Radiological investigation in patients with renal colic

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Acute renal colic

- 0.9-1.8/1.000 inhabitants and year
- Average age ~40 years
- Recurrence of upper urinary stone disease within 10 years: 40-50%
  (Ljunghall 1977, Ahlstrand et al 1981)

Critical issues

- Obstruction must be detected and treated
  - Increased intrarenal pressure due to ureteric obstruction may lead to impaired function and parenchymal damage
  - Restitution of renal function is possible if obstruction is relieved within 2 weeks
  - Obstruction + infection shortens this interval and may lead to "uro-sepsis"

Spontaneous stone passage

(based on size at CT)

- Transv diam ≤4 mm: 78% spontaneous stone passage
- Trans diam 5-7 mm: 60% spontaneous stone passage
- ≥8 mm: 39%
- ≥10 mm: 0%
  Coll et al, AJR 2002;178:101
- ~75% of all stones pass "spontaneously"

Likelihood of passage of ureteral stones

<table>
<thead>
<tr>
<th>Stone size</th>
<th>Mean time to pass stone (days)</th>
<th>Likelihood of eventual need for intervention (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2 mm</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>3 mm</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>4-6 mm</td>
<td>22</td>
<td>50</td>
</tr>
<tr>
<td>&gt;6 mm</td>
<td>-</td>
<td>99</td>
</tr>
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</table>

Teichman, NEJM 2004;350:684-693

Acute renal colic

Do we need acute imaging in all patients?
EAU Guidelines

"The clinical diagnosis should be supported by an appropriate imaging procedure."

Guidelines on Urolithiasis
European Association of Urology (EAU) 2006

Acute flank pain

Swedish Guidelines

- Acute imaging
  - Uncertain diagnosis
  - Fever
  - Single kidney
  - Analgetics ineffective
- Elective imaging (2-3 w) All others

~75% of all stones pass spontaneously

- If we do imaging acutely on all patients we will detect all stones, before spontaneous stone passage occurs
- Once detected, a ureteric stone has to be checked with IV imaging in every patient to ensure stone passage
- Thus, such a strategy leads to at least 2 imaging procedures in every patient with stone

In only a minority (~1/4) of patients with renal colic, acute imaging is absolutely mandatory
- Intractable pain
- Fever
- Single kidney
- Unclear diagnosis

In the rest of the patients, imaging can be deferred and a large proportion of patients will be spared a second imaging, since their stone has passed in 75% of the cases at the time of imaging (2-3 weeks)

Acute or deferred imaging?

Acute renal colic

Acute or deferred imaging?

What difference does it make?

Acute or deferred imaging?
Prospective, randomized study

- Acute renal colic, suspected stone disease
- Attending Sahlgrenska University Hospital
- Patients who became pain free after 2 or 3 IV injections of analgetics
- Excluded:
  - Fever, not pain-free on treatment, single kidney or unclear clinical diagnosis (acute imaging)
- 172 patients randomised
  - Acute imaging or deferred imaging

K.Lindqvist, M.Hellström, G.Holmberg R. Peeker, L.Grenabo
Scand J Urol Nephrol 2006
Patients attending the Emergency Departments at Sahlgrenska University Hospital for acute renal colic

Randomised within 24 hours after start of symptoms
N=172

Acute Imaging (within 24 h) N=86
Deferred Imaging (after 2-3 weeks) N=86

Results
Morbidity and diagnostic timing
Structured, self-assessed questionnaire, 4 weeks daily reporting

<table>
<thead>
<tr>
<th></th>
<th>Acute imaging</th>
<th>Imaging after 2-3 w</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>78</td>
<td>72</td>
</tr>
<tr>
<td>Impaired daily activities, days</td>
<td>3.6 (2.0-25)</td>
<td>3.4 (2.0-19)</td>
</tr>
<tr>
<td>Consumption of analgetics, days</td>
<td>4.8 (2.0-38)</td>
<td>3.6 (2.0-20)</td>
</tr>
<tr>
<td>Acute medical consultation, pat</td>
<td>11 (14%)</td>
<td>11 (15%)</td>
</tr>
<tr>
<td>Acute hospital admission, pat</td>
<td>5 (4%)</td>
<td>5 (7%)</td>
</tr>
<tr>
<td>Interventional procedure</td>
<td>13 (17%)</td>
<td>6 (8%)</td>
</tr>
<tr>
<td>Frequency of stones</td>
<td>70%</td>
<td>39%</td>
</tr>
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</table>

K.Lindqvist, M.Hellström, G.Holmberg R. Peeker, L.Grenabo
Scand J Urol Nephrol 2006

Timing of imaging

- Acute imaging
  - Uncertain diagnosis
  - Fever
  - Single kidney
  - Analgetics ineffective
- Elective imaging (2 w)
  - All others

What do we want to know?

- Number of stones
- Size
- Shape
- Position
- Renal function
  - Degree of obstruction

Acute flank pain, suspected stone disease

- Urography
- Computed tomography (CT)
- (Ultrasonography)
- (MRI)

Ultrasonography
Dilatation + stone

BC
Ultrasonography

Stone in renal pelvis, most proximal or most distal parts of ureter can be demonstrated, but....

- Small stones in pelvicalyceal system are easily missed
- Stones in the midureter are easily missed
- Renal function can not be assessed
- Observer dependent
- Patient dependent
- Image documentation insufficient

Ultrasonography is insufficient as primary method for assessment of stone disease

...however...

