ORIGINAL RESEARCH PAPER

Radiodiagnosis

A SPECTRUM OF RARE FETAL PATHOLOGIES : MAGNETIC RESONANCE IMAGING AND DIFFUSION-WEIGHTED IMAGES WITH APPARENT DIFFUSION COEFFICIENT VALUES

KEY WORDS: fetal mri, rare pathologies, diffusion weighted imaging

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ABSTRACT

INTRODUCTION: Familiarity and experience of radiologists and clinicians on fetal MRI are limited. We shared fetal MRI and DWI findings of rare pathologies during prenatal period. It is obvious that sharing rare case findings through fetal MRI would contribute to experiences of the radiologists.

METHODS: Totally 17 fetal MRIs which were taken within the last 1 year in our hospital were reviewed retrospectively. In the fetal MRI, T2 and T1-weighted seqences were taken and DWI was obtained, apparent diffusion coefficient was calculated.

RESULTS: Fetal MRIs were reviewed retrospectively. Among seventeen MRIs, the fetuses with giant chondroma originated from the fetal foot, intracranial huge cystic mass, segmental MCDK, UCDK concomitant to anal atresia, suspicious partial palate cleft and hepatic cyst were selected; and image characteristics and signal features on T2- and T1-weighted series; aparent diffusion coefficient values of the lesions were calculated.

DISCUSSION: A fetal MRI which is performed properly and interpreted by experienced radiologists contributes to the diagnosis and serves as a guide for treatment, birth planing and consultancy. DWI provides a great contribution to differential diagnosis of rare prenatal pathologies, especially differentiation of malign and benign formations.

INTRODUCTION

Fetal MRI is a screening method of a moving fetus through rapid sequences. Ultrasonography (USG) is a preferred screening modality in fetus. Fetal MRI should be performed if USG findings give an impression about an abnormality that may be scanned by MRI. Indications for fetal MRI were defined in detail in ACR-SPR guidelines in 2015([1]). Use of MRI for detailed imaging of the fetus as well as prenatal formations has gradually increased during pregnancy and such method is accepted widely by the clinicians([2]). MRI enables to differentiate individual fetal structures such as lungs, liver, kidneys and intestines through soft tissue contrast resolution (3). However, it is obvious that normal anatomy of a developing fetus coincides with a wide range of fetal pathology spectrum. Familiarity and experience of radiologists and clinicians on fetal MRI are limited. It is obvious that sharing rare case findings through fetal MRI would contribute to experiences of the radiologists. A fetal MRI which is performed properly and interpreted by experienced radiologists contributes to the diagnosis and serves as a guide for treatment, birth planing and consultancy. We believe that experiences on fetal MRIs which are taken less in many of the hospital would provide significant contributions to the literature. We shared the MRI findings of rare conditions from 17 fetal MRIs taken because of the indications compliant to ACR-SPR guidelines.

METHODS

All MRIs were obtained by 1.5 T superconducter magnet and phase array surface bandage (Magnetom Aera 32-channel SIEMENS Healthcare). Fetal MRI should be performed following bladder discharge at postprandial hours 3-4. The expectant mother should be positoned at supine position; and MRI may be performed at left lateral decubitus position. Our imaging is performed at supine position. After one localiser is obtained from three planes according to the fetus, T2-weighted SSFSE/SSFFE (HASTE, TrueFISP) and T1-weighted S/U-FGRE sequences (FLASH; and DWI (b0-b500-b1000) was obtained for those with indication (Table 1). Apparent diffusion coefficient values (mm/s) were calculated in prospective evaluation Signal characteristics of the pathologies assessed were interpreted in comparison of amniotic fluid, CSF and placenta. All pregnant women exposed to fetal MRI were TORCH negative. MRI was performed on the following indications: Cisterna magna variation in six cases,; Dandy-walker variant in one case; intracerebral cystic mass in one case; cleft lip and partial cleft palate in one case; atypical segmental multicystic dysplastic kidney (MCDK) in one case; unilateral dysplastic kidney (UDK) and anal atresia in one case; chondorma on fetal foot in one case, mesenteric cyst in one case, hepatic cyst in one case and scar pregnancy in two cases (Table 2). Among the aforesaid cases, rare conditions of which MRI and DWI findings highly contribute to patient management were shared.

