Pictorial essay

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Thoracic wall ultrasonography–normal and pathological findings. Pictorial essay.

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Abstract

Ultrasonography represents an efficient diagnosis method for thoracic pathology evaluation. The diseases of the pleura and thoracic wall receive the greatest benefit from the ultrasound examination. Establishing the cause of an acute thoracic pain or assessing a palpable tumor may easily benefit from essential data provided by ultrasonography. Afterwards it is possible to use a complementary imaging method or to perform US guided interventional procedures. This pictorial presents the ultrasonographic aspects of thoracic wall pathology, considering also differential diagnosis issues.

Keywords: ultrasonography, thoracic wall, diagnosis.

Rezumat

Ultrasonografia reprezintă o metodă eficientă de diagnostic a unor afecţiuni toracice, cele ale pleurei şi peretelui toracic beneficiind în mod deosebit de examinarea ecografică. Stabilirea cauzei unei dureri toracice acute sau investigarea unei formaţiuni depistate la palpare beneficiază rapid de informaţii esenţiale furnizate de ecografie. Ulterior este posibilă alegerea unor metode complementare de diagnostic sau realizarea unor manopere intervenţionale sub ghidaj ecografic. Acest pictorial prezintă principalele aspecte ultrasonografice ale patologiei parietale toracice, cu problemele de diagnostic diferenţial.

Cuvinte cheie: ecografie, perete toracic, tumori

Ultrasonography represents an efficient diagnosis method in thoracic pathology, as pleural and thoracic wall diseases especially benefit from the ultrasonographic examination. Furthermore it also gives the possibility to perform invasive ultrasound guided diagnosis and therapeutic procedures.

The examination can be performed with 3.5-5 MHz transducers in order to quickly identify pathologic aspects, but it is useful and sometimes necessary to complete the investigation with higher frequency transducer such as 7.5-13 MHz. The advantages of ultrasound compared with other imaging methods are represented by the high accuracy, the possibility to repeat the examination, even at patient bedside if needed and using mobile devices in emergency situations.

The examination of the thoracic wall can be performed with the patient in several positions:

- sitting – anterior, lateral, posterior and supraclavicular approach;
- dorsal, lateral and ventral decubitus in order to completely visualize the bones and the soft structures of the thoracic wall [1,2].

The ultrasonographic examination is indicated in the following situations [1,2]:

- after radiological detection of pleural, pulmonary or parietal alterations;
- for the evaluation of thoracic pain (posttraumatic or of unknown cause);
- in assessing palpable thoracic tumors of unknown etiology discovered during the clinical exam;
- staging and monitoring intrathoracic masses with potential extension into the thoracic wall;
- invasive US guided procedures – biopsy or drainage.

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Ultrasonography allows an accurate identification of the layered structure of the thorax wall. Therefore the superficial, echoic layers correspond to the skin, followed by the hypoechoic layers of hypodermic tissue and intercostal muscles (fig 1). The ribs, clavicle, scapula, vertebra bodies with their transverse and spinous processes can be visualized as hyperechoic, linear structures with intense shadowing. The costal cartilages appear as hypoechoic, parasternal entities, in continuation of the ribs (fig 2). The hyperechoic interface corresponding to the parietal and visceral pleura is visualized deeper, as well as the aerated lung parenchyma [1-3].

Thorax wall pathology encompasses extremely divers lesions that may generate just as divers ultrasonographic appearances: benign and malignant tumoral masses, post-traumatic lesions (hematomas, fractures), inflammations, local infections and several other entities (parasite cysts, subcutaneous emphysema, fistulas, etc) [2,4,5].

Primary wall tumors are very diverse as far as histopathology is concerned, but they are not as different as far as the ultrasound appearance is concerned. Most often they appear as hypoechoic masses.

