Space occupying lesions in the fetal chest evaluated by MRI

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Aims and objectives

The purpose of our study is to evaluate MRI findings in the diagnosis and follow-up of space-occupying lesions in the fetal chest with the review of relevant literature.

Methods and materials

The fetuses with space-occupying lesions of the chest were retrieved from our 1.5T fetal MRI database of 17 patients. MRI features including the shape, signal characteristics, feeding artery, margin, mass effect, affected organ parts and anatomic location were reviewed. The results were correlated with the pathology results, follow-up and surgical findings.

Nineteen MR images of 17 fetuses (mean gestational age, 23.8 weeks) with space occupying lesions (1 CCAM, 1 BPS, 1 neuroenteric cysts, 14 CDH) were evaluated. Two cases of CDH completely involuted in utero, 14 newborns were operated, and the resulting 2 fetuses were terminated. The surgical and pathological findings were in accordance with MRI findings.

Results

The most common space occupying lesions of the fetal thorax are congenital diaphragmatic hernia (CDH), congenital cystic adenomatoid malformation (CCAM), and bronchopulmonary sequestration (BPS) (1, 2).

MRI technique and normal anatomy of fetal chest:

In recent years, with the development of ultrafast sequences, MRI has been established as a valuable diagnostic modality complementary to ultrasonography (US). MRI offers several technical advantages over US, including a larger field of view, fewer limitations due to maternal habitus, and the ability to visualize fetal anatomy regardless of fetal presentation (3).

The normal fetal lung on T2-weighted images is homogeneous and has moderate signal intensity. With progressive maturation of the lungs, there is increased signal intensity.
within the lungs from increased production of alveolar fluid. Most pulmonary pathology demonstrates increased T2 signal as compared with normal lungs. In addition, MRI can also help determine the nature of extrathoracic abnormalities which have thoracic manifestations, such as CDH (1, 3).

**Congenital diaphragmatic hernia**

The incidence of CDH is found to be 1: 2000-5000 of life births and CDH-related mortality is high (3, 4). CDH is a developmental defect of variable size in the posterolateral diaphragm that allows herniation of abdominal viscera (such as liver, stomach, spleen and bowel) into the thorax (Figure 1) with subsequent pulmonary compression and hypoplasia. They occur on the left (88%), right (10%) and bilateral (2%) (3).

Herniation of viscera usually occurs during the period of early lung development. This causes a decrease in the number of bronchial branches, alveoli, and blood vessels. The ipsilateral lung is most affected, but hypoplastic changes also may be seen in the opposite lung as the result of the shift of mediastinal structures (1).

The major risk factors of CDH are pulmonary hypoplasia and pulmonary hypertension (3). Quantification of pulmonary hypoplasia in CDH can help in the choice of management options, including termination of pregnancy, planned delivery with intensive postnatal therapy, and fetal surgery (3, 5).

Fetal volumetric measurements can be readily performed on MR images with planimetry, better than US(Figure 2) (5, 3).

The presence of a hernia sac in congenital diaphragmatic hernia is associated with better prognosis (Figure 3a) (6). The diaphragmatic defect itself is occasionally visualized on MRI (80% are left-sided) (Figure 3b).

**Congenital cystic adenomatoid malformation**

CCAM is a rare lesion characterized by a multicystic mass of pulmonary tissue with abnormal proliferation of bronchial structures (1, 2). CCAM represents 25% of all congenital lung lesions (1) Most CCAMs communicate with the normal tracheobronchial tree and receive blood supply from the normal pulmonary artery and vein (1, 2).

Prenatal MRI is helpful in diagnosing CCAM. On MRI, the appearance of these tumors is variable, depending on whether they are microcystic or macrocystic (Figure). The microcystic lesions are high in signal intensity compared to the normal lung. Discrete cysts can be identified within these tumors using MRI.
Bronchopulmonary sequestration

BPS is a mass of non-functioning lung tissue that was supplied by an anomalous systemic artery and do not have a bronchial connection to the native tracheobronchial tree (7). The estimated incidence is at 0.1% (7, 8).

With advances in both fetal ultrasonography and magnetic resonance imaging, abnormalities of the thorax are increasingly being recognized antenatally, allowing providers to anticipate management issues at the time of delivery or later in neonatal life, and help parents comprehend the prognosis.

Ultrasonography is important in the diagnosis of pulmonary sequestration and its complications, in assessing progression, and in forming a prognosis, which, in turn, is important for appropriate parental counseling and fetal therapy (8). This imaging modality is noninvasive and safe, which make its use ideal in the prenatal and postnatal periods. The diagnosis can be made as soon as the early second trimester (9). Color flow and duplex Doppler ultrasonography can elegantly depict the ectopic blood supply and drainage (Figure 4a). Occasionally, these vessels may not be identified at Doppler US, making extralobar sequestration indistinguishable from a microcystic CPAM (7, 9).

