Case 15576

Diffusion-weighted MRI for diagnosis and monitoring of acute pyelonephritis
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Section: Uroradiology & genital male imaging
Area of Interest: Kidney
Procedure: Diagnostic procedure
Imaging Technique: Ultrasound
Imaging Technique: CT
Imaging Technique: MR-Diffusion/Perfusion
Imaging Technique: MR
Special Focus: Infection Case Type: Clinical Cases
Authors: Tonolini Massimo, MD.
Patient: 60 years, female

Clinical History:

Woman with long-standing history of Crohn’s disease including multiple bowel surgeries (most recent 11 years ago), hystero-adnexectomy for benign disease, urolithiasis and recent (eleven months earlier) right nephro-ureterectomy and cystectomy with left uretero-cutaneostomy to manage necrotising pyeloureteritis with pyonephrosis. Presents with low-grade fever, elevated acute phase reactants, worsened renal function.

Imaging Findings:

With normal ultrasound (Fig.1) findings, CT (Fig.2) confirmed non-obstructed normal-sized left kidney with homogeneous parenchymal enhancement, uretero-cutaneostomy with stent, enhancing pyelocalyceal mural thickening consistent with urinary tract infection.

To comprehensively assess bowel and renal disease, MR-enterography (Figs. 3-4) was performed, without gadolinium because of impaired renal function, and excluded signs of Crohn’s disease reactivation. Chronic kidney disease (CKD) had progressed compared to previous months (creatinine clearance 25 ml/min).

The left kidney showed normal thickness, marked decrease of normal corticomedullary differentiation consistent with CKD, no appreciable focal or diffuse T2-weighted signal changes. Diffusion-weighted imaging (DWI) showed multiple parenchymal regions with abnormally increased signal, mostly located at the renal poles, with corresponding low apparent diffusion coefficient (ADC) indicating restricted diffusion consistent with acute pyelonephritis.

After intensive antibiotics, repeated MRI (Figs. 5-6) showed marked decrease of DWI pyelonephritis changes consistent with good treatment response, mural DWI hypersignal with corresponding ADC hypointensity of renal pelvis indicating persistent infectious pyelitis.

Discussion:

A highly prevalent disease, acute pyelonephritis (APN) results from either ascending urinary infection or more rarely haematogenous bacterial dissemination. Traditionally, APN was diagnosed on the basis of symptoms (fever, costovertebral angle tenderness, lower urinary tract infection), elevated C-reactive protein, leukocytosis and positive cultures. However, recent works showed very poor correlation between clinical / laboratory abnormalities and the variable severity of renal changes, which impacts duration and intensity of treatment. Furthermore, following
empirical antibiotic therapies, urine and blood cultures test positive only in 23.5%-40% and 15.8-30% of cases, respectively. Therefore, there is a growing demand for “pathological” diagnosis by imaging demonstration of renal parenchymal involvement. [1-3]

Compared to CT, gadolinium-enhanced MRI is preferable in young patients due to lack of ionising radiation, and is highly effective in demonstrating the well-known imaging hallmark of uncomplicated APN, consisting in zones of decreased renal enhancement reflecting poor or non-functioning parenchyma from vasospasm, tubular obstruction and/or interstitial oedema. On coronal images, these changes are typically oriented perpendicularly to the cortex from the papilla. Furthermore, MRI well shows associated kidney enlargement, perinephric fluid or inflammatory fat stranding, and the not-unusual development of abscesses. [4-6] Alternatively, low-mechanical index contrast-enhanced ultrasound may be helpful to visualise renal regions of interstitial oedema and hypoperfusion, and detect centrally non-enhancing abscesses. [7]

More recently, high b-value diffusion-weighted (DW)-MRI has been increasingly used to visualise APN, which appears as “patchy” hyperintense regions reflecting oedematous inflammatory “swelling” with interstitial space reduction and decreased water diffusivity. DW-MRI demonstrated very high accuracy and diagnostic agreement (~95%) with gadolinium-enhanced MRI. Albeit with heterogeneity between different scanners and sequences, the corresponding apparent diffusion coefficient (ADC) values have been shown to reliably differentiate between spared parenchyma, nephritis and abscesses. As this case exemplifies, a rapid and cheap unenhanced MRI protocol including DWI may reliably exclude or confirm APN, by showing the typical multifocal and wedge-shaped configuration of oedematous changes. As a result, DW-MRI is an appealing diagnostic alternative to contrast-enhanced CT and MRI, particularly in children and young people, in uncooperative or sedated claustrophobic individuals, and in patients with contraindications to iodinated and/or paramagnetic contrast such as renal impairment, pregnancy and lactation. Finally, repeated DW-MRI every 3-4 weeks enables rapid, noninvasive and effective monitoring of APN. [7-10]

