

MR Imaging characteristics of the fetal gastrointestinal tract and abdomen

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Prenatal fetal diagnostics should fulfil many medical, diagnostic, psychological and ethical criteria. Prenatal ultrasonography (US) fulfils most of these criteria. Fetal US has however also limitations. Maternal obesity, bowel gas and pelvic osseous structures may obscure the view to the fetus. Late in pregnancy, the small field-of-view of US may limit the identification of complex, multilevel fetal pathologies.

Many recent studies have shown that fetal magnetic resonance imaging (MRI) is a valuable adjunct to US in complex pathologies. Initially, the studies were focussed on the central nervous system (CNS) (1,2,3), lately fetal MRI gained importance in the evaluation of the fetal thorax and abdomen (4,5,6,7,8,9,10,11,12,13).

Goal of this lecture is to present the normal anatomy of the fetal gastrointestinal tract and abdomen.

Fetal MRI sequences

T2-weighted FIESTA-sequences covering the entire uterus are used as localizer and give an initial impression about the location, size and anatomy of the fetus. Alternatively, a breath-hold, thick-slab heavily T2-weighted (long TE and TR-time) image (slice thickness: 50-80 mm) can be acquired. The abundance of amniotic fluid

are ideally suited to render a fast (~1-2s) “survey-image” of the fetus (MR-fetography).

T2-weighted images are acquired using a single-shot fast spin-echo (SSFSE) sequence as previously published (2, 3). Care is taken that the single-shot images are acquired with a 1-2 seconds time interval to prevent saturation effects that would degrade image quality.

T1-weighted images are acquired using a breath-hold, fast spoiled gradient-echo (FSPGR) sequence. This sequence acquires up to 15 images within 15 seconds. This sequence is however susceptible for fetal motion.

Finally, a dynamic T2-weighted FIESTA sequence can be added to study fetal motion.

Imaging of the gastrointestinal tract

During pregnancy, the gastrointestinal (GI) tract is progressively filled/distended by swallowed T2-hyperintense and T1-hypointense amniotic fluid. The T2-hyperintensity of the amniotic fluid serves as an intrinsic contrast allowing to identify small anatomic details within the oral cavity, pharynx and larynx. In healthy fetuses, the oesophagus, stomach and duodenum should always be filled with T2-hyperintense amniotic fluid. The distal ileum and colon is filled with T2-hypointense and T1-hyperintense meconium. The progressive mixture of amniotic fluid with meconium comparing the upper with the lower GI tract is characterized by a gradual reduction of the T2-signal intensity and an increase of the T1-signal intensity. T2-hyperintense small bowel loops are seen within the left upper abdomen while T2-

hypointense loops are identified within the right lower abdomen. With advancing pregnancy, the amount of meconium will increase gradually. The T1-hyperintensity of the meconium compared to the moderate signal intensity of the abdominal organs can be used for maximum intensity projection reconstructions of the colon.

Rarely the mesentery can be identified as a soft tissue structure suspending the bowel loops.

Imaging of the liver, pancreas and spleen

The liver is initially symmetric because both liver lobes are equally well perfused; the left lobe by the umbilical vein and the right lobe by the portal vein. Towards the end of pregnancy the right lobe progressively increases in size relative to the left lobe. The liver is T2-hypointense and T1-iso/hyperintense. The periportal fat is T2-hyperintense and T1-hypointense. The gallbladder is T2-hyperintense and T1-hypointense. The umbilical vein is seen as a T2-hypointense tubular structure entering the liver along the ventral, median surface.

The pancreas is difficult to identify. The T2- and T1-hyperintense peripancreatic fat may enhance delineation of the pancreas. The pancreas is discrete T2-hyperintense and T1-isointense relative to the liver. The pancreatic ducts are rarely seen. The close relation to the T2-hyperintense duodenum may help to identify the pancreatic head.

The spleen is seen within the left upper abdomen and is discretely T2-hyperintense and T1-hypointense relative to the fetal liver. The signal intensity may change during progression of pregnancy.

Imaging of the urogenital tract

The kidneys display a clear cortico-medullary differentiation towards the end of gestation; the cortex is somewhat T2-hypointense compared to the medulla, the renal pelvis filled with T2-hyperintense urine. The cortico-medullary differentiation is less pronounced on T1-weighted sequences. The kidneys' surface shows the typical fetal lobulation. The urinary bladder is filled with T2-hyperintense and T1-hypointense urine. The urinary bladder should always be seen. The combination of an empty urinary bladder, oligohydramnios and small, T2-hypointense lungs should raise the suspicion of bilateral renal agenesis.

The adrenals are large in fetuses compared to adults. The adrenals are triangular in shape and can be differentiated from the kidneys because they are surrounded by fat. The adrenals are isointense to the kidneys or slightly hypointense.

The normal uterus and adnexes are difficult to recognize. The penis and scrotum are demarcated by amniotic fluid.

Imaging of the abdominal wall and umbilical cord

The abdominal wall is closed by the 10th week of gestation. Fetal MRI displays the umbilical cord from the placenta until the insertion into the abdominal wall. Two small umbilical arteries swirl around the larger central umbilical vein. On T1-fast-spoiled-gradient-echo sequences flow related enhancement is frequently seen within the umbilical arteries.

Conclusion

The indications for fetal MRI are continuously expanding. In the past, fetal MRI has proven its value in CNS-pathologies, nowadays the fetal thorax and fetal abdomen become accessible for fetal MR-studies. High resolution T2- and T1-weighted images allow examining the gastrointestinal tract and abdominal organs. Multiplanar reconstructions as well as three dimensional MIP's may be helpful to study the complex abdominal anatomy. Knowledge of the normal fetal abdominal anatomy is essential to understand and depict fetal pathology. The fetus should be studied as a unit. The umbilical cord and placenta should not be forgotten. US remains the primary imaging modality in pregnancy, fetal MRI can however serve as an imaging modality to confirm, complete or correct complex US-findings.

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