RESULTS

A Giant Chondroma of the Fetal Foot

A primigravide case with a gestational age of 37 weeks according to LMP was referred to our hospital because of fetal abnormality. In the prenatal USG, fetal biometry was consistent with LMP and the amniotic fluid index was normal. In USG and doppler examination, a significantly hypervascularized mass with dimensions of 170x130 mm surrounding toes of the fetus was detected. Soft tissue tumor was considered with these findings; and a fetal MRI was performed. In the fetal MRI; a mass which was originated from the cortex of right toes and extending to the distal side of cruric through an exophytic growth between the toes was detected with a minimally hyperintense pattern according to amniotic fluid in T1-weighted series, significantly hypointense according to the placenta; and slightly hypointense according to the amnion fluid and hyperintense according to the placenta in T2-weighted series (Figure 1a,b). There was not any diffusion restriction in DWIs and apparent diffusion coefficient values was measured: as 2.240 mm/s (Figure 1c,d). Such characteristics were interpreted as a benign soft tissue tumor. The pregnant women delivered the baby via Caseraen section. In the physical examination of the newborn, a mass which completely surround the right foot and extend to the ankle was observed (Figure 1e). Furthermore, syndactylia on both fingers and concomitant deformities on the left toes were detected. Other organ systems were normal, and the patient was referred to newborn service. Upon rapid growth in the mass on the foot, amputation of the right leg was performed during newborn period. Pathological examination was reported as chondroma. We did not detect any prenatal MRI findings for chondroma. Chondroma is a cartilage originated benign tumır and may be detected with similar rates in both genders. It is characterized by mature hyalinized cartilage formation. It is considered to be originated from the abnormal

zone created by dysplastic chondrocytes in the growth plate ([3]). The lesion is called enchondroma if located centrally in the bone or chondroma if located outside the cortex. This condition is rare during intrauterine period. Short tubular toes and fingers are invaded in general whereas long bone and costa invasion is rare. Malign transformation is rare. Treatment is wide resection([4]).

Huge Intraventricular Cystic Mass

A primigravide case with a gestational age of 37 weeks according to LMP was referred to our hospital because of fetal abnormality. The prenatal USG revealed normal fetal biometry consistent with LMP and the amniotic fluid index was normal. An avascular cystic mass with dimensions of 29x26 mm which is located on the periventricular side of left hemisphere was detected in the USG and doppler examinations; the relation of the mass with the ventricle could not be evaluated. Fetal cranial MRI was performed for differential diagnosis. In fetal MRI; a mass of 33x29x26 mm including a cystic component which is isointense with CSF and a solid or septa parts which are isointense with the cortex in T2- and T1-weighted series was detected on the left hemisphere associated with the temporal horn and periventricular extension (Figure 2a). There was not any diffusion restriction in DWIs and apparent diffusion coefficient values was measured: as 2.542 mm⁄s (Figure 2b). Such characteristics were interpreted as benign cystic mass. The pregnant woman delivered the baby through Cesasearn section.

