Case series: Fetal* MR Imaging of the Brain at 3T

Jacques F. Schneider

University Children’s Hospital, Basel, Switzerland

Background

Fetal MR imaging (MRI) is a recognized complementary method to fetal ultrasound to identify fetal central nervous system (CNS) pathology. It can provide additional and diagnostically-relevant information, add certainty to ultrasound diagnosis and help parental counselling. In most imaging centers MRI is performed at 1 or 1.5 Tesla field strength, with no proven deleterious effect on the fetus to date. According to national and international guidelines, fetal MRI is recommended from the second trimester of gestation, and specific absorption rates (SAR) for each pulse sequences are limited by the manufacturers to ensure that increase in body temperature is less than 0.5°C. Experimental physical evidence suggests that SAR deposition to the fetus in utero is only minimally higher at 3 Tesla, and still within the guidelines recommendation, but care still needs to be taken. This case series intends to provide an insight into the enhanced visualization of fetal CNS in selected brain pathologies at 3 Tesla.

Materials and methods

All images in this case series were acquired on a 48-channel whole-body 3T scanner (MAGNETOM Skyra) with a combination of the Body Matrix coil anteriorly and integrated spine coil posteriorly. Fetal brain protocol typically consists of T2-weighted (w) HASTE single-shot in all three planes, T1w FLASH in the axial plane, Diffusion-tensor imaging in the axial plane. Selected sequence parameters were as follows and adapted to the patient:

**Sequence parameters**

<table>
<thead>
<tr>
<th>Protocol</th>
<th>TR/TE</th>
<th>SL</th>
<th>FOV</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial / Coronal / Sagittal T2w HASTE (free-breathing)</td>
<td>1100 / 96 ms</td>
<td>3 mm</td>
<td>(280*280) mm²</td>
<td>(256*230) px²</td>
</tr>
<tr>
<td>Axial T1w FLASH (breathhold)</td>
<td>122 / 2.46 ms</td>
<td>3 mm</td>
<td>(280*280) mm²</td>
<td>(224*168) px²</td>
</tr>
<tr>
<td>Axial epi2D mddw20 (free-breathing)</td>
<td>4300 / 85 ms</td>
<td>3 mm</td>
<td>(220*220) mm²</td>
<td>(142*142) px²</td>
</tr>
<tr>
<td>Sagittal T2w trufi2d (breathhold)</td>
<td>3.88 / 1.7 ms</td>
<td></td>
<td>(376*376) mm²</td>
<td>(614*768) px²</td>
</tr>
</tbody>
</table>

Conclusion

This short case series shows that fetal MRI at 3T is feasible and delivers excellent visualization of fetal brain and spine structures. With growing experience, the use of 3T systems for fetal MRI could add much-needed certainty in the diagnostic workup of fetal brain pathologies.

*MR scanning has not been established as safe for imaging fetuses and infants under two years of age. The responsible physician must evaluate the benefits of the MRI examination compared to other imaging procedures.*
Case 1

A 30-year-old female in her 23rd week of pregnancy was referred for a fetus presenting with hydrocephalus, thickened neck sign, incomplete falx and suspicion of corpus callosum agenesis. Imaging findings show only a partial absence of the corpus callosum with persistency at the genu (1A) and a massive dilatation of the ventricular system (1B, 1C). There is also a parafalcine cyst on the right side (1C). No calcification or bleeding (1D) and no parenchymal diffusion anomaly were detected (1E).
Case 2

A 29-year-old female in her 26th week of pregnancy was referred for a fetus with progressive hydrocephalus and inconsistent visualization of the midline structures. MRI shows intact corpus callosum and midline structures, a moderate dilatation of both side ventricles but clear depiction of cysts at the caudothalamic groove (2A), as well as intraventricular septations in both occipital horns (2B), raising the suspicion of an intrauterine infection. Diffusion trace images did not show parenchymal ischemia or infarctions (2C) nor were calcifications detected on T1w imaging (2D). Recent cytomegalovirus infection was subsequently confirmed in the mother, and in the fetus after delivery.
Case 3
A 30-year-old female in her 26th week of pregnancy was referred for a fetus presenting with massive hydrocephalus and a large posterior fossa. MRI findings demonstrate massive dilatation of both side ventricles, a cystic dilatation of the posterior fossa (3A), a large communication between the retrocerebellar space and the fourth ventricle (3B) and a partial absence of the vermis (3A–B). These findings are characteristic for a malformation of the Dandy-Walker variant type.

Case 4
A 35-year-old woman in her 36th week of pregnancy was referred for a suspicion of myelomeningocele and Arnold Chiari II malformation. MRI clearly depicts the defect of the posterior spine at the level of the promontorium at L5 with tethered cord and myelomeningocele (4A). Nevertheless, at the craniocervical junction the usual signs of an Arnold-Chiari II malformation are missing (4B), and no hydrocephalus was present (4C).