

MR Urography In Pediatric Population: A Real Assessment

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Abstract

Various conditions affecting the pediatric genitourinary system can be assessed with Radiography, Ultrasound, Computed tomography, Nuclear Medicine and Magnetic Resonance Imaging. Imaging modalities based on the use of ionizing radiation are a big drawback in this patient group. Magnetic resonance imaging offers a big advantage in this regard. MR urography (MRU) represents the next step in the evolution of genitourinary imaging in children by combining visualization of great anatomic details with functional evaluation of the kidneys. Adequate patient immobilization coupled with rapid imaging sequences allows acquisition of high-quality images. In the future, MRU is expected to become the most important diagnostic tool in genitourinary imaging in pediatric age group.

Keywords: MR imaging, MR urography, Pediatric

Introduction

Magnetic resonance urography comprises an evolving group of techniques introduced about 10-15 years ago with the potential for noninvasive evaluation of the urinary tract. It is clinically useful in the evaluation of congenital anomalies, suspected urinary tract obstruction, hematuria, vesicoureteric reflux, infections, tumors as well as in evaluation of transplants. MRU is a powerful imaging modality capable of acquiring both morphologic and functional data of the genitourinary system. It combines excellent anatomic information with inherent soft tissue contrast of MR Imaging, multiplanar visualization as well as assessment of renal function.

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The purpose of this article is to discuss the techniques, advantages and limitations, as well as future projection of MRU in pediatric urology.

Technique

Adequate preparation of children requires hydration and immobilization. The amount of ingested/intravenous fluid depends on the age and body weight. To assure adequate examination, the patient must be properly immobilized. This can be achieved by either sedation and/or use of immobilizing bands. During MR examination, monitoring of vital functions can be performed by ECG and a pulse oximeter. Monitoring of body temperature is more important in neonates. The use of coils is adapted according to the child's body size. Generally, a head and neck coil is utilized for children below 2 years of age and a spine coil in patients older than 2 years of age.

After the patient is positioned in the scanner, scout images are acquired.

MR urographic techniques for displaying the urinary tract can be divided into two categories:

- **Static-fluid MR urography and**
- **Excretory (Functional) MR urography.**

These two techniques are usually coupled with conventional MR imaging for comprehensive evaluation of the urinary tract.

Static-fluid MR urography uses heavily T2 weighted sequences and is based on the principle that pelvicalyceal system, ureter and urinary bladder are filled with urine which has long T2 time in comparison to other tissues. Heavily T2 weighted sequences clearly depict the fluid within the urinary tract with suppression of surrounding tissues with lower T2 time. Static-fluid MR is ideally suited for patients with dilated, obstructed collecting systems. Breath hold sequences give better image quality than respiratory triggered sequences. Other fluid-filled structures like bowel can interfere with static-fluid MR urography. For this reason, intravenous hydration may be preferable to oral hydration prior to static-fluid MR urography. T2 weighted sequences include Single-shot turbo spin-echo (SSTSE) and Steady state Free Precession (SSFP) and Fast recovery Fast spin Echo (FRFSE).

Three-dimensional urograms are obtained by processing the source images using maximum intensity projection.

Excretory MR urography gives functional information like conventional intravenous urography. A gadolinium-based contrast agent is administered intravenously, and as the contrast appears in the collecting system,

3D fat sat T1 weighted SPGR sequence is used to image the collecting system, ureters and urinary bladder. Furosemide (1 mg/kg, maximum 20 mg) is administered intravenously 15 min prior to the administration of intravenous contrast agent. Furosemide is given prior to the injection of contrast medium to ensure that the urinary tract is adequately distended and gadolinium is diluted. Basically Fat Sat 3D SPGR sequences like VIBE (volumetric interpolated breathhold examination), THRIVE (T1-weighted high-resolution isotropic volume examination), or LAVA (liver acquisition with volume acceleration) are used. These sequences vary in the degree of background soft tissue suppression. Here again breath hold sequences give better image quality than respiratory triggered ones.

Advantages and Limitations

MR Urography in general offers the advantage that no ionizing radiation is involved, no iodinated contrast media is used, cross sectional imaging and multiplanar imaging is possible with excellent soft tissue contrast and useful functional imaging is also possible. In individual case scenarios MRU has become investigation of choice in evaluation of complex genitourinary anatomy in congenital anomalies of urogenital system, not only providing a three-dimensional evaluation of the entire urinary tract but also giving information of renal function that aids operative decision. In obstructive conditions, detailed information can be obtained regarding the cause, level and extension of obstruction. However MRU has been reported to be less sensitive in detection of calcifications and calculi than non contrast spiral CT. It has proved to be very useful in preoperative assessment of children with pelviureteric junction obstruction and in follow up of pyeloplasty

patients. MRU has been shown to be superior to renal scintigraphy for the diagnosis of pyelonephritis and renal scarring. Magnetic resonance voiding cystourethrography has become a potential alternative to conventional voiding cystourethrography in evaluation of vesicoureteral reflux but technical refinements are required.

But like any other modality of imaging it has its limitations and drawbacks as well like Long time for examination about 30 – 60 min which requires sedation of small children and infants, expensive technique, requirement of technical expertise and poor spatial resolution than conventional urography.

Various artifacts including respiratory and motion artifacts interfere with image interpretation. Motion suppression is very critical for MR urographic sequences and image quality is significantly affected by inconsistent breath-holding. This is an important consideration in pediatric patients. When interpreting MR urographic images created with MIP algorithms, one should always consult the original source images to detect artifacts and pitfalls.

Gadolinium used in excretory urography is not absolutely safe in renal function compromised children leading to a fatal disease - NEPHROGENIC SYSTEMIC FIBROSIS

At present there is also no uniform consensus on complete imaging protocol of MR urography.

Future Projections

With ever new emerging technical improvements including the use of high field strength machines, improved soft ware, new imaging sequences which will be faster and

/or more sensitive for detection of calcifications, parallel imaging and development of less nephrotoxic gadolinium compounds we can hope for a much wider role of this excellent technique of MR Urography in evaluation as well as in interventional therapeutic procedures of pediatric and even fetal urogenital system.

Suggestion For Further Reading

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