**Differential Diagnosis List:** Acute pyelonephritis in post-surgical solitary kidney, Renal infarcts, Renal venous thrombosis, Neoplastic infiltration, Acute urinary obstruction

**Final Diagnosis:** Acute pyelonephritis in post-surgical solitary kidney

**References:**


Description: Sonographically, the left kidney showed normal size, parenchymal thickness and echogenicity, without dilatation of the collecting system. **Origin:** Tonolini M, Radiology Department, "Luigi Sacco" University Hospital – Milan (Italy)
**Description:** On precontrast (a) and nephrographic phase (b...d) images, the normal-sized left kidney had uretero-cutaneostomy with stent (thick arrows) in place, non-dilated collecting system with minimal pyelocalyceal mural thickening (thin arrow). Note absent right kidney. **Origin:** Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)

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Description: The normal-sized left kidney had uretero-cutaneostomy with stent (thick arrows) in place, non-obstructed collecting system with minimal, hyperenhancing pyelocalyceal mural thickening, preserved homogeneous parenchymal enhancement. Note absent right kidney. **Origin:** Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)
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Description: T2-weighted MRI images (fat-suppressed a...c) showed left kidney with normal size and parenchymal thickness, without appreciable focal or diffuse signal abnormalities. Non-obstructed collecting system. Note distended residual bowel by ingested polyethylene glycol solution. Origin: Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)
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Description: On conventional T2-weighted MRI images (d) the left kidney showed normal size and parenchymal thickness, non-obstructed collecting system with minimal pyelic mural thickening (thin arrow). Note distended residual bowel by ingested polyethylenglycole solution. Origin: Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)
Description: On fat-suppressed T1-weighted images, the left kidney showed marked decrease of normal corticomedullary differentiation, consistent with chronic kidney disease. Origin: Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)
Description: On coronal high b-value (800) DWI images (a,b), the left kidney showed multiple parenchymal regions with abnormally increased signal (arrowheads), mostly located at the renal poles.
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Description: Coronal fat-suppressed T1-weighted images confirmed marked decrease of normal corticomedullary differentiation of left kidney, consistent with chronic kidney disease. Origin: Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)
Conventional (b) and fat-suppressed (c,d) T2-weighted images showed stable findings concerning left kidney compared to Fig.3, without development of abscess cavities, or appreciable signal abnormalities of the renal parenchyma, and non-obstructed cavities. Origin: Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)
Description: Conventional (b) and fat-suppressed (c,d) T2-weighted images showed stable findings concerning left kidney compared to Fig.3, without development of abscess cavities, or appreciable signal abnormalities of the renal parenchyma, and non-obstructed cavities. Origin: Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)
Description: Compared to Fig.4, repeated MRI showed marked decrease of DWI-hypersignal changes (arrowheads in a) with corresponding low ADC regions (arrowhead in b) in the left renal parenchyma, consistent with improvement of acute pyelonephritis after treatment. Origin: Tonolini M, Radiology Department, "Luigi Sacco" University Hospital – Milan (Italy)
**Description:** Compared to Fig.4, repeated MRI showed marked decrease of DWI-hypersignal changes (arrowheads in a) with corresponding low ADC regions (arrowhead in b) in the left renal parenchyma, consistent with improvement of acute pyelonephritis after treatment. **Origin:** Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)

**Description:** The renal pelvis (thin arrows) showed residual high b-value DWI hypersignal (c) with corresponding ADC hypointensity (d) consistent with infectious pyelitis. **Origin:** Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)
Description: The renal pelvis (thin arrows) showed residual high b-value DWI hypersignal (c) with corresponding ADC hypointensity (d) consistent with infectious pyelitis. Origin: Tonolini M, Radiology Department, “Luigi Sacco” University Hospital – Milan (Italy)