Differential diagnosis in the children with intraventricular mass includes papilloma of the choroid plexus, ephendimoma , primitive neuroectodermal tumor teratoma and astrocytoma ([5]). Astrocytoma is the most common pediatric cerebral neoplasm([6],[7]). PNETs may appear on the lateral ventricles rarely. Despite astrocytoma, vesogenic edema findings may be detected. Such neoplasm presents MRI signal intensities like papilloma of the choroid plexus ([6]). Intraventricular ephendimomas are well defined lesions with a wide age range. MRI reveals in a hyperintense signal in T2-weighted series and heterogenous density in T1 weighted images([6,8–10]). Radiological findings indicate that there is not any difference between papilloma and carcinoma. Choroid plexus cysts (CPC) locate on intraventricular area and usually regresses; they appear in 0.18% to 3.6% of fetal abnormalities. Although such cysts are benign, they may be associated with fetal aneuplody ([1,11]). Prognosis of the cerebral tumors diagnosed prenatally is poor; however, this is less significant in intracranial cysts.([9]). Hydrocephalus is observed both in papilloma and carcinoma; however, rapid enlargement is natural for papilloma, especially in the newborn. Mass volume and colored doppler imaging findings do not allow to differentiate benign and malign tumors. Since papilloma and carcinoma are considered as possible causes and histological examination cannot be performed prenatally, a careful consultancy is especially important in such cases ([12]). Effect of many conditions like mentioned above has a variable effect on further development of a child. During the decision process bout termination or continuation of the pregnancy, the information that guide the clinicians should be increased. Although MRI is considered in association of a certain neoplasm, majority of the tumors actually different non-patognomonic imaging patterns. Early diagnosis skills may contribute to better differentiate specific tumor types, better surgical planning and better postnatal outcomes through more specific morphological details achieved by MRI([10])

Atypical Segmental MCDK and Ureterocele

A primigravide women with gestational age of 22 weeks according to LMP was referred to our clinic because of perinatological USS screening during 2nd trimester. The prenatal USG revealed that the fetal biometry was consistent with the gestational age and amniotic fluid index was normal. A mass which fills the left adrenal compartment with indistinct upper renal pole margin and dimensions of was detected in the fetal abdomen. Lower pole of the left kidney appeared as pushed to downwards and medial side. In addition, a cystic image considered as uretherocele was detected in the bladder lumen. Fetal MRI was performed due to preliminary diagnosis of renal or adrenal-originated mass. In the MRI; an image consistent with segmental multicystic dysplastic kidney presenting a shunting with upper kidney pole including multiple cysts in T2- and T1-weighted series. Lower renal pole presented near-normal characteristics (Figure 3a). No diffusion restriction was detected in DWIs; apparent diffusion coefficient values were measured: 2,901 mm⁄s (Figure 3b). The septation of uretherocele was clearly identified within the bladder (Figure 3c). The fetus was delivered via Ceaseran section at term. In the postpartum USG, atypical segmental MCDK and dublex collecting system with ureterocele diagnosis were confirmed. MCDK is the second common cause of renal masses in the newborns following hydronephrosis. MCDK is a common abnormality which is well defined in the literature; however, segmental type is very rare. Segmental MCDK typically appears on the upper pole of a kidney which has dublex collecting system and proximal urether atresia. Renal tumors consist of 2.5% to 7% of all congenital tumors ([13]). Mesoblastic nephroma (MN) and Wilm's Tumor (WT) may be considered for differential diagnosis. MN is also known as renal hamartoma and one of the most commonly diagnosed renal tumor during prenatal period. WT may be diagnosed as in utero and consists of 80% of all childhood renal tumors. ([14]). MN and WT may not be differentiated in utero and they require pathological analysis for differentiation ([15]). Cystic lesions may be detected in MCDK or simple renal cysts. A useful tip for differential diagnosis of dysplastic kidney is loss of brightness on ADC images in DWI sequences. Another finding for differentiation of the cysts from dilatation of collective systems is localization pf the cystic lesions. The lesions are more likely to be cystic if located on the periphery whereas central lesions may be caused by dilatation of the collective system.([16]). Duplex collective system is the most common structural modifications of the urinary tract. The upper part is dysplastic in many case and indicates dilatation of the collective system([17]). In such cases, conditions of the urethers should be searched thoroughly. Ectopic urehter requires different surgical approaches and may locate at any height such as urether located on the bladder base due to union with renal pelvis. Ectopic urether may be associated with ureterocele. ([16]) . In the present case, cystic part of the segmental dysplastic component was hyperintense in ADC mapping and diffusion restriction is not detected.

