Fetal MRI in evaluating renal anomalies

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Aims and objectives

Our aim was to detect the accuracy of fetal MRI in diagnosing urinary tract anomalies in comparison to ultrasonographic findings and fetal outcome.

Methods and materials

We examined 30 fetuses with sonographically suspected congenital urinary tract anomalies by 2D/3D ultrasound, Doppler and MRI. MRI was done within one week following US examination. The maternal age range was 19-35 years with 26 years mean age. The gestational age range was 18-36 weeks. 43% of the women were in the second trimester while 57% were in their third trimester. The diagnosis was confirmed by postnatal ultrasound, cystogram and biopsy in born babies and autopsy in still born or abortus fetuses.

Ultrasonography

Full 2D combined gray-scale and color Doppler studies and 3D pelvic ultrasound evaluation was done in all cases using 3.5-5 MHz 3D transducer on (Voluson 730 ProV, GE Healthcare, Milwaukee, WI, USA).

Image analysis

Ultrasonography was performed by three well experienced sonographers in the field of obstetric US. The following parameters were assessed in each fetus:

- Calculation of gestational age, fetal number, position, viability, biophysical profile.
- Amount of amniotic fluid was calculated using four quadrants amniotic fluid index
- Assessment of the kidneys and urinary bladder.

Presence of extraurinary anomalies.

MRI Protocol

All patients were imaged by a 1.5 T super conducting magnet (Gyroscan Achieva Philips Medical Systems, Best, The Netherlands) using the synergy body coil in supine position.

After a scout acquisition, a series of fetal images in the axial, sagittal, and coronal planes were obtained with a fast gradient-echo sequence, [balanced FFE] with TR/TE of 3.1/1.6, flip angle 60° or single shot fast spin echo sequences with TR/TE of 1000/80 and matrix of 128-256x256, slice thickness of 5mm and 30-35cm FOV.
**Image analysis**

Images were analyzed by two radiologists experienced in the field of fetal MRI. Five areas were assessed in the fetuses during image review: (1) The presence, size, and signal intensity of the kidneys. (2) Detecting the presence and degree of pelviureteric dilatation and the level of obstruction. (3) The presence and fullness of the urinary bladder. (4) Amniotic fluid was qualitatively assessed as normal or diminished on the basis of the ability to identify at least three large pockets of fluid with a depth greater than 2 cm. (5) Search for other anomalies specially CNS and abdominal (known syndromes).

**Results**

We found different urinary tract anomalies including: Bilateral autosomal recessive polycystic kidney disease (n=8), unilateral autosomal recessive polycystic kidney disease (n=1), Dilated collecting system (n=8), Renal agenesis (n=3), Bilateral enlarged multicystic dysplastic kidneys (n=5), Unilateral enlarged multicystic dysplastic kidney (n=4) and Renal dysplasia (n=1). Fourteen fetuses had oligohydramnios (52%) and three had anhydramnios while the rest (n=13) had normal amniotic fluid volume according to their gestational age as detected by both MRI and US.

**MRI altered the diagnosis regarding the urinary system in six cases (20%).** In the first case where US showed suspected megacolon of the fetus MRI detected marked right hydronephrosis with dilated tortuous ureter and normal colon. In the second fetus MRI changed the diagnosis from unilateral autosomal recessive polycystic kidney disease into bilateral autosomal recessive polycystic kidney disease. In the third; ultrasound misdiagnosed one of the kidneys as renal agenesis due to a small kidney with absent renal artery and associated anhydramnios and the other one as hydronephrosis; however MRI clearly depicted bilateral MCDKs showing multiple small noncommunicating cysts in addition to cerebellar hypoplasia diagnosing Meckel Gruber syndrome (MGS) (Fig.3).
Fig. 3: Bilateral multicystic dysplastic kidneys with hydrocephalus and hypoplastic cerebellum

References: Radiology, Cairo University, Kasr El Aini Hospital - Cairo/EG

In the fourth case where ultrasound showed marked hydrenephrosis and hydroureter, MRI detected hydrenephrosis with dilated extrarenal pelvis with no evident ureteric dilatation changing the diagnosis from hydro-uretronephrosis to hydrenephrosis (Fig.4).
In the fifth fetus MRI added the presence of left hydronephrosis into a case of right hydroureter and hydronephrosis. Thus, altering the diagnosis from right hydro-ureteronephrosis to bilateral hydro-ureteronephrosis indicating an infravesical cause likely posterior urethral valve which was confirmed postnatally by cystogram.

**MRI showed additional extraurinary findings in four fetuses [13%].**

In three cases with multicystic dysplastic kidneys and one case of autosomal recessive polycystic kidney disease; MRI showed the presence of associated CNS anomalies [Dandy Walker malformation and cerebellar hypoplasia] which altered the diagnosis to Meckel Gruber syndrome. Thus; MRI showed additional renal and extrarenal findings in 9 cases (30%) which changed the patients diagnosis (The last case showed both renal and extrarenal findings).

MRI confirmed the findings of ultrasonography in 20 cases (66%) especially in one case of inconclusive renal agenesis with anhydraminos in a 20 weeks gestational fetus.

Ultrasound was superior to MRI in one case of renal dysplasia. Associated extrarenal anomalies were detected in 9 cases (30%). MRI showed 96% accuracy in diagnosis. Mortality rate reached 56%.
Fig. 3: Bilateral multicystic dysplastic kidneys with hydrocephalus and hypoplastic cerebellum
Fig. 5: Bilateral ARPKDs with Dandy Walker in a case of MGS
Conclusion

Our study showed that fetal MRI has the ability to diagnose urinary tract anomalies and associated extrarenal fetal anomalies with high accuracy, hence it can be used as a complementary method to ultrasonography specially in inconclusive cases and moreover in cases with a decision of termination of pregnancy on ultrasound basis.

MRI is not only important to confirm or diagnose urinary tract anomalies, but due to its high field of view which enables the visualization of the whole fetus in a single cut associated anomalies could be easily detected.

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References