Malignant tumors usually have irregular margins, inhomogeneous structure and a tendency to invade the pleura and the skin. They also present vascular signal upon Doppler investigation [2,5,6]. The different tumoral types include tumors of the muscles, adipose tissue, blood vessels, nerve sheath and bones, especially sarcomas. In the order of their occurrence frequency soft tissue sarcomas are predominantly fibrous or fibrohistiocytic (50%), followed by liposarcomas and nerve sheath tumors (each 14 %), muscle tumors (8%), vascular (4%) and synovial tumors (2%). Sarcomas are inhomogeneous (fig 3) and most often presents extended intratumoral necrosis (fig 4).

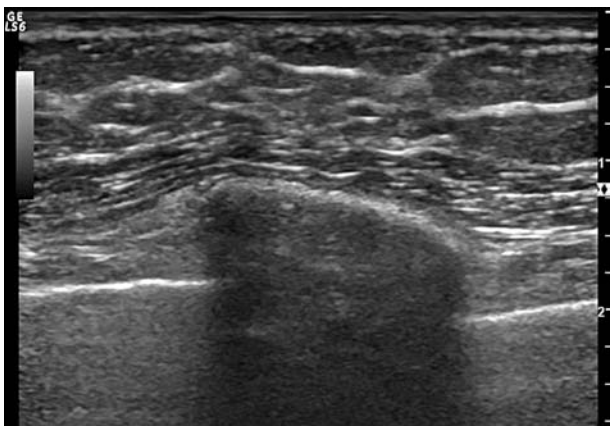

Fig 1. Layered structure of the thoracic wall: skin, adipose tissue, intercostal muscle, rib (acoustic shadowing), pleuropulmonary interface.

Fig 3. Malignant fibrous histiocytoma – almost round, hypoechoic, inhomogeneous mass, extending towards the skin.

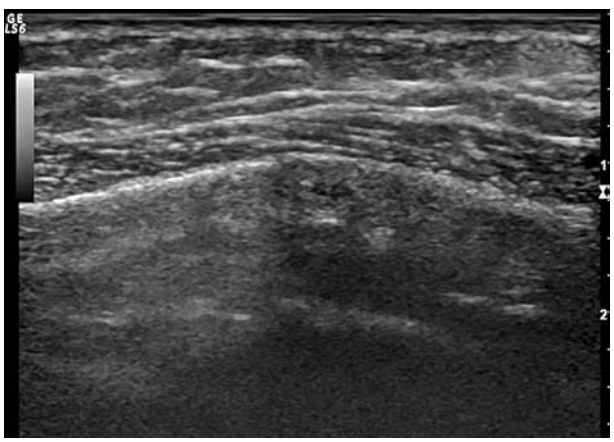

Fig 2. Layered structure of thoracic wall: skin, adipose tissue, intercostal muscle, rib (acoustic shadowing on the left), rib-sternum cartilage (hypoechoic, partially penetrated by the ultrasounds on the right of the image).

Fig 4. Rhabdomyosarcoma – giant, very inhomogeneous tumor, with large transonic areas inside (necrosis) and areas of hypoechoic parenchyma.

Even more frequent are **benign tumors** such as lipomas or fibrolipoma. These are well circumscribed, usually hypoechoic, relatively homogeneous and hypovascular (fig 5, fig 6). Other parietal masses are represented by extra-abdominal desmoid tumors, elastofibroma dorsi, myositis ossificans and the mesenchymal hamartoma of the chest wall (fig 6) [1,4,7].

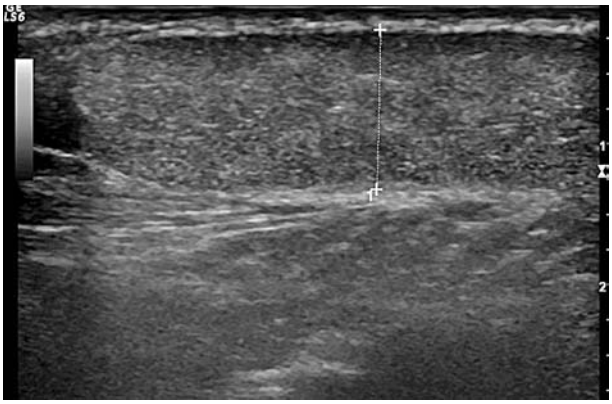

Fig 5. Thoracic wall lipoma – oval, flattened, hypoechoic, inhomogeneous, well-circumscribed mass.

