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METHODS OF RADIOLOGICAL EXAMINATION OF CHEST DISEASES IN CHILDREN

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Abstract:

Chest symptoms are one of the most common reasons pediatric patients present for clinical evaluation. Imaging plays a critical role in elucidating differential considerations, provides valuable information in assessing the extent of disease and associated abnormalities, influences patient management decisions, and provides a detailed assessment of response to treatment. Given the wide range of pathologies that affect the pediatric chest, anatomic localization is a useful approach to classification and can be considered in a three-component model including primary lung parenchymal processes, large airway abnormalities, and pathology arising in the mediastinum. This practical approach can be applied to some of the most commonly encountered pediatric chest pathologies. This article also reviews the advantages and limitations of current imaging techniques and characteristic imaging findings of pediatric thoracic disorders encountered in daily clinical practice.

Keywords: chest radiography, pathology, computed tomography, bronchography, X-ray methods.

INTRODUCTION

The X-ray method is still the leading and main method in the diagnosis of diseases of the chest organs. Modern radiology has many methods for the effective recognition of the pathological process in the lungs and bronchi (X-ray, longitudinal tomography, bronchography, computed tomography, magnetic resonance imaging). With the help of these methods, it is possible to identify with high reliability not only changes in the lung parenchyma, pleura, vessels, bronchi, but also to characterize them from the morphological and functional side. Improvement of X-ray methods contribute to the diagnosis of lung diseases using a minimal, but sufficient set of X-ray studies [1]

The anatomical and physiological features of the respiratory system in newborns are structural and functional immaturity and rapid exhaustion of adaptive reactions. In the structure of morbidity, respiratory disorders in newborns occupy 2nd place - 8.8% [1]. The leading causes of respiratory failure (RF) in newborns are:

1. Pathology of the airways (malformations with airway obstruction: atresia, choanal hypoplasia, malformations of the jaws, laryngeal membranes, tracheobronchomalacia, cysts of the tongue, gums, neck; acquired diseases: edema of the nasal mucosa of various origins, paralysis of the vocal cords, aspiration);
2. Non-infectious pathology of the lungs (RDS, malformations, neonatal aspiration syndrome, atelectasis, pulmonary hemorrhage, pulmonary edema);
3. Infectious and inflammatory processes in the lung tissue (pneumonia, pleuropulmonary diseases);
4. Pathology of the pulmonary vessels (congenital malformations of the cardiovascular system, transient or persistent pulmonary hypertension);
5. Extrapulmonary pathology (damage to the brain and spinal cord, congenital malformations of the central nervous system, heart, diaphragm, gastrointestinal tract, mediastinal tumors, thymus pathology).

Advantages and Disadvantages of Imaging Techniques

The three most commonly used imaging techniques for the evaluation of pediatric thoracic diseases are chest radiography, magnetic resonance imaging (MRI), and computed tomography (CT). Their advantages and disadvantages are summarized in the following section.

A chest X-ray can reveal:

- the presence of inflammation in the lungs, including those characteristics of diseases such as pneumonia and tuberculosis;
- the presence of tumors and edema, which may be a consequence of heart failure;

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- the presence of pathological accumulations of gases and liquids;
- fluid accumulation in the pericardium, an increase in the size of the heart, aorta and lymph nodes;
- foreign objects in the lungs, esophagus and respiratory tract.

Chest X-ray is prescribed for diagnostic purposes and to assess the condition of diseases such as:

- Pneumonia. In complex cases, chest X-ray data are the basis for diagnosing acute pneumonia;
- Tuberculosis;
- Inflammatory diseases of the pleura (pleurisy, pleural empyema);
- Tumor diseases of the lungs, bronchi, trachea;
- Pulmonary embolism;
- Occupational lung diseases caused by prolonged inhalation of dust and other small particles;
- Pneumothorax (mechanical rupture of lung tissue);
- Parasitic diseases of the chest (echinococcosis);
- Diseases of the thoracic spine.

Chest Radiography

Chest radiography is the first and most commonly performed imaging technique in children with potential thoracic diseases. It is also often the only imaging study required for diagnosis. For chest pathologies that cannot be fully characterized by chest radiography alone, such as mediastinal or airway lesions, it is often sufficient to appropriately tailor subsequent imaging techniques. Given that chest radiography requires ionizing radiation, its use must be balanced against the potential risk factor for radiation-induced malignancies. This is heightened in children due to their increased susceptibility to ionizing radiation exposure as well as their longer-term potential for re-exposure compared to adults. By implementing the ALARA principle, which states that radiation levels are kept as low as reasonably achievable (ALARA), diagnostic chest radiography can be performed with a very low radiation dose [1, 2]. This therefore results in a very low risk of developing radiation-induced malignancies. In addition, chest radiography offers the advantages of ease of acquisition, low cost, and availability.

Computed Tomography

CT is the most common cross-sectional modality used to evaluate lung parenchymal abnormalities. This is due to its excellent anatomical resolution and high contrast between lung pathology and adjacent air-filled lung parenchyma, a difference that can be further enhanced with the use of intravenous contrast. Compared with chest radiography, CT provides superior characterization of abnormalities and aids in pre-procedural evaluation by providing excellent relational anatomy. Specialised CT techniques such as high-resolution imaging, inspiratory and expiratory sequences and 3D/4D volume reconstruction can be used to answer specific clinical questions [3]. The rapid acquisition times provided by the multidetector CT (MDCT) scanners currently in use have additional benefits, particularly in pediatrics, as they can reduce the need for sedation. Although the benefits of CT are numerous, the most glaring disadvantage is the added ionising radiation compared to radiography and thus the risk/benefit ratio must be carefully weighed. To reduce the dose, individualised acquisition parameters that take into account the patient's body size and image optimisation techniques such as iterative reconstruction according to the ALARA principle should be used [4].

Magnetic resonance imaging

MRI provides superior soft tissue contrast compared to CT. It is therefore an ideal modality for characterizing extraparenchymal soft tissue lesions such as mediastinal or chest wall soft tissue lesions. The absence of ionizing radiation compared to CT provides additional advantages, particularly in susceptible children. The use of MRI to evaluate the lung parenchyma is hampered by the intrinsic paucity of photons in the air-filled alveoli, resulting in a low magnitude of MRI signal generation [5]. This generated signal is further degraded by the susceptibility artifact that arises from the multiple air-tissue interfaces in the lung. The reduced specific resolution of MRI compared to CT further limits its use for evaluating subtle pathological changes in the lung parenchyma [6]. Thus, MRI has limited utility in evaluating lung parenchymal pathologies that result in increased air, so-called negative pathologies, such as cystic lung disease or emphysema. However, the recent development of improved MRI sequences has increased the use of MRI for the evaluation of so-called plus pathologies that result in the deposition of material in the lung parenchyma [7, 8]. Because of this additive process, more photons are present in the lung parenchyma, thereby increasing the magnitude of the MRI signal generated. Disadvantages of MRI include availability and cost. In addition, due to the long acquisition times, sedation is usually required since patient motion, in addition to the respiratory and cardiac motion inherent in chest imaging, can significantly degrade image quality and interfere with image interpretation.

CONCLUSION

Thus, X-ray examination plays a significant role in the diagnosis of acute inflammatory lung diseases.

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Traditional methods of X-ray examination remain the leading ones. Computer tomography in acute inflammatory diseases in children has limited application, in particular in cases of X-ray negative, but clinically obvious manifestations of the disease, when it is necessary to conduct a control examination of patients with a torpid, poorly amenable to therapy course of the inflammatory process.

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