Chest Sonography

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Neuausgabe

Chest Sonography – Mathis

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1.1 Indications

Sonography is a long-established supplementary imaging procedure in the diagnosis of pleural effusions. Technical advancement and ongoing scientific evidence have caused the spectrum of application for sonography in diseases of the chest to be steadily extended over the last few years (Stender et al. 1994; Broaddus and Light 1994; Müller 1997; Kinasewitz 1998; Beckh 2002; Fig. 1.1).

The sonographic image does not provide a complete overview of the chest; however, it does image a certain section of it, which, given a specific problem under investigation, provides valuable additional information to substantiate overview radiographs. Occasionally sonography is the only noninvasive diagnostic procedure that throws significant light on pathological findings (Walz and Muhr 1990; Fraser et al. 1999).

Up to 99% of the ultrasound wave is reflected in the healthy lung. Intrapulmonary processes can be detected by sonography only when they extend up to the visceral pleura or can be imaged through a sound-conducting medium such as fluid or consolidated lung tissue (Fig. 1.2).

Sonic shadow zones are caused by nearly complete absorption of the ultrasound wave in bone, especially behind the sternum, scapula and vertebral column. Limitations caused by rib shadows can at least partially be balanced by respiratory mechanics.

From a percutaneous route the immediate retrosternal and posterior portions of the mediastinum cannot be viewed. A complementary method for this location is transesophageal and transbronchial sonography, which, however, are invasive investigation procedures in terms of effort and handling. (Lam and Becker 1996; Arita et al. 1996; Silvestri et al. 1996; Becker et al. 1997; Broderick et al. 1997; Serna et al. 1998; Aabakken et al. 1999; Herth et al. 2004; Fig. 1.3).

Sonography provides diagnostic information when individual structures of the thorax are investigated:

1. Thorax wall
   (a) Benign lesions
      • Benign neoplasms (e.g., lipoma)
      • Hematoma
      • Abscess
      • Reactivated lymph nodes
      • Perichondritis, Tietze’s syndrome
      • Rib fracture
   (b) Malignant lesions
      • Lymph node metastases (initial diagnosis and course of disease during treatment)
      • Invasive, growing carcinomas
      • Osteolysis

2. Pleura
   (a) Solid structures: thickening of the pleura, callus, calcification, asbestosis plaques
   (b) Space-occupying mass
      • Benign: fibrous tumor, lipoma
      • Malignant: circumscribed metastases, diffuse carcinosis, malignant pleural mesothelioma
   (c) Fluid: effusion, hematotherax, pyothorax, chylotherax
   (d) Dynamic investigation
      • Pneumotherax

**Fig. 1.1 Spectrum of application of sonography for pleural and pulmonary disease**
1.2 Technical Requirements in Terms of Equipment

Further pathological alterations in the heart visualized by sonography will not be described in this book. For this subject the reader is referred to pertinent textbooks on echocardiography.

3. Formation of peripheral foci in the lung
   (a) Benign: inflammation, abscess, embolism, atelectasis
   (b) Malignant: peripheral metastasis, peripheral carcinoma, tumor/atelectasis

4. Mediastinum, percutaneous
   (a) Space-occupying masses in the upper anterior mediastinum
   (b) Lymph nodes in the aorticopulmonary window
   (c) Thrombosis of the vena cava and its supplying branches
   (d) Imaging collateral circulation
   (e) Pericardial effusion

All the apparatuses used for sonographic investigation of the abdomen and thyroid may also be used to examine the thorax. A high-resolution linear transducer of 5–10 MHz is suitable for imaging the thorax wall and the parietal pleura (Mathis 2004). More recently introduced probes of 10–13 MHz are excellent for evaluating lymph nodes (Gritzmann 2005), pleura and the surface of the lung.

For investigation of the lung a convex or sector probe of 3–5 MHz provides adequate depth of penetration.

Vector, sector or narrow convex probes are recom-
mended for the mediastinum. The smaller the connecting surface, the better the transducer can be placed in the jugulum or the supraclavicular fossa. The range of frequency should be 3.5–5 MHz. It should be noted that device settings commonly used for examining the heart are not suitable for the rest of the mediastinum. Contrast, image rate and gray-scale depth balance must be adjusted to image structures of the mediastinum.

Transesophageal sonography requires a special probe with a suitable connecting tube to the sonography device. Endobronchial sonography is performed with special, thin high-frequency probes (12–20 MHz) that are introduced via the working tube of the flexible bronchoscope. Currently very few manufacturers offer suitable probes along with a sonography unit.

