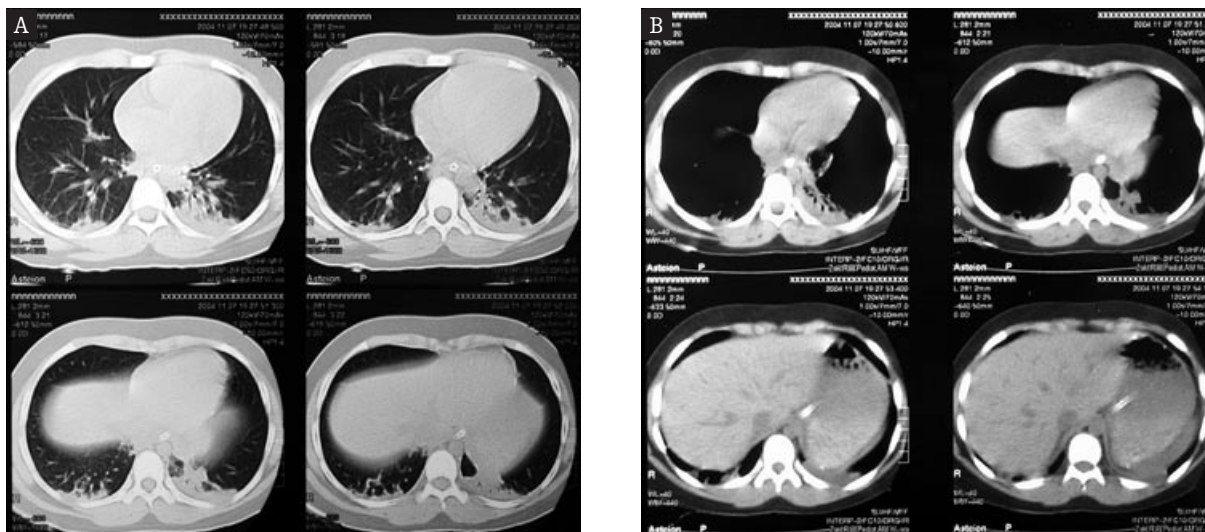


Figure 3. Chest CT: A) contusion of the lower parts of both lungs, B) free fluid between spleen and diaphragm.

after the intubation showed the right lung surrounded by a large quantity of free liquid in the pleural cavity. Ultrasonography examination of the abdomen revealed liver rupture with presence of haematoma, high location of the diaphragm and liquid in the right pleura. The CT exam performed after pleural drainage on the 3rd day of hospitalization proved that the right diaphragmatic dome was situated very high and liver was located within the thorax. Although it seemed that such high location was related to a massive haematoma of the ruptured liver, the fracture of diaphragm was also taken into consideration. The definite diagnosis of the right diaphragmatic dome fracture was made during the operation.

The third patient (table – patient no. 3), a 7-year-old boy, was hit by a car and was admitted to hospital in serious condition, with multiorgan injury. Thoracoabdominal CT scan was performed urgently after the intubation. CT revealed a small contusion area in both lung lobes and traces of liquid around the spleen (fig. 3a, 3b). X-ray of the thorax was also made and showed consolidation in the lower lobe of the left lung (fig. 4). The ultrasonography examination of the abdomen revealed trace quantity of liquid near the upper pole of the spleen. In view of patient's good condition he was referred to the surgery department on the 5th day of hospitalization, after the extubation. Within the next few hours spent at the surgery department, abdominal pain, nausea and vomiting appeared. Abdominal CT examination was prescribed. It revealed displacement of the stomach and intestine loops into the thorax. Owing to that the traumatic fracture of the left diaphragmatic dome was diagnosed. The same image also showed a high position of the gastric tube (in the thorax), what was an unequivocal symptom of the fracture (fig. 6). The child underwent a surgical procedure. During the operation a 2 cm long fracture of the left diaphragmatic dome was confirmed – the stomach and part of small intestine was placed back in the abdominal cavity, and the diaphragm was sutured. On the 6th day after the operation the child was discharged from hospital in a very good general condition, with normal image of thoracic organs (fig. 7).

