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BRIEF COMMUNICATION

Prenatal Diagnosis of Renal Failure by Fetal Biparametric Magnetic Resonance Imaging

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Abstract Congenital anomalies of the kidneys and urinary tract represent 93% of all prenatally diagnosed malformations. In the reported case, fetal Biparametric MRI (Bp-MRI) by morphologic (T1- and T2-weighted) and functional diffusion-weighted (DW) images allowed both diagnosis of congenital anomalies (e.g., hydrometrocolpos with septate vagina and uterus didelphys), and associated malfunction of kidneys by means of measurement of cortical and medullary apparent diffusion coefficient (ADC) values.

Keywords Urogenital anomaly · Renal failure · MRI · Prenatal diagnosis

Introduction

Magnetic resonance imaging (MRI), thanks to better spatial resolution and its independence from the position taken by the fetus, is currently recognized as a valuable tool for the imaging of fetal anatomy, providing diagnostic accuracy in evaluating fetal abnormalities of brain, spine, neck, chest, abdomen, and urinary tract and can be helpful in planning antenatal treatment [1, 3–5].

Fetal diffusion-weighted MRI (DW-MRI), in addition to T1- and T2-weighted imaging [Biparametric MRI (Bp-MRI)], allows functional information and represents a useful complementary tool for diagnosing fetal urogenital anomalies. Particularly, the kidney is an interesting organ to analyze by means of DW-MRI because of its high blood flow and water transport functions. DW-MRI has already been successfully applied in fetal imaging and in children providing information on normal renal development [1, 2] with the consequent potential of disease assessment. In diffuse renal disease, diagnosis based on morphology is made usually late in the course of the disease process and an adequate treatment is therefore often delayed. DW-MRI has shown promising results for the evaluation of acute and chronic renal failure with decreased apparent diffusion coefficient (ADC) values, reported in this group of patients [1, 2] compared to healthy fetuses.

We report the value of Bp-MRI in the assessment of failure of the hypoplastic kidney and contralateral agenesis in a case of hydrometrocolpos with septate vagina and uterus didelphys.

Report of Case

A 30-year-old woman, gravida 4 para 0, was referred to our institute at 35 weeks' gestation for evaluation of a fetal abdominal cystic mass. A routine fetal ultrasound examination in the second trimester showed no abnormal findings, but at 35 weeks of gestation, a cystic mass was detected in the fetal abdomen. Ultrasonography (US) at referral revealed a retrovescical septate hypoechogenic

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mass (80 mm × 70 mm × 55 mm) within the fetal abdomen. The right kidney was absent. Cerebral and cardiac anatomy and the extremities were normal. Due to late gestation, it was not possible to visualize the fetal external genitalia by US.

Fetal Bp-MRI was performed using a 1.5-T magnet (Siemens Magnetom Avanto, Erlangen, Germany) with the manufacturer's 16-channel phased-array torso XL coil for signal reception.

Bp-MRI protocol consisted of T1-weighted fast low-angle single shot (FLASH) gradient echo (GRE) with and without fat saturation, T2-weighted single-shot turbo spin echo (SS-TSE) and DW images with b values of 0, 200, and 700 s/mm^2 in free breathing mode using respiratory gating acquisitions.

Bp-MRI confirmed the abdominal mass located in the midline posterior to the bladder. The mass was fluid-filled with a midplane septum and showed that it was connected to two small uterine cavities (Fig. 1). These findings were consistent with a diagnosis of hydrometrocolpos with septate vagina and uterus didelphys. Absence of right kidney was confirmed and hypoplastic contralateral kidney was found. In addition, DW-MRI showed failure of the hypoplastic kidney by a decrease in the cortical and medullary ADC values (ADC = 0.98 × 10^{-3} mm^2/s) (Fig. 2).

Discussion

Fetal MRI plays an increasingly important role in evaluating fetal anatomy, in the diagnosis of fetal abnormalities and can be helpful in planning antenatal care and surgical procedures [1, 3–6].

Therefore, fetal MRI has proven to be a correlative imaging modality that provides a more detailed anatomic description and better soft-tissue resolution in the vast majority of cases, whereas US has been inconclusive, especially if oligohydramnios, altered fetal anatomy or pathologic findings of the pelvic structures are present [7].

The standard technique mostly used in clinical practice for fetal MRI includes T1-weighted GRE, ultrafast T2-

