Pediatric Chest MR Imaging
Sedation, Techniques, and Extracardiac Vessels

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KEYWORDS

• MR imaging • MR imaging technique • Vascular anomalies and abnormalities • Pediatric patients

KEY POINTS

- Proper patient preparation is essential for thoracic MR imaging in pediatric patients.
- Sedation proves necessary to obtain diagnostic quality chest MR imaging in infants and young children.
- Various MR imaging techniques can visualize vascular anatomy both with and without the use of intravenous contrast.
- Evaluation of thoracic outlet syndrome is improved by dynamic MR imaging technique.

INTRODUCTION

Since its introduction to clinical practice, MR imaging has become a cornerstone of radiologic imaging. In recent years, advances in MR imaging technology including the use of 3T scanners and parallel imaging, have overcome many of the limitations that previously hindered the use of MR imaging for thoracic disorders. Particularly, the excellent soft tissue contrast and anatomic detail provided by MR imaging has encouraged its widespread adoption for thoracic vascular imaging. This review addresses practical strategies to improve thoracic MR image quality including overcoming motion artifacts and the necessity for sedation in many pediatric patients when performing thoracic vascular MR imaging. With tailored pediatric protocols, one can accurately diagnose myriad conditions without exposing the patient to ionizing radiation. Selected examples of pathology that vascular thoracic MR imaging can diagnose in the pediatric population are also provided.

TECHNICAL ISSUES: MOTION

Motion in chest imaging is typically caused by cardiac and respiratory activities. Cardiac gating relies on the use of an electrocardiogram (ECG) for monitoring the cardiac cycle during the MR imaging examination, allowing for the acquisition of images during diastole, the most quiescent portion of the cardiac cycle.[1] Respiratory motion generally

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plays a much larger role in noncardiac thoracic imaging compared with cardiac motion. In an ideal setting, breath-hold imaging yields the highest quality images, as it can largely eliminate respiratory motion.[2] Because the ability to perform breath holding is limited in infants and young children (<5 years old), this technique is reserved for older (≥5 years) or intubated children and, of course, requires rapid pulse sequences.

Another way to manage respiratory motion involves acquiring signal over a longer period, but only during the same phase of respiration. One can perform respiratory gating with the use of a bellows or belt strapped to the patient that monitors the respiratory cycle. Such methods can be deployed to selectively acquire MR signals only during end expiration, the portion of the cycle at which the abdomen and chest remain motionless.[3] One can also monitor the phase of the respiratory cycle with the use a navigator echo. Navigator echoes allow either retrospective or prospective gating of signal by sampling a small area in the region of the diaphragm to assess diaphragmatic excursion.[4] Similar to the use of the bellows, only signals acquired during the appropriate phase of the respiratory cycle are then used for final image reconstructions (**Fig. 1**).[5]

Children may have difficulty with extended breath holds or the concept of quiet breathing. In addition, the average resting respiratory rate increases with decreasing age. For this reason, multiple pulse sequences have been developed to optimize image quality.[6,7] A simplistic way of categorizing these sequences is to divide them into sequences that only acquire data while the lungs are not moving and those sequences that acquire signal throughout the respiratory cycle in quiet breathing. Other methods to perform non–breath hold imaging involve faster sequences that undersample k space or sample k space in a fashion that minimizes motion artifact such as periodically rotated overlapping parallel lines with enhanced reconstruction (PROPELLER/BLADE).[8]

PATIENT PREPARATION ISSUES: SEDATION

In the previous section, cardiac and respiratory motion were discussed as especially problematic to thoracic imaging. Even when optimizing the

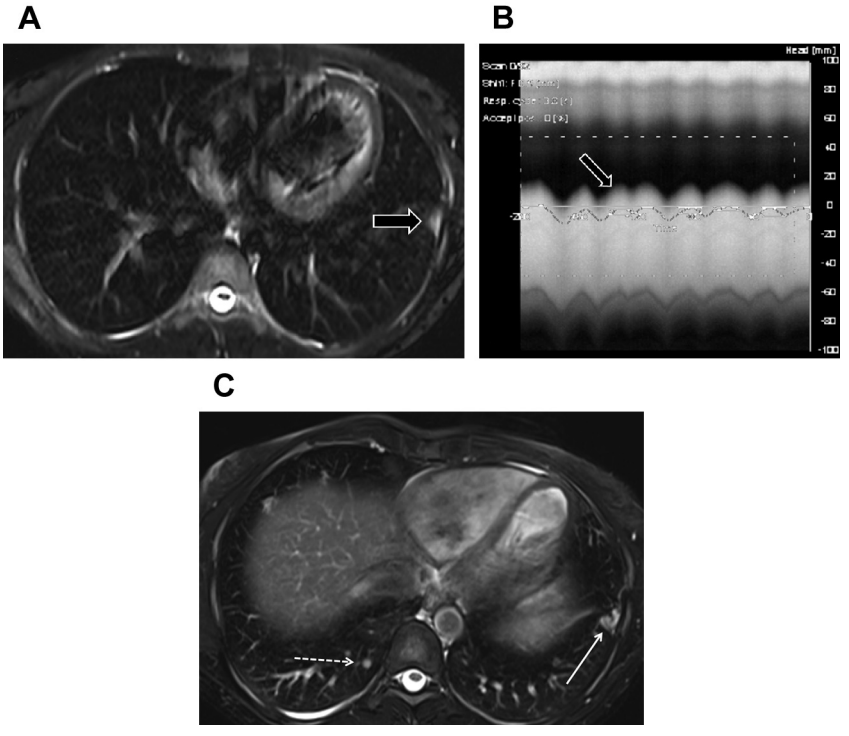

Fig. 1. Navigator gating. (*A*) Axial T2 HASTE MR image shows pleural thickening (*arrow*) in the left lower lobe, but motion artifact degrades image quality. (*B*) The use of navigator gating improves image quality by only accepting signal acquired during the same phase in the respiratory cycle, typically end expiration. The diaphragmatic excursion is plotted (*arrow*) on a time axis. (*C*) The use of navigator gating can improve image quality, although it increases overall imaging time. The previously noted pleural thickening (*solid arrow*) in the left lower lobe is better visualized. A right lower lobe pulmonary artery (*dashed arrow*) clearly seen on this gated sequence was not evident on the nongated sequence.