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Ultrasound diagnosis of multicystic dysplastic kidney: Is a confirmatory nuclear medicine scan necessary?

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Abstract *Objective:* It is critical to differentiate between a multicystic dysplastic kidney (MCDK) and a kidney with severe hydronephrosis as the treatment varies significantly. We designed a study to compare renal ultrasound (RUS) to nuclear medicine (NM) scan in the diagnosis of MCDK, in order to determine if RUS can be used for the definitive diagnosis of MCKD without use of NM scan.
Materials and methods: We performed a retrospective review of children with MCDK, who underwent both a RUS and Tc-99m MAG3 or DMSA scan. We planned to calculate the positive predictive value of an RUS diagnosis of MCDK, using NM scan diagnosis of a nonfunctioning kidney as the gold standard.
Results: The diagnosis of MCDK was made by RUS in 91 patients, 84 of whom had a normal bladder US. NM confirmed the diagnosis of MCDK in all 84 of these patients (100%).
Conclusion: We have demonstrated a high predictive value for RUS in the diagnosis of MCDK. Our data support that in healthy infants with RUS diagnosis of unilateral MCDK and normal bladder US, NM scan may be unnecessary to confirm the diagnosis.

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Introduction

The antenatal diagnosis of urinary tract abnormalities has increased over the last decade because of the increased use of prenatal screening and improvements in ultrasound technology [1—3]. Multicystic dysplastic kidney (MCDK) is one of the most common genitourinary malformations detected in the prenatal and early neonatal periods, with an incidence documented in the literature of approximately 1 in 4300 live births [4]. MCDK is also one of the most common causes of palpable abdominal mass in infants, second only to hydronephrosis [5].

An extensive imaging work-up has been employed in patients with suspected MCDK to define both the functional and anatomical characteristics of the genitourinary system. NM scans have classically been used to confirm the absence of function in the MCDK; an important finding in differentiating indeterminate RUS reports of severe hydronephrosis versus MCDK.

As these two diagnoses vary greatly in treatment — surgical intervention for hydronephrosis secondary to obstruction versus observation for MCDK — making the correct diagnosis is critical.

As the management and treatment of MCDK has become more conservative, and ultrasound technology improves, our group questioned how much imaging is necessary to diagnose a MCDK. To answer this question, we retrospectively reviewed the charts and imaging of children diagnosed with a MCDK on RUS who subsequently underwent a confirmatory NM scan to determine if RUS is sufficient to diagnose MCDK.

Materials and methods

Patient selection and data abstraction

We retrospectively reviewed 220 children who underwent both a RUS and NM scan for the diagnosis of MCDK from January 2002 to December 2012. Children with the diagnosis of MCDK made on initial RUS were included in the study. Children who did not undergo a NM scan or who had other significant congenital abnormalities ($n = 31$), multiple significant minor and major genitourinary abnormalities, for example prune belly, MCDK in one moiety of a duplicated system, posterior urethral valves ($n = 34$) or incomplete clinical data ($n = 54$) were excluded. We attempted to exclude all patients who would undergo a NM scan regardless of diagnosis of MCDK. The institutional review board of Indiana University School of Medicine approved this study.

Diagnosis of MCDK

The diagnosis of MCDK on RUS was based on radiology reports. The RUS diagnosis of MCKD was typically made according to the following criteria: multiple non-communicating cysts of varying size and non-medial location of the largest cyst, absence of normal renal sinus, and absence of normal renal parenchyma [6]. Initial postnatal RUS were read by both community radiologists and pediatric radiologists. 99m Tc-mercaptoacetyletriglycine (Mag3) or 99m Tc-dimercaptosuccinic acid (DMSA) NM studies were performed per current standard of care at Riley Hospital for Children in all patients to confirm the diagnosis of MCDK.

Radiology protocols

RUS: In the last 10 years we have used three US machines (Sequoia 512, ATL HDI-5000, and Philips IU22). Our protocol includes multiple longitudinal and transverse images of the kidneys with color Doppler study at the level of the hilum and transverse and longitudinal images of the bladder. High resolution images are performed selectively for more detailed evaluation of parenchymal abnormalities with the use of a linear transducer (frequency of 12 mHz). Since 2011, we also perform cine images of the kidneys.

NM: 1.8 mCi of Tc-99m MAG-3 was administered intravenously and posterior blood flow imaging of the kidneys was performed. Serial posterior images were then obtained for up to 20 min. Lasix (6 mg) was administered intravenously and serial posterior images were then obtained for another 20 min. Quantification of renal flow and function before and after lasix was performed.

Statistical analysis

Children were included if diagnosed with unilateral MCDK on RUS, and subsequently underwent confirmatory NM scan to determine the positive predictive value of the RUS diagnosis of MCDK. Positive predictive value and 95% confidence intervals were constructed using Wilson's method in Stata, version 10.1.

Results

The initial study population consisted of 91 patients, 57 males (62.6%) and 34 females (37.4%). The mean ages at the time of RUS and NM scan were 13.6 (0—70 days), and 27.4 days (1—249 days) respectively. MCDK was diagnosed in the left kidney in 54 children (53.5%) and in the right kidney in 47 (46.5%). Prenatal ultrasound was available in 50 of 91 children (52.4%). In patients with MCDK diagnosed postnatally with prenatal ultrasound available for review, the diagnosis was correctly made antenatally in 70% (35/50). Thirty percent (15/50) were diagnosed as hydronephrosis antenatally (See Table 1).

Seven of 91 patients (11.9%) had a ureterocele on bladder US and were excluded from final analysis.

Thus, 84 patients were included in the final analysis. These 84 patients had a RUS diagnosis of unilateral MCDK with a normal appearing bladder on US and had undergone a confirmatory NM scan. NM scans verified absence of function in 84/84 of these patients (100%) representing a positive predictive value of 100% (95% CI: 95.6—100%). Of these patients, 18 (21.4%) had their RUS performed and read by a community radiologist (not pediatric fellowship trained).