MRI of the Fetal Central Nervous System and Body

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KEYWORDS

• MRI • Prenatal diagnosis • Fetal abnormalities
• Central nervous system

Fetal MRI is increasingly used in clinical practice, partly because of the increasing interest in fetal surgery and fetal medicine. It is a powerful modality to evaluate the fetal brain, fetal spine, and fetal body, and is a valuable complement to prenatal ultrasound. The development of ultrafast- imaging techniques has contributed to the increasing clinical use of fetal MRI. Fetal MRI allows direct visualization of certain structures, such as the developing brain parenchyma, is not susceptible to the same limitations as ultrasound, and has higher contrast resolution than prenatal ultrasound, thereby allowing better differentiation of normal from abnormal tissue. Structural brain abnormalities, such as developmental malformations and destructive lesions, can be sonographically occult on prenatal ultrasound, yet detectable by fetal MRI. Fetal body abnormalities can also be well characterized using fetal MRI. As fetal-surgical techniques are increasingly developed, fetal MRI is also useful in evaluation of patients before and following surgery. Moreover, fetal MRI offers the promise of contributing to our understanding of normal and abnormal fetal development with continued advances in MRI techniques.

INDICATIONS

Fetal MRI is primarily used to evaluate abnormalities of the fetal central nervous system (CNS) or fetal body that are detected by routine prenatal sonography. Most commonly, fetal MRI is performed to evaluate suspected brain abnormalities. In these cases, it is performed to confirm the sonographically detected abnormality, further characterize it, and identify any additional sonographically occult CNS abnormalities.[1,2] Although no formal data exist, it is well accepted that prenatal ultrasound is limited in its ability to detect many of the destructive and developmental lesions that occur prenatally.[3,4] MRI of the fetal brain is most commonly performed for prenatally

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detected ventriculomegaly, followed by abnormalities of the corpus callosum and posterior fossa, including Chiari II malformations.

Fetal MRI is also used to detect brain abnormalities in cases where the fetus is at increased risk for brain abnormalities, even if the prenatal ultrasound of the brain is normal. This includes complicated twin pregnancies and patients with a history of a prior child or fetus with developmental brain abnormalities. In these cases, fetal MRI is performed even when the prenatal sonogram is normal, since many brain abnormalities can be difficult to detect with sonography.

With recent advances in fetal surgical techniques, fetal MRI is being increasingly used to evaluate the fetal brain and spine before or following surgical intervention. In particular, fetal MRI is used to evaluate the fetal brain in complicated monochorionic twin pregnancies, including twin-twin transfusion syndrome or co-twin demise. Because complicated monochorionic twin pregnancies are associated with higher risk of neurodevelopmental childhood disabilities, fetal MRI is used to evaluate these fetuses, even when the prenatal ultrasound of the brain is normal. Fetal MRI is also performed to evaluate the brain and spine in cases of myelomeningocele. In centers that perform in utero repair of myelomeningoceles, it is typically performed before surgery.

Fetal MRI is also performed for evaluation of fetal masses, including neck masses, thoracic masses, and abdominal masses. In cases of congenital diaphragmatic hernia, congenital cystic adenomatoid malformation, neck masses, and urinary tract obstruction, fetal MRI can provide important diagnostic information which can be used to evaluate for fetal surgery.[1]

Fetal MRI can also be useful in situations where the fetus is difficult to image by ultrasound. These include cases of decreased amniotic fluid, such as in urinary tract obstruction, large maternal body habitus; and when fetal position makes it difficult to evaluate the structure of interest. In cases of suspected brain abnormalities, fetal MRI is also useful at advanced gestational ages when shadowing from the calvarium can interfere with ultrasound images.

SAFETY OF FETAL MRI

There are no known deleterious effects of fetal MRI on the fetus when performed on MRI scanners that are 1.5 Tesla strength or lower.[5–12] Recent guidelines by the American College of Radiology on safe MRI practice states that ''Pregnant patients can be accepted to undergo MRI scans at any stage of pregnancy if, in the determination of a Level Two MRI Personnel designated attending radiologist, the risk/benefit ratio to the patient warrants that the study be performed.''[9] When performing fetal MRI, sedating agents are not administered during the examination. Intravenous contrast is also not recommended in fetal MRI because of the potential risk to the fetus. Prior to the examination, all patients are screened for possible contraindications to MRI. It is also recommended that all patients sign a consent form at the time of the fetal MRI. Because of the current technical limitations of fetal MRI, it is preferable to wait until at least 20 to 22 weeks gestation to minimize the difficulties created by the small size of the fetus and the excessive motion of younger fetuses.

IMAGING TECHNIQUES

Fetal MRI is routinely performed on 1.5 Tesla scanners. There are several limitations to fetal MRI, including fetal motion, the small size of the structure being imaged (particularly at younger gestational ages), and the distance between the receiver coil and the structure being imaged. Because of this, fetal MRI is usually not performed until 20