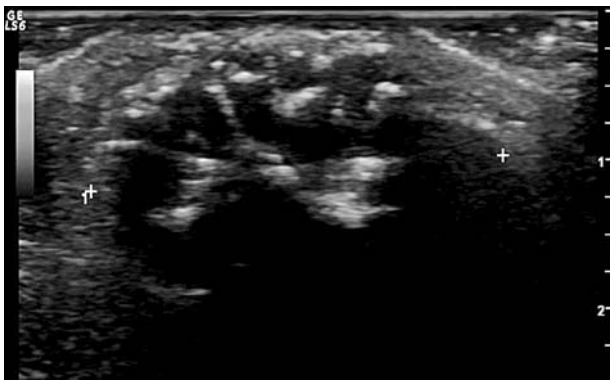

Fig 6. Partially calcified thoracic wall hamartoma – poorly circumscribed, hypoechoic mass with calcifications inside.

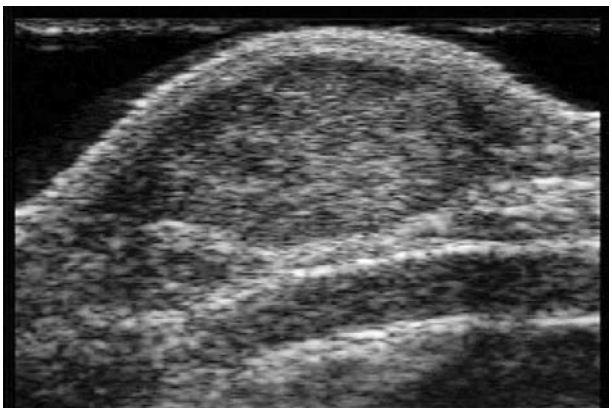

Fig 7. Local breast cancer recurrence – hypoechoic, poorly circumscribed mass.

A secondary malignant invasion (fig 7, fig 8) of the chest wall may be realized through local extension in the case of lung cancer, pleural mesotelioma and breast cancer. Less often the chest wall becomes involved in invading lung metastasis or through dissemination (from various types of carcinomas) in the bones or the soft tissue. Soft tissue metastasis meet the malignancy criteria – they are poorly circumscribed, hypoechoic, inhomogeneous, vascular masses that invade the pleura. Ribs, sternum and scapula metastasis lead to bone fragmentation with periosseous extension (usually hypoechoic); the masses also present vascular signal [2,3,6,8,9].

Posttraumatic lesions are most frequently represented by **hematomas** and rib **fractures**, with or without displacement (fig 9-12). Blood effusions have a hypoechoic or transonic appearance with poorly circumscribed margins. Fracture lines with discontinuity of the anterior rib margin, may be accompanied by periosseous edema and pericostal or pleural effusions [1,2].

Fig 8. Scapular metastasis with bone fragmentation and periosseous invasion – hypoechoic mass that replaces the muscle structure.

Fig 9. Thoracic wall hematoma – poorly circumscribed, inhomogeneous mass.

Cystic masses may be caused by parasites (fig 13) – with transonic content, well-defined wall and sometimes with daughter vesicles or they can be serous cysts [8].

Parietal effusions may develop through spontaneous or postinterventional fusion of pleural empyema. In these situations the pleural empyem can be visualized as well as the liquid collection between the ribs and surrounding them (fig 14-16). Other types of effusions are those with serous or lymphatic content.