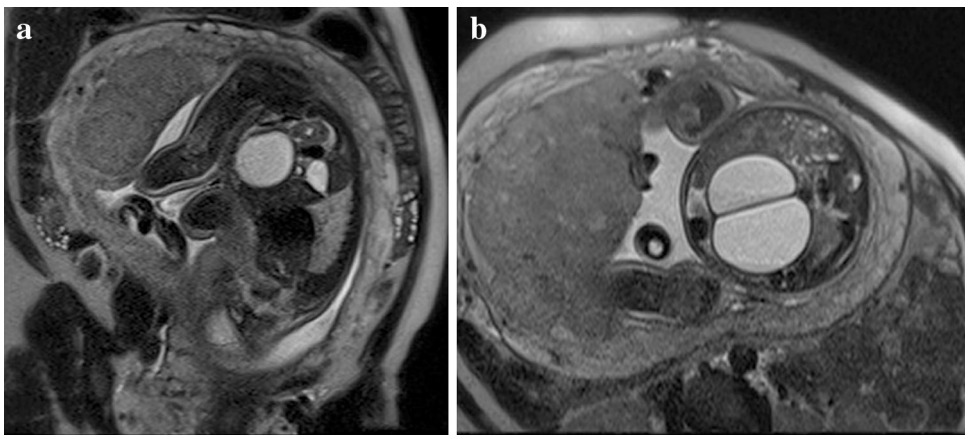

Fig. 1 Fetal magnetic resonance imaging (MRI) in a 30-year-old woman, gravida 4 para 0, at 35 weeks' gestation. T2-weighted showed a hypoplastic *left kidney* (**a**) and a voluminous mass in the midline posterior to the bladder in the fetal abdomen; the mass was fluid-filled with a midplane septum and showed that it was connected to two small uterine cavities (hydrometrocolpos with septate vagina and uterus didelphys) (**b**)

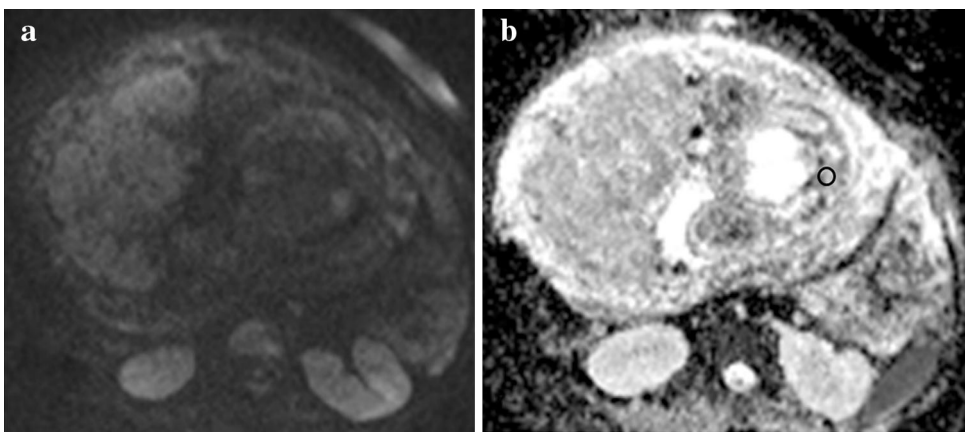

Fig. 2 Diffusion-weighted magnetic resonance imaging (DW-MRI) with b = 700 s/mm^2 (**a**) and ADC map (**b**) demonstrated decreased cortical and medullary ADC values (ADC = 0.98 × 10^{-3} mm^2/s) (*O* in **b**) suggesting failure of the hypoplastic left kidney

SSFSE and balanced steady-state free precession (B-SSFP) sequences. DW-MRI sequences can be added to the standard technique in certain indications [8].

In a recent revised report on practice parameter for safe and optimal performance of fetal MRI, the American College of Radiology and the Society of Pediatric Radiology listed the indications of DW-MRI in only two occasions: the first is evaluation of suspected ischemic or metabolic brain changes, and the second is identification of renal tissues [9].

The potential and the evaluation of the fetuses using DW-MRI for indications other than those mentioned was done at research level in scarce studies [6, 10–12]. Two established indications for using this sequence in clinical practice are, namely, those investigating fetal cerebral white matter diseases and presence of renal tissues [13].

Fetal Bp-MRI allows morphologic and functional information representing a useful complementary tool for diagnosing fetal urogenital anomalies, particularly for kidney that has high blood flow and water transport functions. In addition, DW-MRI allows the calculation from tridirectional gradients (*b* values) of ADC, a quantitative parameter that combines the effects of capillary perfusion and water diffusion [14].

At our institution we use Bp-MRI for: (1) neurologic vascular disease; (2) assessment of lung parenchyma maturation; (3) renal pathology (such as polycystic disease, suspected renal infarction due to venous thrombosis with a decrease in the ADC or the twin–twin transfusion syndrome) and diagnosis of (unilateral or bilateral) renal agenesis thanks to high sensitivity in detection of the renal parenchyma; (4) placental pathologies (e.g., placenta accreta); (5) fetal tumors [benign cystic or congenital hepatic masses (e.g., hemangioendothelioma, hepatoblastoma or metastatic neuroblastoma), renal cystic lesions (e.g., mesoblastic nephroma)], (6) differential diagnosis with adrenal hemorrhage and retroperitoneal teratomas solid mass.

In the reported case, MRI by T1- and T2-weighted sequences allowed diagnosis of congenital anomalies (e.g., hydrometrocolpos with septate vagina and uterus didelphys) associated with renal malformations (e.g., hypoplastic kidney with contralateral renal agenesis). In addition, DW-MRI demonstrated failure of the hypoplastic kidney by a decrease in the cortical and medullary ADC values (ADC = 0.98×10^{-3} mm^2/s) compared with the ADC values in normal renal parenchyma (ranged from 1.1 to 1.8×10^{-3} mm^2/s) of the same gestational week age [1, 2].

In conclusion, fetal Bp-MRI represents a useful tool in clinical practice providing a prompt diagnosis of congenital anomalies and renal failure for an appropriate therapy.

Compliance with Ethical Standards

Conflict of interest None.

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