RARE RENAL ANOMALIES DESCRIBED IN SECOND TRIMESTER FOETUSES USING POST MORTEM MRI CASE SERIES


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Abstract

The current study describes the renal anomalies of three second trimester fetuses using post-mortem Magnetic Resonance Imaging (pm-MRI). The results were compared with the conventional autopsy.

This study demonstrates that without altering the integrity of the human body the pm-MRI using a 7 Tesla machine is a reliable option in describing congenital renal anomalies.

Also it reinforces the idea that post mortem imagistic procedures may provide an important adjuvant to conventional autopsy in small gestational age fetuses.

INTRODUCTION

Urinary tract abnormalities are accountable for approximately half of the structural abnormalities detected in utero (1).

Early recognising of this pathology plays an important role in establishing the proper therapeutic management, and can influence the long term prognosis of these patients.

Prenatal findings are commonly confirmed by conventional post mortem examination but, in the last decades an increasing interest has been noted
for the non invasive approach using post mortem MRI (pm-MRI) (2), especially as an alternative offered for the parents who do not agree to standard procedure.

While foetal nervous and cardiac pathology is extensively study using pm-MRI, there is less information about how well intra-abdominal abnormalities can be detected and characterised at early gestational ages using non invasive imagistic methods (3).

In the present study, we explore whether pm-MRI using a magnetic resonance imaging machine of 7T magnetic field may provide reliable information for the diagnostic of renal anomalies in second trimester foetuses comparing with conventional autopsy.

**MATERIALS AND METHODS**

We examined using pm-MRI two foetuses age 16 respectively 17 weeks of gestation and one pair of kidneys from an 18 weeks of gestation foetus. The foetuses were referred to termination of pregnancy for chromosomal or severe abnormalities diagnosed by detailed prenatal imaging in our prenatal diagnosis department. The therapeutic abortion was induced using prostaglandin, after the comittee decision that the foetus is over the therapeutic resources.

The examinations were performed on a 7 Tesla machine (Bruker Biospec), belonging to the National Centre for Magnetic Resonance of Cluj – Napoca.

Each embryo was placed in dorsal position, head first and scanned after a 24-hour setting in formaldehyde solution.

First foetus was scanned using a 35 slice 2D TurboRare-High Res sequence with a field of view of 4.33 cm, in coronal orientation, 0.75 mm slice thickness and a 384 x 384 matrix that offer a resolution of 0.0146 cm/pixel, the repetition time of 6883.6 ms and the echo time to 12 ms.

In the third case, we analyzed the kidneys ex vivo acquiring 59 axial slices using a 2D TurboRare-high Res sequence, with a field of view of 4.33 cm, with 0.75 mm slice thickness and a 384 x 384 matrix, offering a resolution of 0.0113 cm / pixel, repetition time of 7002.3 ms and the echo time to 12 ms.

The images obtained were interpreted by a radiologist and the autopsy was conducted by a paediatric pathologist, after being informed about the radiological report.

The results were compared with the conventional autopsy. The study protocol was approved by the local Ethics Committee and written informed consent was obtained before the procedures.

**RESULTS**

First case analysed was a foetus diagnosed at 16 weeks of gestations with Trisomy 18.

The pm-MRI examination of the foetal abdomen revealed a complex renal malformation with a bilateral duplex collecting system and a fusion anomaly of the inferior renal poles – horseshoe kidney. All four collecting systems were dilated, probably secondary to uretero-pelvic junction obstruction, as a common complication of horseshoe kidney. There were no dilated uretheres and no bladder distension. The renal parenchyma showed polycystic dysplasia and no cortico-medullary differentiation.

The pathological exam confirmed the fusion of the kidneys at the lower poles, the existing bilateral duplex collecting system and undifferentiated tubular structures surrounded by primitive mesenchyme consistent with multicystic dysplasia (Figure 1).

The second foetus was detected at 17 weeks of gestation with hydrocephaly.

The pm-MRI examination revealed a complex cerebral anomaly with marked enlargement of the lateral ventricles and 3rd ventricle with floor displaced downward into the interpeduncular cistern, secondary to aqueduct stenosis.

At the level of the foetal abdomen, both ureters presented in the proximal portion a tortuous,
corkscrew-like course. Furthermore was noted bilateral slightly dilated renal pelvis (Figure 2).