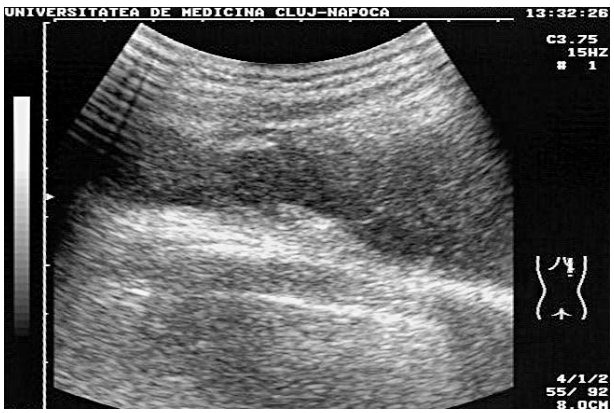

Fig 10. Thoracic wall hematoma – hypoechoic, slightly inhomogeneous, relatively ill-defined mass.

Fig 11. Well-circumscribed thoracic wall hematoma – oval, hypoechoic, homogeneous mass, located at the lung interface, resembling a solitary fibrous tumour of the pleura.

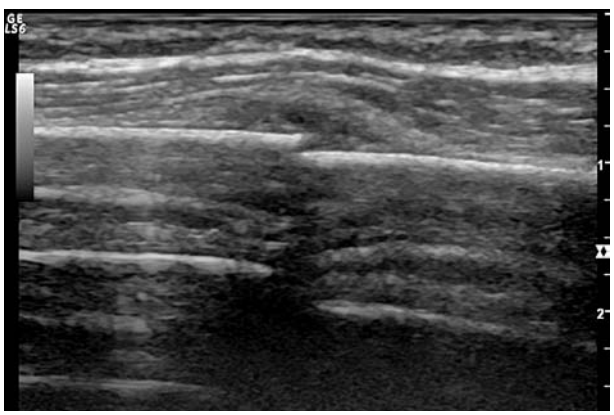

Fig 12. Rib fracture – discontinuity of the bone cortex surrounding of a small hematoma.

Fig 13. Hydatid cyst of the thoracic wall – cystic lesion with fine walls; the deep part of the wall appears doubled.

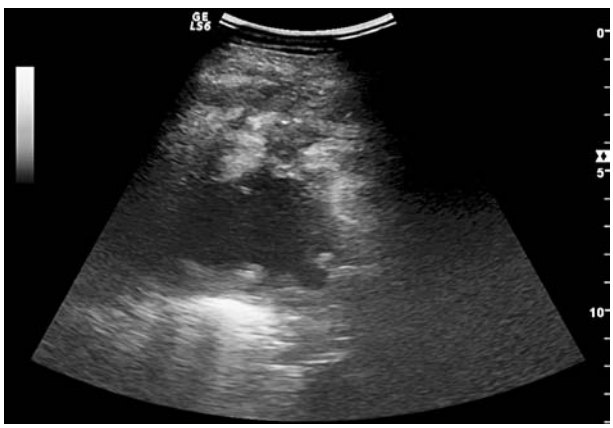

Fig 14. Pleural empyema and pachypleuritis – transonic fluid collection with irregular margins and thickening of the visceral and parietal pleura.

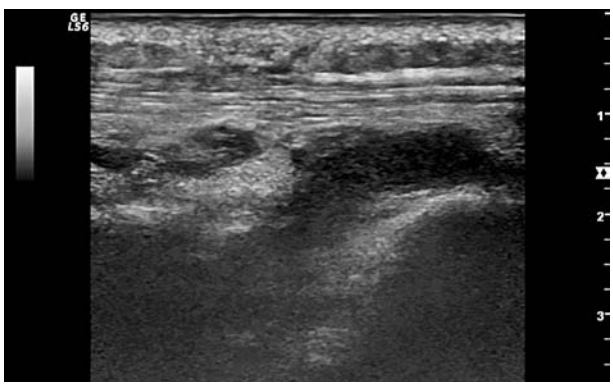

Fig 15. Pleural empyema with intercostal fistula – fluid collection that is extending cranially and externally from the hypoechoic image of a rib.