Anal atresia and unilateral CDK presenting with postnatal renal agenesia

A primigravide patient with gestational age of 19 weeks according to LMP was referred to our clinic because of 2nd trimester screening by USG. In the USG, fetal biometry was consistent with LMP and amniotic fluid index was at 5th percentile. Right kidney appeared as hypoplasic and dysplastic; and included a cystic lesion with a diameter of 12 mm. Such findings were considered as unilateral dysplastic kidney. Fetal abdominal MTRI was performed. In the MRI; the right kidney appeared small and dysplastic cystic in T2-weighted series (Figure 4a); second, an anal atresia was detected in the fetus (Figure 4b). Upon development of IUGR at week 34, delivery was planned via Casearen section. A boy with a body weight of 20.75 was born. The newborn was operated due to anal atresia and in the USS, the cystic dysplatic kidney could not be visualized and it was accepted as agenesia. We could not detect any finding of MRI defined for concomitant unilateral CDK and anal atresia at 2nd trimester in the literature. Last meeting of the European Union, the anorectal malformation network (ARM-Net) detected that prenatal diagnosis of anorectal malformations have an important value for patient care. Increasing diagnosis rates for the fetuses with gastrointestinal pathology during prenatal period would also increase the number of the mothers who may have access for antenatal care. Although USS remains to be a strong tool for prenatal pathologies, fetal MRI obtains a ground and accepted by the clinicians for rare pathological conditions. Fetal MRI plays an increasing and valuable role for perinatal treatment of fetal gastrointestinal abnormalities. MRI provides a highly diagnostic confirmation for diagnosis of common or rare gastrointetsinal abnormalities([18]). DWI is very helpful to find the kidneys, to confirm or exclude the suspicion of agenesia; and to show horseshoe or ectopic kidney([19]). Fetal MRI may show the location of the atresia or stenosis in detail and help to diagnose other possible abnormalities. T1-weighted imaging helps to determine concomitant anal atresia, if any([18]). All these have a significant value for ğrenatal consultancy and surgical planning.

Suspected Partial Cleft Palate

A primigravide patient with a gestational age of 21 weeks were referred to our clinic because of 2nd trimester screening USG. In the USG, fetal biometry was consistent with LMP and the amniotic fluid index was at 95th percentile. Cleft lip and suspected cleft palate as well as metatarsus adductus appearance on the feet were detected. Since the obstetrics and gynecology department reported that confirmation of the partial cleft palate would be important for postpartuj management, a facial fetal MRI was performed. The partial cleft palate was confirmed by indicating the linear defect on anterior cortex of the maxilla which was hyperintense in T2 series and hypointense in T1 series (Figure 5). The pregnant woman delivered an alive baby boy by C/S at term. The newborn who had cleft lip and partial cleft palate was admitted to intensive care unit due to swallowing problems. The newborn was diagnosed with Trisomy 18 and died in 2nd month.

Fetal Hepatic Cyst

A pregnant women with a gestational age of 26 weeks according to LMP was referred to our center for MRI due to detection of an intraabdominal mass in the fetus. In the additional USG, fetal biometry was consistent with LMP and the amniotic fluid index was at 25th percentile. In the fetal abdominal examination, a cystic mass of 28x22 mm with digitate protrusions and septa located on the hepatic hilus dysplacing the umbilical vein was detected at superior side of the gall bladder. Fetal MRI was performed. The mass was isointense with the amniotic fluid in T1 and T2 series (Figure 6a). No diffusion restriction was detected in DWIs; apparent coefficient values were measured as 2.537 mm⁄s and assessed as benign (Figure 6b). The incidence of congenital hepatic cyst is 2.5% during postnatal life. Such incidence is low during perinatal period and there are a few cases identified in the literature([20]). Fetal hepatic cysts are benign and poorly associated with hepatobiliary tract. Progression rate of congenital biliary cysts is higher([21]). Final diagnosis of hepatic and biliary cysts may be difficulty during prenatal period. However MRI may be utilized to differentiate benign and malign tumors.