The diagnostic examinations which seem to visualize the injuries best include the computed tomography and magnetic resonance. The latter is more sensitive and specific but is rarely used for diagnostics in emergency cases. Spiral tomography with secondary reconstructions in the frontal, sagittal and axial planes has sensitivity and specificity up to 80% [3, 4]. On the contrary – the ultrasonography examinations are difficult and not unequivocal [4]. In most cases the ultrasonography visualizes only the consequences of diaphragmatic injury, e.g. its high position, free liquid in the abdomen or thorax. Sometimes we can also see the reduction of mobility of the diaphragm, but this syndrome does not necessarily prove the traumatic fracture. In all patients we observed free liquid in the pleural cavity and abdomen and high position of the diaphragm in one of the three children (patient no. 2).

The sensitivity of thoracic plain film examinations, which are performed to almost every patient, is only about 50% [2]. Displacement of the gastric tube seen on the image of the thorax can lead us to the correct diagnosis [2, 3], what happened in case of one of our patients. The passage of the upper segment of digestive tract [3, 7] can also be a diagnostic examination. Neither of our patients required the use of this method.



Figure 4. Chest X-ray: consolidation of the left lower lobe.

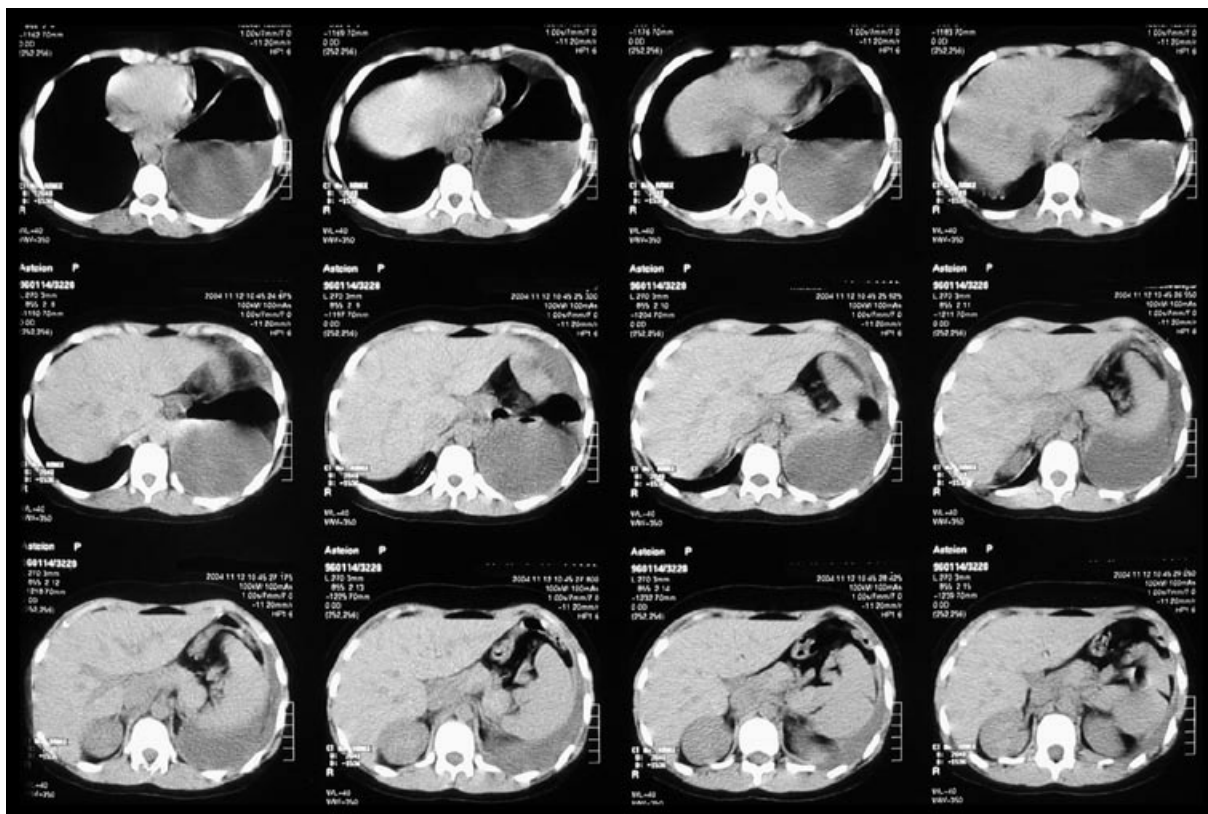


Figure 5. Abdominal CT: dislocation of the stomach and bowels to the left hemithorax.