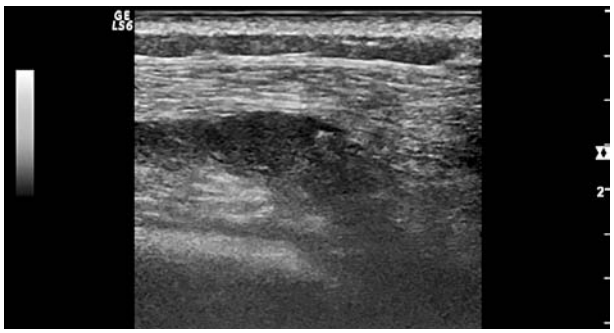

Fig 16. Pericostal fluid collection resulted from a pleural empyema – hypoechoic, inhomogeneous lesion located between the rib and the wall muscle.

Fig 17. Costochondritis – tumefaction with loss of cartilage delineation (between arrows); comparing image of the above normal costal cartilage (N).

Subcutaneous emphysema appears as hyperechoic, intraparietal images with posterior attenuation an aspect characteristic to gases.

Costochondritis is manifested through a hypoechoic tumefaction and eventually through a perichondral edema and effacement of the cartilage (fig 17).

Other entities that can be visualized by ultrasound are:

- **fistulas –** millimetre, hypoechoic, anfractuous images that connect pleura to the skin (fig 18);
- **drainage tubes –** linear, hyperechoic, tube-like images that determine posterior attenuation and cross the thoracic wall;
- **foreign bodies –** hyperechoic images accompanied by posterior attenuation;
- **post operative scars** with different changes of the chest wall structures – disorganized muscles layers that appear as hyperechoic images or discontinued hypoechogenicities (fig 19).

The structure of the chest wall may become difficult to asses in the case of fibrothorax development as the intercostal spaces are diminished and the echogenicity of the muscle layer increases (fig 20).

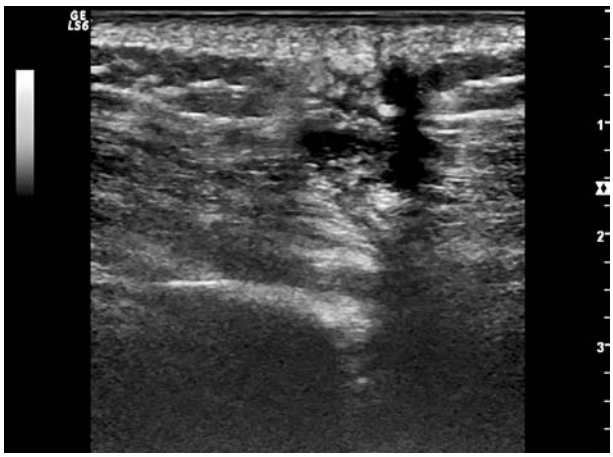

Fig 18. Transonic fistula with posterior enhancement situated in the muscle layers and in the hypoderm.

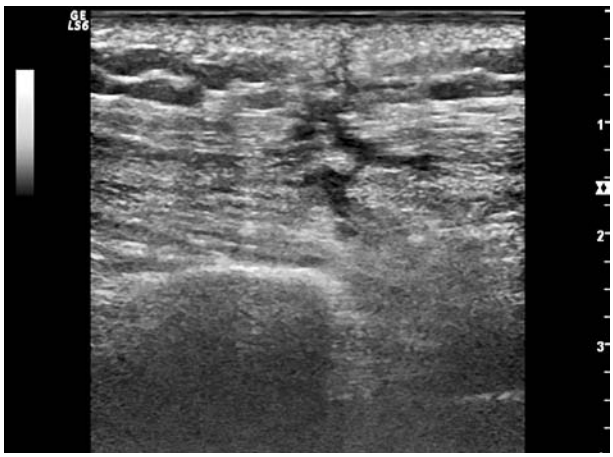

Fig 19. Postoperative scar and edema – hypoechoic, anfractuous lesion within the muscle and hypoderm layers (surgically removed empyema).