DISCUSSION

Prognosis of fetal tumors is poor despite some exceptions. Histology as well as location and dimensions of fetal tumors are important factor for prognosis. Some benign tumors may progress fatally when they are large and cause any cardiovascular effect and airway obstruction. Early detection and recognition of imaging characteristics are very important for fetal, maternal and neonatal care of fetal neoplasms. USG is usually used as a first imaging method for detection and differential diagnosis of fetal tumors. Use of fetal MRI as a complementary workup gradually increases. The aim of the present study was to define prenatal imaging findings and characteristics according to their location and origins. Furthermore, contribution of diffusion restriction and apparent diffusion coefficient values is important for differential diagnosis of malign and benign masses.

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DECLARATIONS

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Conflict of interest : We declare that we have no conflict of interest.

Ethical approval:made

Figure Legends

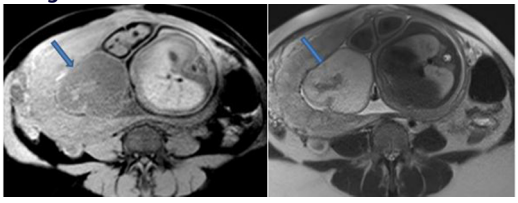

Figure 1a-b

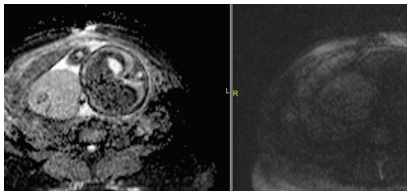

Figure 1c-d

Figure 1 (a-e). Fetal foot mri, (a,b), axial T1 and T2-weighted images, a mass which was originated from the cortex of right toes and extending to the distal side of cruric through an exophytic growth between the toes was detected with a minimally hyperintense pattern according to amniotic fluid in T1-weighted series (blue arrow), significantly hypointense according to the placenta; and slightly hypointense according to the amnion fluid and hyperintense according to the placenta in T2-weighted series (blue arrow). (c,d), There was not any diffusion restriction in DWIs and apparent diffusion coefficient values was measured as 2.240 mm⁄s. (e), Macroscopic photo and sagital T2 images, In the physical examination of the newborn, a mass which completely surround the right foot and extend to the ankle.

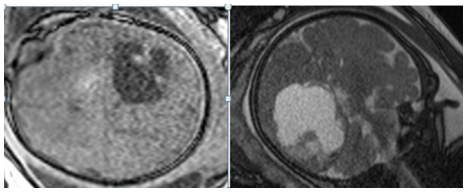

Figure 2a

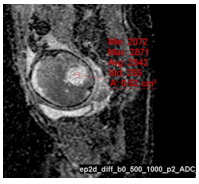

Figure 2b

Figure 2 (a,b). Fetal axial cranial MRI, (a), a mass of 33x29x26 mm including a cystic component which is isointense with CSF and a solid or septa parts which are isointense with the cortex in T2- and T1-weighted images was detected on the left hemisphere associated with the temporal horn and periventricular extension. (b), There was not any diffusion restriction in DWIs and apparent diffusion coefficient values were measured as 2.542 mm⁄s.

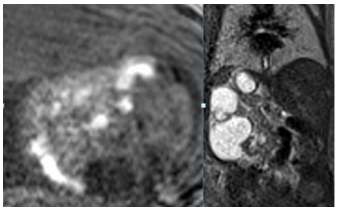

Figure 3a

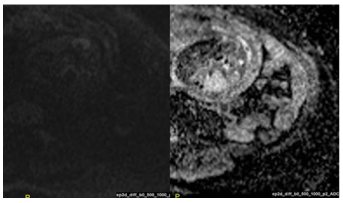

Figure 3b

Figure 3 (a-c). Fetal abdominal MRI, (a), coronal T2- and axial T1-weighted images, an image consistent with segmental multicystic dysplastic kidney presenting a shunting with upper kidney pole including multiple cysts. Lower renal pole presented near-normal characteristics. (b), No diffusion restriction was detected in DWIs; apparent diffusion coefficient values were measured 2.901 mm⁄s . (c) The septation of uretherocele was clearly identified within the bladder (blue arrow).