The findings were confirmed by the foetal necropsy.

The third patient was referred to in vivo MRI for severe oligoamnios and diagnosed with renal malformations at the prenatal ultrasound at 18 weeks of gestation.

The in vivo foetal MRI identified a plurimalformed foetus with enlarged micropolycystic kidneys, with cysts up to 3.8 mm diameter. The investigation of the foetal abdomen revealed liver fibrosis and dilatation of the intrahepatic biliary ducts, splenic fibrosis and pancreatic cysts and ascites.

Also the foetus presented hypoplastic lungs, curved short and long bones and associated cervical occult spina bifida and occipital cervical oedema.

The post mortem examination of the kidneys completed the in vivo MRI investigation, depicting a micropolycystic sponge-like parenchyma and collapsed renal sinus and collecting system.

DISCUSSIONS

The pathological examination confirmed all the imaging findings (Figure 3).

The information obtained from both examinations was consistent with a Potter type 1 sequence. Therefore genetic testing was offered to the patient, in order to detect a mutation in the PKHD1 gene.
prenatally detected congenital anomalies of the kidney and the urinary tract.

This vast category of anomalies includes: kidney abnormalities such as kidney aplasia, multicystic dysplastic kidney, hypoplastic kidney, ureteropelvic abnormalities such as ureteropelvic junction obstruction, or megaureter, duplex collecting system, ectopic ureteral orifice, ureterovesical junction obstruction or incompetence and anomalies of the bladder and urethra (4).

Up to present the description of these abnormalities was the prerogative of the pathological examination.

Still, considering the small sizes of second trimester foetuses, the manipulation and dissection is extremely difficult thus requiring high experienced pathologists and appropriate equipment.

Using high-resolution post-mortem MRI we were able to identify important details regarding the existing renal abnormalities and also provide a guide for the fetal autopsy.

Although the horseshoe kidney identified in the first case, is a common renal fusion anomaly and may be encountered in two-thirds of the patients with Trisomy 18 (5), the association with multicystic dysplasia diseases and a bilateral duplex collecting system is rare and may pose diagnostic challenges, thus requiring autopsy for final confirmation (6).

The excessive spiral twisting of the ureters observed in the second case analyzed is considered normal for the second trimester foetuses, being the consequence of a differential growth rate between the urinary tract and the spine (7).

Although it may have limited clinical importance, in some cases, the tortuous course of the proximal portion of the ureters may explain the dilated aspect of the renal pelvis and can be the cause of obstructive hydronephrosis (8).

For the third foetus analysed, the imagistic details discovered using in vivo and pm-MRI oriented towards a targeted genetic analysis, thus improving the patient counseling.

Figure 3. A) 3T in vivo MRI, T2, WI depicting micropolycystic kidneys. B) 7T post mortem MRI T2, proving similar appearance and collapsed renal sinus and collecting system (arrow). C) Cut section of the kidneys with a sponge-like renal parenchyma composed of fusiform cysts in the cortex.
In the present study, the images obtained using 7T pm-MRI was comparable with the microscopic panoramic view and additional information was revealed only at magnifications higher than 10 X, using special stains.

Our case series was examined using an experimental 7T MRI machine, and it could be argued that there are limited applications in the clinical setting.

However, there are several current clinical studies being performed using ultra-high field MRI on human subjects(9).

Higher magnetic field strengths in MRI are becoming a new strong trend because of a superior signal-to-noise ratio, stronger spectral resolution and susceptibility effects, compared with lower magnetic fields (10).

In our study of foetal renal pathology, using pm-MRI of higher magnetic field we were able to overcome some of the weaknesses of conventional autopsy.

The present research shows an important concordance between conventional autopsy and 7T pm-MRI. The non-invasive technique is a valid method to detect and describe small renal lesions in second trimester foetuses, this aspect being entirely confirmed by the microscopic pathological examination.

The images obtained offered a permanent three-dimensional record and may be useful in future studies or in clinical practice as an important reference for the in vivo MR appearance of the pathology.

Advanced imaging studies may help improve the pathology analysis and prenatal diagnosis facilitating further patient counseling and fetal care.

REFERENCES