MR imaging may help in the diagnosis of pulmonary sequestration by demonstrating a solid, well-defined, uniformly hyperintense mass on T2-weighted images, and the feeding artery may be identified. Systemic blood supply is seen particularly arising from the aorta to a basal lung mass. In addition, MRA may demonstrate venous drainage of the mass and may obviate more invasive investigations (Figure 4b) (8, 9).

Neuroenteric cysts

The enterogenous type of duplication cyst, when associated with vertebral anomalies, is known as a neuroenteric cyst. Neuroenteric cysts are rare congenital anomalies, with only about 30 cases reported in the literature (11). It is a rare posterior enteric remnants that result in a cystic mass in the posterior aspect of the thorax. It results from incomplete separation of the notochord from forught in the third week of embryogenesis. It is speculated that the cause is a persistant ommunication or adhesion between the ectoderm of the spinal cord and endoderm of the forught before neurul tube closure. The cysts are lined with epithelium of endodermal origin.

Neuroenteric cyst may occure in the chest or spinal canal. In the chest, thyre are commonly located in the mediastinum, 90% posteriorly and 66% in the right side. The cysts can penetrate the diaphragm and communicate with small bowel. Vertebral anomalies are always associated.
Few prenatally detected thoracic neuroenteric cysts have been reported. The typical ultrasound appearance is that of septated or bilobed cysts mass in the posterior chest (Figure 5).

Antenatal MRI is very useful for further evaluation as it can show abdominal extension better. Because of the watery content of the cyst it appears hyperintense on T2W images (11, 12). A right-sided or posteroinferior mediastinal location favors the diagnosis of an esophageal duplication cyst. The wall is relatively thicker than that of a bronchogenic cyst. Continuity with the oesophagus, if present, can also be demonstrated by MRI (Figure 6).

Postnatal chest radiographs may show a posterior mediastinal opacity (Figure 7a). CT scan helps in delineating the size, location, extent, and the anatomic association of the mass to other organs. The adjacent lung and vertebral malformation can also be assessed on CT scan (Figure 7b) (11).

**Images for this section:**
Fig. 1: Figure 1: Left congenital diaphragmatic hernia in fetus 37 weeks' gestational age (a, b, d) and 28 weeks' gestational age (c). T2-W sequence, axial (a) and coronal (b, c) and sagittal T1-W sequence (d) scan. 1: right lung, 2: heart, 3: stomach, 4: upper bowel, 5: spleen, 6: distal bowel.
**Fig. 2:** Figure 2: The fetal lung volume measurements were determined by using a workstation and tracing a single free-form region of interest around the visible portions of both the right and left lungs manually on individual consecutive sections in the transverse, sagittal, and coronal planes. The area of each region of interest obtained per image was calculated (based on the cross-sectional area and section thickness), and these calculated areas were summed to determine the total volume of both lungs.
Fig. 3: Figure 3: Left Congenital diaphragmatic hernia in a fetus 21 weeks' gestational age (a) and 32 weeks' gestational age. (a): T2-W sequence, sagittal scan: Note the sac hernia of the left CDH. (b): T2-W sequence, coronal scan. The diaphragmatic defect measurement.

Fig. 4: Figure 4: (a) Left sagittal sonogram of fetal chest: echogenic pulmonary mass. Note systemic feeding artery arising from the abdominal aorta. (b): Coronal prenatal MR image: left-sided triangular pulmonary mass of increased signal intensity and visualization of systemic feeding artery arising from the abdominal aorta (arrow).
Fig. 5: Antenatal USG: Transverse (a) and longitudinal (b) sections show a craniocaudally elongated, posterior mediastinal cyst (arrows).

Fig. 6: Antenatal MRI at 38 weeks gestation: Axial (a) and coronal scans (b) on T2-W sequences, sagittal T1-W sequence scan (d). (a): Partitioned cystic mass of
the right hemi thorax occupying the posterior inferior mediastinum (arrows). (b): Note the continuity with the oesophagus (thin arrows). (c): Lesions is hypointense. (d): The remaining right lung has a satisfactory volume (arrowhead).

**Fig. 7:** Figure 7: Postnatal Radiograph (a) and 3D processing of CT images: (a): A right mediastinal opacity (arrowhead) associated with vertebral abnormality. (b) Coronal reformatted scannogram shows butterfly (arrow) and hemi vertebrae (thin arrows) without opening spinal cord.
Conclusion

Congenital abnormalities of the chest are not common. MRI is useful as an adjunct to prenatal US diagnosis to confirm an abnormality within the fetal chest. MRI is most helpful in those lesions that are atypical or very uncommon masses. It also is very helpful in planning prenatal in utero interventions.

Personal information

References


