Prenatal Imaging of Fetal Lung Lesions: Magnetic Resonance Imaging Complements Ultrasound

■ Beth Kline-Fath, MD; and Constance Bitters, RN, RDMS

ABSTRACT: **Prenatal ultrasound has been used for 30 to 40 years in the evaluation of the fetus. In the 1980s, magnetic resonance imaging (MRI), given its high soft tissue detail, was introduced as an alternative method for fetal evaluation. Initially, MRI of pregnancy was limited to assessing maternal complications, as the fetal detail was poor because of motion on long acquisition times. However, in the 1990s, with the advent of short imaging sequences, fetal MRI rapidly established itself as a technique of diagnostic value. In this article, the authors present a case review of a fetus with a lung lesion, demonstrating the value of this modality. (J Radiol Nurs 2010;29:3-9.)**

KEYWORDS: **Congenital pulmonary airway malformation (CPAM); EXIT procedure; Fetal diagnosis; Lung lesion.**

INTRODUCTION

Ultrasound (US) is the first modality used in fetal imaging and has become the standard of care in obstetrics. US provides good fetal detail without exposure to radiation. It is noninvasive, highly acceptable to patients, easily accomplished, and is not cost prohibitive. In addition, it provides excellent real-time imaging and good-quality vascular detail. However, this technique does have limitations. The field of view is small, soft tissue contrast is limited, and fetal position, maternal body habitus, and decreased amniotic fluid can significantly diminish fetal detail. In the presence of an abnormality, confirming and defining the anomaly is essential to providing appropriate counseling, prenatal, and postnatal care. In these instances, magnetic resonance imaging (MRI) complements US and can improve diagnostic capabilities. At our institution, after prenatal US has identified an abnormality, fetal MRI is typically performed for further clarification and/or definitive diagnosis.

MRI is an excellent modality to evaluate the fetus, as it is also a procedure without ionizing radiation. This technique is performed with the use of radiofrequency waves, a large magnet bore, and a receiver coil. MRI is obtained by imaging the hydrogen particles; the main constituent of water in the human body. Because of the properties of this technique, the images demonstrate superior soft tissue contrast, and multiple planes can be acquired at a large field of view. Fetal MRI is not limited by lack of amniotic fluid or fetal position and provides good detail despite large maternal body habitus. Fetal organ volumes, especially lung volumes, are also accurately calculated with this imaging technique.

However, there are disadvantages with this modality in that it is operator dependent, similar to US. MRI is also performed at a higher cost and assessment of small parts and fetal extremities is often hindered because of limited signal. Fetal or maternal motion can also create artifact, detracting from study detail.

Fetal MRI has been used for 20 to 30 years. During this period, there have been no documented biological risks with fetal MRI (Levine, 2004). Safety in fetal

Corresponding author: Beth Kline-Fath, Department of Radiology, Cincinnati Children's Hospital Medical Center, ML 5031, 3333 Burnet Avenue, Cincinnati, OH 45229-3039. E-mail: beth.kline-fath@cchmc.org

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MRI can be separated into three major categories: teratogenesis, acoustic damage, and heat production. Teratogenesis in pregnancy is a prime consideration for the fetus. The time of greatest risk to the fetus is in the first trimester during organogenesis. Animal studies with chick embryos exposed to a strong electromagnetic field in the first 48 hrs of life resulted in excess number of dead and malformed embryos (Yip, Capriotti, Talagala, & Yip, 1994). Imaging in the second and third trimester, therefore, is favored because this is a time of fetal tissue growth rather than development. Maternal acoustic damage is prevented by providing ear protection. The fetus, however, is exposed to the loud tapping of the rapidly oscillating gradients. A 3-year postnatal study was performed in which 18 fetuses were exposed to the loud gradients during fetal MRI without significant hearing deficits (Baker, Johnson, Harvey, Gowland, & Mansfield, 1994). However, there are no large studies to verify the lack of risk.

Heat production can be detrimental to the fetus, with animal studies showing neural tube and facial defects in first trimester and deficient growth in second trimester when exposed to increase in maternal core temperature 1.5 to 2.0 °C for 1 hr (Graham & Edwards, 1998). It is important to know, that heat production in MRI occurs at the maternal surface. Many believe that there is little or no significant change in maternal core temperature when imaging (Kanal, Shellock, & Talagal, 1990).

Gadolinium is a contrast agent that can be used with MRI. The physiology of gadolinium in pregnancy is not known. This contrast crosses the placenta, enters the fetus, and is then excreted by the fetal kidneys into the amniotic cavity. No studies have been performed to determine the length of time the gadolinium remains in the amniotic fluid. It is also unknown if the compound dissociates into the toxic gadolinium ion. Therefore, administration of gadolinium during pregnancy is not recommended (Kanal, Borgstede, Barkovich, Bell, & Bradley, 2004).

At our institution, fetal imaging is not performed in a pregnancy without an indication and less than 16 weeks gestation. A written consent for the procedure is obtained allowing the family to know that fetal MRI has not been approved by the Food and Drug Administration but that no known complications have been documented. Through the consent, the family is also advised that fetal MRI can identify additional abnormalities of unknown significance, which could increase anxiety during the pregnancy. All mothers are kept without solids for 3 hrs and liquids for 2 hrs before imaging in an attempt to decrease fetal stimulation. Water can be given up to the time of the study. Questions regarding the procedure are answered by the radiologist before the examination. All patient and family members entering the scanner room must fill out a screening sheet for metal devices. Some metals and surgical hardware are ferromagnetic, and therefore can present danger to the patient.

Because imaging is very dependent on maternal comfort, every effort is undertaken to make the patient as relaxed as possible. Before going into the tunnel, patients are asked to empty their bladder and remove any heavy clothing and/or those containing metal as well as their shoes. Because the tunnel of the magnet is small and narrow, some mothers experience claustrophobia and/or positional discomfort. Every effort is taken to reduce these feelings. At our institution, we encourage the patient to lie in a decubitus rather than in a supine positioning as it usually provides maximum imaging quality, patient comfort, and decreases the likelihood of claustrophobia or vasovagal response. A body torso-phased array coil is placed around the mother centered at the level of the pregnancy (Figure 1). Pillows or wedges are used to support the back, abdomen, and legs. The mothers are offered the opportunity to use earplugs, goggles to watch videos, or headset to listen to music. The study usually lasts 30 min to 1 hr. During this time, various images of the whole fetus are obtained, with special emphasis on the area of fetal abnormality. At the end of the examination, the patient is assisted to the sitting position and given time to acclimate to being upright. All mothers are offered crackers and juice and guided to their next appointment.

CASE REPORT

A pregnancy, at 25-weeks gestation, was referred to our facility for evaluation of a fetal lung lesion. On imaging with US, a large heterogeneous echogenic lesion measuring $4 \times 4 \times 5$ cm was identified in the left lung.

Figure 1. Patient is placed in a decubitus positioning with torso-phased array coil centered over area of pregnancy.