The most common problem in diagnostics of diaphragmatic injuries is the delayed recognition of its damage. Late diagnosis of traumatic hernia of the diaphragm can be caused by numerous factors. In patients who suffered from diaphragmatic muscle rupture as a result of blunt injury of abdomen and thorax, positive pressure in the abdomen leads to displacement of organs into the thorax. States of tympanites or paralytic ileus increase the pressure inside of the abdomen and can cause organ displacement into the thorax or even incarceration of these organs in traumatic

diaphragmatic opening. It was observed in an 8-year-old patient (patient nr 2) with fracture of the right diaphragmatic dome and extensive liver haematoma which moved this organ upwards. It was such an important diagnostic difficulty that the definite diagnosis of post-traumatic diaphragmatic hernia was not made until the operation.

In the intubated patients supported with artificial ventilation, maintenance of high pressure in the respiratory system prevents from the possible wandering of organs to the thorax [8]. In these patients the image of thoracic organs on plain films or CT examinations performed after intubation can be normal. Therefore, the diaphragm fraction can be



Figure 6. Chest X-ray – large space of air in left hemithorax. Abnormal position of the gastric tube. White arrow – the proximal end of tube in the stomach, black arrow – the distal end of the tube.



Figure 7. Chest X-ray on the day of discharge from hospital – normal image of the thoracic organs.

overlooked in 30–50% of patients [7, 8]. Such situation took place in one of our cases (table – patient no. 3), whose plain film and CT scan did not show any serious anomalies within the thorax. However, within a few hours after the extubation the stomach and intestines were displaced into the thorax. Dislocation of the organs can cause other serious clinical symptoms (pain, dyspnea, cyanosis, hypoxia, vomiting) which occurred in our patient (table – patient no. 3).

However, it should also be emphasized that posttraumatic diaphragmal hernia, unrecognized soon after the trauma, can be diagnosed much later, e.g. during an endoscopic examination performed if the pain symptoms in patients after blunt injuries of thorax or abdomen remain [3, 8].

References:

1. Soundappan SVS, Holland AJA, Cass DT, et al: Blunt traumatic diaphragmatic injuries in children. *J Care Injured* 2005; 36: 51–54.
2. Killeen KL, Mirvis SE, Shanmuganathan K.: Helical CT of diaphragmatic rupture caused by blunt trauma. *AJR* 1999; 173: 1611–1616.
3. Sacco R, Quitadamo S, Rotolo N, et al: Traumatic diaphragmatic rupture personal experience. *Acta Bio Medica* 2003; 74; Suppl. 2: 71–73.
4. Blaivas M, Brannam L, Hawkins M, et al: Bedside emergency ultrasonographic diagnosis of diaphragmatic rupture in blunt abdominal trauma. *Am J Emerg Med.* 2004; 22 (7): 601–604.
5. Murray JG, Caoili E, Gruden JF, et al: Acute rupture of the diaphragm due to blunt trauma: diagnostic sensitivity and specificity of CT. *AJR* 1996; 166(5): 1035–1039.
6. Barsness KA, Bensard DD, Ciesla D et al: Blunt diaphragmatic rupture in children. *J Trauma* 2004; 56: 80–82.
7. Ramos CT, Koplewitz BZ, Babyn PS et al: What have we learned about traumatic diaphragmatic hernias in children? *J Pediatr Surg* 2000; 35(4): 601–604.
8. Carter YM, Karmy-Jones RC, Stern EJ. Delayed recognition of diaphragmatic rupture in a patient receiving mechanical ventilation. *AJR* 2001; 178(2): 428.

Conclusions

1. Injuries of the diaphragm are rarely recognized and constitute a serious diagnostic problem in spite of the use of various diagnostic imaging techniques.
2. Computed tomography is important for diagnostics and recognition of consequences of multitrauma.
3. Plain film examinations of the thorax still play an important role in the diagnostic algorithm of diaphragmatic injuries. In previously intubated patients the check-up examination of the thorax ought to be performed right after the extubation.