Respiratory Distress in Neonates

Underlying Causes and Current Imaging Assessment

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KEYWORDS

• Neonatal • Respiratory distress • Pulmonary • Preterm • Full-term • Congenital lung malformations

KEY POINTS

- Respiratory distress in the newborn can be caused by a variety of underlying conditions, and appropriate management depends on accurate and timely imaging and diagnosis.
- Imaging and pathologic features of congenital lung malformations often overlap and lesions are best considered on a spectrum, with each lesion demonstrating various degrees of parenchymal, airway, and vascular involvement.
- The leading cause of morbidity and mortality among premature infants remains surfactant deficiency disorder (previously known as hyaline membrane disease or respiratory distress syndrome) but advances in treatment, including prenatal glucocorticoids and exogenous surfactant, have altered the classic radiographic findings of surfactant deficiency disorder.
- Advances in treatment have resulted in a change in the radiographic features of chronic lung disease of prematurity (previously known as bronchopulmonary dysplasia). Though certain radiographic features are typical for chronic lung disease of prematurity, current diagnostic criteria for chronic lung disease of prematurity are based solely on clinical criteria.
- The congenital surfactant dysfunction disorders are a rare group of genetic diseases that lead to abnormal production and/or function of surfactant in the lungs and produce typical, though nonspecific imaging findings.

INTRODUCTION

Respiratory distress is among the most common clinical indications for imaging the newborn. A variety of underlying conditions can cause respiratory distress in the neonate, and familiarity with the imaging appearance of each of these conditions is essential to timely diagnosis and appropriate management. In this article, current imaging techniques and modalities are described and the most commonly encountered neonatal lung diseases are discussed, including congenital

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lung malformations and lung abnormalities in preterm infants, as well as full-term infants.

IMAGING MODALITIES AND TECHNIQUES

Radiography

Chest radiographs are the primary imaging modality used in the assessment of the newborn with respiratory distress. In many cases, the management of neonates relies only on chest radiographs without the use of other imaging modalities. Chest radiographs are relatively inexpensive, easy to obtain, and use a very low amount of radiation, making them an ideal initial test to evaluate many neonatal lung diseases. Radiation doses can be further minimized through shielding and proper coning of images.[1,2]

Most chest radiographs performed in neonates are obtained portably and consist of a single anterior-posterior (AP) view with the child in a supine position. In certain scenarios, a lateral view may be useful to localize a finding. AP lateral decubitus views may be used in select cases, such as to visualize layering pleural effusion or to better assess a suspected pneumothorax. Though chest radiographs are an indispensable tool, they do not provide the same anatomic detail as computed tomography (CT) or MR imaging, and these may be indicated to further evaluate a finding seen on chest radiograph.

Fluoroscopy

Fluoroscopy can be useful to evaluate dynamic disease processes that change throughout the respiratory cycle but its role in neonatal respiratory distress is limited to a few scenarios. Fluoroscopy may be used to evaluate diaphragmatic motion in cases of suspected diaphragmatic paralysis or eventration, though ultrasound is often preferred due to its portability and lack of radiation.[3] Airway fluoroscopy may be performed in cases of suspected tracheobronchomalacia to evaluate for large airway collapse during expiration.[4]

Ultrasound

In recent years, ultrasound has received increasing attention as a tool in the evaluation of lung disease, though inherent physical properties of the chest, including acoustic shadowing from air-filled lung and ribs, often impede ultrasound's diagnostic utility in the thorax. Despite these limitations, ultrasound can be very useful in selected scenarios.[5] When chest radiograph demonstrates a completely opacified hemithorax, ultrasound can help differentiate pleural fluid from pulmonary parenchymal disease.[5] Doppler ultrasound can assess for anomalous vasculature in cases of suspected pulmonary sequestration.[5] Real-time, cine, and M-mode ultrasound imaging are the preferred methods for assessing diaphragmatic motion in cases of suspected paralysis and eventration, and can be helpful in the evaluation of congenital diaphragmatic hernia.[3,6–9] The aerated lung can even be assessed in selected scenarios through analysis of B-lines, the comet-tail artifacts that are produced when the sound beam interacts with the interlobular septa at the pleural surface. Increased B-lines have been reported in transient tachypnea of the newborn (TTN) and surfactant deficiency,[10,11] though these entities are more commonly diagnosed and managed using chest radiography alone.

Computed Tomography

CT has the ability to produce cross-sectional images with excellent anatomic detail, making it a powerful tool in the evaluation of many thoracic diseases. CT uses ionizing radiation to produce images, and every effort should be made to use low-dose pediatric protocols and limit unnecessary CT scans, particularly in neonates who are inherently more sensitive to the effects of radiation than adults.[12–15] Alternative modalities that use less or no ionizing radiation, such as radiography, ultrasound, and MR imaging, should always be considered before performing CT. After considering these factors, CT is often the best imaging modality to assess many neonatal lung diseases given its excellent anatomic detail and is lower susceptibility to artifacts. The addition of intravenous contrast is often indicated to better evaluate the mediastinal structures and vasculature.

MR Imaging

MR imaging has received much attention due to its ability to generate images without the use of ionizing radiation, though its role in the evaluation of respiratory distress in the newborn is limited. Cost, availability, and physical properties of the lung, including low signal-to-noise ratio, respiratory and cardiac motion, and signal dephasing at air-tissue interphases, limit the routine use of chest MR imaging in neonates. Despite these limitations, MR imaging with MR angiography (MRA) may be used as a first-line alternative to CT in several specific conditions, including pulmonary sequestration, pulmonary artery hypoplasia, pulmonary vascular anomalies, partial or total anomalous pulmonary venous return, and vascular rings and sling.[16,17] Small-bore and modified MR imaging scanners have been used in research settings to evaluate changes of chronic lung disease of