PEDIATRIC MR UROGRAPHY FOR THE TECHNOLOGIST

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EVOLUTION OF UROGRAPHY

Intravenous pyelography (IVP) (1918)
• Earliest imaging technique utilizing intravenous contrast to define GU anatomy

Renal Ultrasonography (1960’s)
• SOC for hydronephrosis and polycystic kidney disease screening

CT urogram (1990’s)
• High spatial resolution
EVOLUTION OF URORADIOGRAPHY

Renal Scintigraphy (1979)

- *Can evaluate renal function*
- *Utilizes ionizing radiation*

*MR Urography* is similar to Scintigraphy but offers superior spatial and contrast resolution without ionizing radiation.
**MR UROGRAPHY**

Introduction

- *Contrast agent is Gadolinium*
- *Fuses anatomic and functional evaluation*

Anatomic imaging

- *Primarily T2 weighted*
- *Dynamic contrast enhanced imaging*
- *T1 post contrast imaging*
MR UROGRAPHY

Clinical Indications

• Hydronephrosis and obstructive uropathy
• Renal scarring and renal dysplasia
• Incontinence
• Renovascular disease
• Wilm’s tumor and renal masses
Medications

- Lactated ringers IV, 10ml/kg over 30-45 minutes or use calculated method (whichever is greater, max 20 ml/kg)
- Lidocaine Uroject (for foley catheter)
- Lasix IV, 1mg/kg (max. 20 mg)
- Gadolinium IV, standard dosing protocol.
PATIENT PREPARATION

Pre-scan Preparation

- Consent and MR screening
- NPO per sedation protocol if sedated or 4 hrs npo for non-sedated (for maximum visualization)
- IV placed, appropriate for power injection
- Serum creatinine drawn and resulted
- IV hydration per protocol
- Foley catheter placed to keep bladder empty
PATIENT PREPARATION

Patient is positioned supine with arms over head.

- *Normal Abdomen/Pelvis coil arrangement*
- *Respiratory gating enabled*
Nephrogenic Systemic Fibrosis

Rare debilitating systemic fibrosing disorder

- Linked to gadolinium exposure
- Agents with less stable molecular binding account for well over 90% of proven cases.
- Use stable agent (Dotarem, Gadavist, Prohance)

Common link is severe renal failure

- Most cases in patients already on dialysis

Very few cases reported in children

- No personal cases of NSF

Be cautious but not “overcautious”
2 primary purposes for pre-contrast imaging

- Define anatomy
- Provide a diagnostic baseline

T2 FS scouts

- Allows better definition of GU structures for scan-planning

High-res T2 TSE FS axial of the kidneys

- Baseline for functional response to Lasix
- Static anatomical and pathological evaluation
Lasix administration

- 1ml/kg, max 20ml (IV)
- Given approximately 15 minutes prior to contrast for peak effectiveness
- Works with pre-scan hydration to dull concentration of contrast in renal collecting system
T2 3D coronal volume

- **Respiratory gated (bellows or navigator)**
- **Must cover entire GU system**
- **Provides high resolution anatomical information without contrast enhanced influence for comparison**
- **Rotate 3D model in MIP format for added diagnostic value**
T2 Volume Rendering
Additional pre-contrast sequences

- **Hi-res T2 TSE coronal fs-cover entire GU system**
- **T1 Flair coronal fs-cover kidneys-helpful in evaluation for renal scarring**
- **DTI axial-cover kidneys-to screen for restricted diffusion**
- **Hi-res T2 axial fs-cover bladder**

*If patient is sedated we increase sedation ~5 minutes prior to power contrast injection.*
Non-Contrast Imaging

High Resolution T2

T1 FLAIR
CONTRAST INJECTION

• Gadolinium via power-injector
• Injection rates are weight based

  <20 kg       0.15 ml/sec
  20-40 kg     0.20 ml/sec
  40-60 kg     0.25 ml/sec
  >60 kg       0.30 ml/sec
POST CONTRAST IMAGING

Power injection approximately 15 minutes after lasix

- *Volumetric high-res T1 GRE coronal 2mm sequences*
- *Must cover entire GU system*
- *Position in line with the aorta*
- *Acquired in time-resolve fashion once about every 6-8 seconds for the first 4 minutes, then about every 15-20 seconds for the next 6 minutes*
- *Repeated in prone position if needed*
Normal MR Urography

Concatenated MIP
Normal MR Urography

Cortical

Medullary
Normal MR Urography

Excretory

3D Volume Rendered
POST CONTRAST IMAGING

Additional post-contrast imaging

- Approximately 10 minutes post injection
- IR coronal-kidneys
- Volumetric T1 GRE sagittal-GU system
- Volumetric T1 GRE coronal-GU system
- PD TSE fs axial-kidneys
T2 and CE Imaging

T2 Volume Rendered

Post Contrast Volume Rendered
Post processing of the dynamic series

1) Convert signal to relative signal (for each voxel divide the signal by the average pre-contrast signal) to remove signal variation due to tissue, magnetic field variation etc.)

2) Measure the signal in the aorta. This is used as a way to compensate for the differences in the bolus profile between different patients as the contrast arrives at the kidneys (injection site, patient size, blood pressure etc.).

3) Semi-automatic segmentation of the kidneys and derive the mean relative signal for each kidney at each time point.
Post processing of the dynamic series

Fit the aortic and renal curves to a mathematical model of how the contrast passes through the kidneys and derive functional information from this.

Absolute values assume perfect bolus and linear relationship between relative signal and contrast agent concentration. May not always be true, so often use relative parameters (one kidney compared to the other).

Vol. (mL)  vDRF  pDRF  upDRF  MTT (Sec.)
L 31.8   37.1%  38.6%  51.6%  45.7
R 53.8   62.9%  61.4%  48.4%  49.8

Results show that while the right kidney is larger than the left (pelvic) kidney, the function is symmetric and the time for the contrast to pass through the kidneys (MTT) is within normal limits.
Normal MR Urography

Concatenated MIP
Malformations
Antenatal Hydronephrosis
UPJ Obstruction
Bilateral Severe Scarring
CONCLUSIONS

• MRU allows a simultaneous anatomical and physiological evaluation.

• Excellent, hi-res, anatomical imaging

• “Quantitative” measure of renal function

• No ionizing radiation

• Ideal exam for evaluation of renal disease in children
NOT SURE IF PRESENTATION WAS SO GOOD
NO ONE HAD ANY QUESTIONS

OR NO ONE WAS PAYING ATTENTION