Radiological Assessment of the Kidney in Patients with Hematuria

Jeremy L. McKay, Harvard Medical School Year III
Gillian Lieberman, MD

March 2005
Hematuria

- **Signs and Symptoms**
  - Microscopic or gross hematuria
  - Abdominal pain
  - Fever
  - Polyuria, dysuria
  - Flank pain

- **Hematuria is common**
  - 2.5% of men ages 28-57 tested positive for heme
  - 5.4% men ages 18-54
Hematuria cont.

Retrospective Study of 100 patients with hematuria

- Most Common Causes:
  - 41.8% Neoplasia
    - 19% BPH
    - 9% Bladder
    - 6% Kidney
    - 6% Prostate
  - 26.6% Infection
  - 13.6% Nephrolithiasis
  - 3.6% Congenital Abnormalities
  - 2% Trauma
  - 12% No identifiable cause
Renal Causes of hematuria

- **Vasculitis**
  - Henoch-Schonlein purpura, periarteritis nodosa, Wegener granulomatosis

- **Glomerular disease**
  - Postinfectious nephritis, IgA nephropathy, Lupus, Alport, thin basement membrane disease, Nail-patella syndrome, Fabry disease

- **Tubulointerstitial disease**
  - Polycystic kidney disease, nephrolithiasis, analgesic nephropathy, reflux nephropathy, tumors, infection

- **Renal Masses**
  - Vascular, neoplastic, congenital

- **Vascular**
  - AV malformations, renal artery disease, renal vein thrombosis
Diagnostic Imaging Methods

**US**

- Best to exclude urinary obstruction
- Can diagnose hydronephrosis and it’s cause
- Should be performed in all patients presenting with renal failure of unknown etiology
- Chronic pyelonephritis with no response to therapy
- Doppler US to evaluate renal vascular flow
CT Scan

- Often compliments findings with ultrasonography
- Non-contrast: Gold standard for radiologic diagnosis of renal stones
- Used to evaluate and stage renal cell carcinoma
- Used to diagnose renal vein thrombosis
MRI

- Gold standard for Dx of renal vein thrombosis along with renal venography and CT
- MRA playing an increasing role in evaluating patients with renovascular hypertension decreasing need for renal angiography
- For patients with dye allergies
Diagnostic Imaging Methods

Plain Film of the Abdomen

- Good for patients complaining of symptoms consistent with nephrolithiasis.
- Will miss small and radiolucent stones
- Not commonly performed on patients with renal disease
Intravenous pyelogram

- Previously the principal radiologic technique used for patients with possible renal disease
- High sensitivity and specificity for detection of stones and degree of obstruction
- Structural disorders: Chronic pyelo, medullary sponge kidney, papillary necrosis
Renal Arteriography
- Used less frequently due to less invasive CT and MRI
- Useful in Dx of polyarteritis nodosa
- Used in preoperative mapping of vasculature

Renal Venography
- Useful for Dx of renal vein thrombosis
Diagnostic Imaging Methods

- **Radionuclide studies**
  - Early detection of vesicoureteral reflux and scarring; More sensitive than IVP in detecting renal scars

- **Voiding cystourethrogram**
  - Vesicoureteral reflux

- **Retrograde/Antegrade Pyelography**
  - Relieve urinary tract obstruction
  - Supplanted by US and CT
CT Urography

- Combines unenhanced, nephrogenic-phase, and excretory phase imaging
  - Unenhanced - detects renal calculi
  - Nephrogenic phase - renal parenchymal abnormalities (esp. masses)
  - Excretory phase - urothelial disease
- Becoming standard diagnostic method
Renal Masses

- Renal masses frequently cause hematuria
- Characterization of the mass is essential
  - Simple cyst, complex cyst, or solid mass
- Bosniak Classification System
  - I and II – benign
  - III-IV – possibly malignant, warranting surgery
- CTU, CT, US, MR
Patient 1: Simple Cysts on CT

Patient 2: Wilms Tumor

Enlarged non-functioning left renal mass
Patient 3: Renal Cell Carcinoma on contrast enhanced CT
Patient 4: Stage III Renal Cell Carcinoma involving left renal vein

Renal Infections

Pyelonephritis
- Acute, chronic, reflux nephropathy
- Flank pain, fever, urgency
- Radiologic imaging:
  - IVP
  - CTU
  - US
Patient 5: Pyelonephritis on CT
Patient 6: Pyelonephritis on CT
Patient 7: Pyelonephritis on CT
Renal Calculi

Nephrolithiasis

- Common cause of hematuria
- 12% will develop kidney stones
- Plain film not as sensitive as unenhanced CT
- CT (unenhanced) for renal calculi
- US also useful for detecting renal calculi as well as hydronephrosis
- “Colicky pain”
Patient 8: Right Hydronephrosis on IVP
Patient 9: Left Renal Pelvis Obstruction on CT
Congenital Anomalies

- Some congenital anomalies in the urinary tract can cause hematuria

- Well visualized with CT, US, IVP, and MR imaging
Patient 10: Adult Polycystic Renal Disease
Patient 11

- **63 year-old male**
  - Presented to the ED with gross hematuria, flank pain, and fever lasting for two days
  - PMH: hypercholesterolemia, HTN, PE, IVC filter, depression, s/p chole
  - Meds: ASA 81, Coumadin 2.5, Lipitor 80, Metoprolol 50, Viagra 50, Wellbutrin 50
  - Exam: 97.5 207lbs 110/70 97% 64
    - Exam relatively normal
    - Labs: UA: gross hematuria. INR = 8
Patient 11: Baseline CTU w/o contrast 10/04
Patient 11: Current CT abd w/o contrast

- Bilateral fat stranding
- Both kidneys appear larger
Patient 11: CT abd w/o contrast

• Dilated renal pelvis
Patient 11: CTU contrast phase

Dilated renal pelvis
Patient 11: CTU contrast phase

• Dilated renal pelvis
Patient 11: CTU reformatted

3/05 CTU Abd. BIDMC Radiology Dept. PACS
Patient 11

Findings:
- New perinephric and periureteral fat stranding
- Bilateral proximal and mid ureteral wall thickening
- Mild bilateral hydronephrosis
- Both enhance symmetrically, no calculi

Impression:
- Concerning for transitional cell carcinoma
- Further evaluation with retrograde ureterogram was recommended after antibiotic treatment
- Likely Diagnosis: Acute Pyelonephritis with possible underlying transitional cell carcinoma
Hematuria is common

- Most Common Causes: Neoplasia, infection, stones.
- Renal causes of hematuria
  - Vasculitis, Glomerular disease, Tubulointerstitial disease, Renal masses, Vascular
- US, CT (U), MR(U), IVP are great techniques for imaging
- CT Urography: Combines unenhanced, nephrogenic-phase, and excretory phase
  - Becoming modality of choice
Works Cited

- Rithie CD, Bevan EA, Collier SJ. Importance of occult haematuria found at screening. BMJ 1986; 292: 681-683
- Gillat DA, O’Reilly PH. Hematuria Analyzed; A Prospective Study. J R Soc Med 1987; 80: 559-562
- http://www.ctisus.com/ctprotocols/
- American College of Radiology (ACR), Expert Panel on Urologic Imaging. Radiologic investigation of patients with hematuria. Reston (VA): American College of Radiology (ACR); 2001
Acknowledgements

- Peter Rosal, MD
- Daniel Cornfeld, MD
- Gillian Lieberman, MD
- Pamela Lepkowskki
- Larry Barbaras, Webmaster