1.3 Investigation Procedure

1.3.1 Thorax Wall, Pleura, Diaphragm, Lung

The investigation is performed as far as possible with the patient seated, during inspiration and expiration, if necessary in combination with respiratory maneuvers such as coughing or “sniffing.” Raising the arms and crossing them behind the head causes intercostal spaces to be extended and facilitates access. The transducer is moved from ventral to dorsal along the longitudinal lines in the thorax (Fig. 1.4):

- Parasternal line
- Middle and lateral clavicular line
- Anterior, middle and posterior axillary line
- Lateral and medial scapular line
- Paravertebral line

Every finding should be allocated to its respective anatomic location and the latter should be specifically mentioned.

Subsequent transverse transducer movement parallel to the ribs in the intercostal space (Fig. 1.5) provides the additional information required for accurate localization of the respective finding.

The investigation of foci behind the scapula needs maximum adduction of the arms until the contralateral shoulder is encircled (Fig. 1.6). The supraclavicular access allows the investigator to view the tip of the lung and the region of the brachial plexus (Sect. 1.3.2).

From suprasternal, the anterior upper mediastinum can be viewed. From the abdomen, in subcostal section by the transhepatic route on the right side (Fig. 1.7) and to a lesser extent through the spleen on the left side, the diaphragm is examined. Additionally, the longitudinal resonance plane from the flank images both phrenicocostal recesses (Fig. 1.8).

The supine patient is examined in the same manner. The abdominal access is better for this purpose. However, viewing intercostal spaces might be more difficult, as the mobility of the shoulder girdle is usually somewhat restricted.
Fig. 1.5 Examination of the seated patient. a Linear probe placed parallel to the ribs in the third intercostal space. b Corresponding sonographic transverse panoramic image (SieScape). M muscle, P line of the pleura.

Fig. 1.6 Position of the patient when structures behind the scapula are examined.
The investigation of the supraclavicular region requires special transducer movements. High-resolution probes allow the imaging of nerves. The viewing of the branches of the brachial plexus means a diagnostic enrichment in sonography of diseases of the chest. The plexus and its branches should be examined in the following cases:

- Infiltration of Pancoast’s tumor
- Trauma (birth, accident)
- Punctures of the supraclavicular region

The examination starts on the lateral base of the neck (Fig. 1.9). The branches of the brachial plexus lead lateral and downward between the gap of M. scalenus anterior and medius. They reach the axilla between the first rib and the clavicle. Infraclavicular placement of the probe shows the course of the nerve along the axillary artery (Fig. 1.10).

The investigation procedure terminates with the probe placed in the axilla (Fig. 1.11).

The procedure for transesophageal and transbronchial sonography is described in the respective chapters.
Fig. 1.9 Examination of the supraclavicular region. 

- **a**: Linear probe placed longitudinally on the lateral base of the neck.
- **b**: Corresponding sonographic panoramic image. AS a. subclavia, VS v. subclavia, R rib, PL pleura, arrow branch of brachial plexus.
- **c**: Linear probe placed medium sagittal on the lateral base of the neck.
- **d**: Corresponding sonographic image. N Branches of brachial plexus, V v. anonyma.
Fig. 1.10 a Linear probe placed oblique longitudinally in the middle clavicular line. b Corresponding sonographic image. A.AX. a. axillaris. The arrows and crosses mark the course of the plexus nerve. c Linear probe placed infraclavicular transverse in the middle clavicular line parallel to clavula. d Corresponding sonographic image. The arrow points to pleural line. e Corresponding color image. V.CE. v. ce-phalica
1.4 Summary

The high resolution of the sonographic image and the real-time examination make a major contribution to the diagnosis of diseases of the chest. Structures of the chest wall and pleural lesions are visualized by ultrasound. Pulmonary consolidations are detected if they reach the visceral pleura, or if they are situated behind an acoustic window. The anterior and superior mediastinum is accessible percutaneously with certain positions of the probe. For thoracic sonography a linear probe (5–10 MHz) for close resolution and a convex or sector transducer (3.5–5 MHz) for access to deeper areas is recommended. The investigation of the supraclavicular region requires high-resolution transducers (5–13 MHz) for making visible the nerves of the brachial plexus.

References


Fig. 1.11 a Linear probe placed longitudinally in the mid axilla. b Corresponding sonographic imaging, probe inclined dorsad. 1 m. serratus anterior, 2 m. intercostalis, 3 pleural line (arrows). c Corresponding sonographic image, probe inclined ventrad