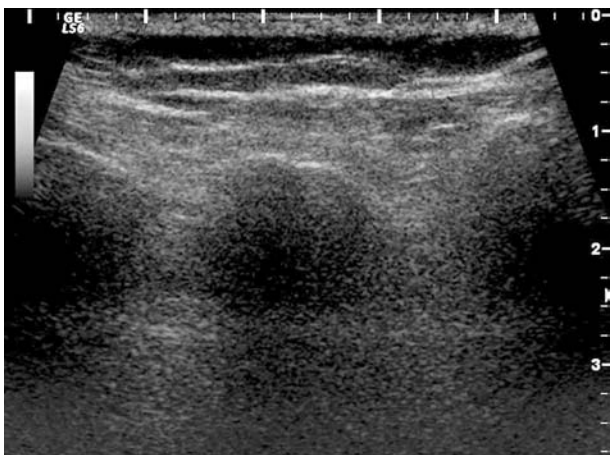

Fig 20. Fibrothorax - the layers of the thorax are difficult to distinguish, the intercostal spaces are narrowed and the interface between lung and pleura is hard to visualize.

Fig 21. Solitary fibrous tumor of the pleura – oval, hypoechoic, well-circumscribed mass, situated at the pleuropulmonary interface.

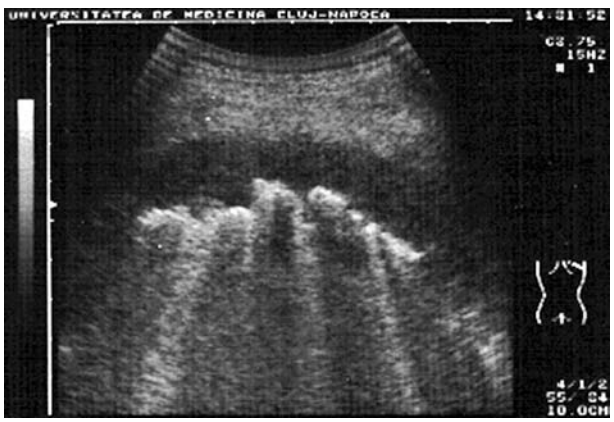

Fig 22. Pleural mesothelioma – important thickening of the pleura (>10 mm), irregular contour of the pleuropulmonary interface.

Fig 23. Calcified pachipleuritis – hypoechoic thickening of the pleura with calcification and intense posterior shadowing.

Significant **differential diagnosis** issues of chest wall lesions are raised by **pleural masses**, especially the solitary fibrous tumor of the pleura, the pleural mesotelioma and calcified pachypleuritis. The ultrasonographic aspect of the solitary fibrous tumor of the pleura is that of a hypoechoic, well-circumscribed, oval, vascular mass, situated between lung and pleura (fig 21). Pleural mesotelioma appears as a nodular or diffuse thickening of the pleura, usually measuring over 1 cm, with an irregular lung interface accompanied sometimes by a pleural effusion (fig 22) [2]. Calcified pachypleuritis contains hyperechoic images with shadowing that do not allow the assessment of the underlying pulmonary tissue that frequently has no mobility in the area of the pachypleuritis (fig 23).

In conclusion, the ultrasonographic examination of the thoracic wall can offer very useful information in the evaluation of chest wall pathology. Establishing the cause of acute thoracic pain or investigating a palpable lesion rapidly benefit from essential data provided by ultrasonography making it easy to choose afterwards a complementary imaging method or to perform US guided interventional procedures.

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