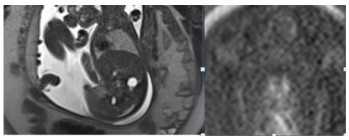

Figure 4a

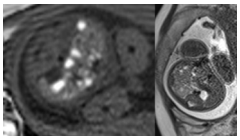

Figure 4b

Figure 4 (a,b). Fetal abdominal MRI, (a), sagital T2- and axial T1-weighted images, the right kidney appeared small and dysplastic cystic (b) axial T2 and T1-weighted series, the central side of the rectum presents hypointense characteristics in line with fetal anal atresia.

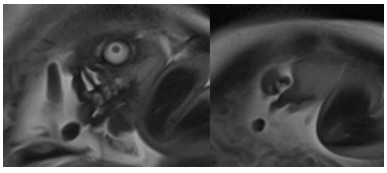

Figure 5

Figure 5. Fetal face MRI, coronal T2 images; a linear defect which is hyperientense in t2 series and hypointense in T1 series is detected in anterior cortex of the maxilla (blue arrow).

Figure 6a

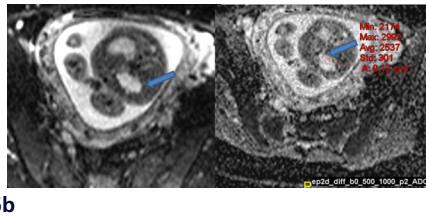

Figure 6b

Figure 6 (a,b) . Fetal abdominal MRI, (a), T1 and T2-weighted series, a cystic mass of 28x22 mm with a thick wall and as well as in both series, with isointensity with amnion mai; digitate protrusions and septa located on the hepatic hilus dysplacing the umbilical vein was detected at superior side of the gall bladder (blue arrows). (b), In DWI images, no diffusion restriction was detected, apparent coefficient values were measured as 2.537 mm/s (blue arows) and assessed as benign.

Table 1. MR imaging protocols (Magnetom Aera, 32-channel siemens)

Parameter	Technical Choice	Sequences
T2-weighted sequences	**Single-shot FSE**	**HASTE**
Planes	Axial, coronal, and sagittal	Relative to fetus, through ROI
TR/TE	1200/105	T2-weighted images, with good SNR
Slice thickness/ gap (mm)	3,5 /4-5	Thinner slices preferred for indications
FOV (cm)	24-30	
Matrix	250 × 320	
	Steady State fast field echo	**True FISP**
Planes	Axial, coronal, and sagittal	Relative to fetus, through ROI
TR/TE	3.8/1.5	T2-weighted images, with good SNR
Slice thickness/ gap (mm)	3,5 /3.5	Thinner slices preferred
FOV (cm)	24-30	
Matrix	512 × 384	
T1-weighted sequences	**Snapshot /Ultra Fast Gradient-echo**	**FLASH**
Planes	Axial, coronal, or sagittal	Relative to fetus, through ROI
TR /TE	178-200/2.4	Provides in phase T1-weighted
Slice thickness/ gap (mm)	3/3-4	Thinner slices may be too grainy
FOV (cm)	20-30	
Matrix	256 × 205	

Table 2. MRI and DWI findings

	Foot chondroma	CPC	Atypical MCDK	Anal atresia	Suspected partial cleft	Hepatic cyst
Gestational age	37 week	20 week	22week	19week	18 week	26 week
Amnion mai	Normally	Normally	Normally	Oligohidramnios	Polihidramnis	Normally
Steady State fast field echo (HASTE, TrueFISP)	hiperintensity	hiperintensity	İzo-hiperintensity	Rectum santrally hipointense	Maxilla anterior cortex; lineer hiperintensity	isointensity
Ultra Fast gradient echo (FLASH)	hipointensity	hipointensity	İzo-hipointensity	Rectum santrally hipointense	lineer hipointensity	isointensity
DWI(b0-500-1000)	No rectricted	No rectricted	No rectricted	-	-	No rectricted
ADC	2.240 mm/s	2.542 mm/s	2.901 mm/s	-	-	2.537 mm/s

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