- In pregnant women and very young patients, ultrasound in combination with plain film (KUB) can be an alternative

Comparison of same-day non-enhanced CT vs Ultrasonography + plain radiography

<table>
<thead>
<tr>
<th></th>
<th>Confirmed stone in ureter, n=82</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>79/82 (96%)</td>
</tr>
<tr>
<td>Plain +US</td>
<td>62/82 (76%)</td>
</tr>
</tbody>
</table>

Catalano et al, AJR 2002;178:379-387

MRI

- Heavily T2-weighted MRI (static MRU)
- Gd-enhanced T1-weighted MRI (dynamic MRU)
- Insufficient for detection of calcifications (stones)
- Limited availability for acute imaging
- Expensive

MRI is insufficient as primary method for assessment of stone disease

Acute flank pain

Do we need urography any more?

- assessment of acute flank pain -

Advantages

- Time-honoured
  Osborne et al. JAMA 1923;80(6)
- Good demonstration of pelvicalyceal system and ureter
- Detects most stones
- Allows evaluation of renal function and obstruction

Urography
Urography reveals very discrete outflow obstruction

Urography - acute flank pain -

Disadvantages
- iv contrast
- Stones may be missed
  - obscuring structures (sacrum, bowel)
  - small stones
  - non-opaque stones
  - adipose patient
  - misinterpretation (phleboliths)
- Takes time if excretion is delayed
- Abnormalities outside urinary tract not identified
Right flank pain

XX a

Stone?

XX b

Delayed excretion

10 min

XX c

Delayed excretion

20 min

XX d

Delayed excretion

40 min

XX e

Excretion after 2 hours, but level of obstruction still not confirmed...additional delayed imaging to follow

Non-enhanced CT
- advantages vs urography -

- No iv contrast needed
  - no hypersensitivity problems
  - no adverse effects on renal function
- Faster
  - MDCT: scan time <20 sec, room time <15 minutes
  - Urography: 20 min - hours
- Virtually all stones (including "non-opaque" stones) can be identified at CT
  - exception: Indinavir-concrements (HIV-treatment)
- Detection of abnormalities outside urinary tract possible
**Non-enhanced CT**

- MDCT from kidneys to symphysis
- No iv or oral contrast
- Avoid micturition before scanning
- Narrow collimation e.g. 8x2.5 mm; 16x0.6 mm
- Cine viewing (follow ureter)
- Variable window settings (perirenal fatty tissue)
- Reduced radiation (lower mAs)

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**Nonenhanced-CT for renal colic**

(Smith et al AJR 1996)

- 100 patients with acute flank pain
- CT + urography + follow-up
  - Sensitivity 97%
  - Specificity 96%
  - Accuracy 97%
- Other diagnoses in 31 patients

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**Nonenhanced-CT in acute flank pain**

- Visible calcification (stone) in ureter
- Hydroureter/hydronephrosis
- Perinephric/periureteric stranding
- Local ureteric edema around stone (tissue rim sign)
- Enlarged kidney
- Reduced density (HU) on affected side
  - ≥5 HU difference: 81% sens; 100% spec; (Goldman et al, AJR 2004)

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**Post ESWL**

LE

LE

LE

LE
Incidental findings
Advantage or disadvantage?

Calcification (stone) in ureter
Edema (tissue rim sign)
Right flank pain
Minimal reaction around kidney
No hydronephrosis
FF 1a

Right flank pain
Tissue rim sign
FF 1b

New episode of acute flank pain
Perinehric stranding
FF 2a

Perinehric stranding
Hydronephrosis
Hydroureter
FF 2b FF 2c FF 2d
Stone + edema (tissue rim sign)
Effects of hydronephrosis

- Fullness of renal pelvis
- Compression of sinus fat

Perinephric stranding

Perinephric stranding and fluid

Left flank pain

LT 66 y
1 hour
Level of obstruction?

Hydronephrosis
Hydroureter, 8 mm

4 mm stone in distal ureter

CT shows small stones not seen by urography
Non-enhanced CT in flank pain

Pitfalls

- Stone, in vesico-ureteral junction or in bladder?
- Opposite body position to determine stone location

Nonenhanced-CT in flank pain

- Pitfalls
  - distal ureteric stone vs phleboliths
  - No direct information on renal function
  - Lack of hydroureter/hydronephrosis
  - Little retroperitoneal fatty tissue

Phleboliths

- Calcifications in pelvic veins
- Normal phenomenon
- Increase with age
- No sex preponderance
- May simulate ureteral stone
- Radiolucent centre on plain film
Phleboliths vs stones

(Traubici et al AJR 1999;172:13-17)

- 120 phleboliths in 50 patients with flank pain
  - urography: 79/120 (66%) radiolucent centre
  - CT: 1/120 (<1%) radiolucent centre

- Radiolucent centre not useful for CT differentiation of stone vs phlebolith

Pitfalls nonenhanced CT

- Obstruction does not always cause dilatation
  - early obstruction (hours)
  - reduced renal function, low filtration pressure
  - calyceal (fornix) rupture may cause decompression

Pitfalls non-enhanced CT

- Dilatation does not always mean obstruction
  - Dilatation may persist after correction of obstruction
Impact of duration of pain?

Varanelli et al, AJR 2001
• Prospective
• 227 consecutive patients with acute ureterolithiasis on non-enhanced CT
• 280-350 mAs at 120 kV
• Duration of pain registered

Impact of duration of pain

• Perinephric stranding
  – Any degree of stranding was seen in 72-79% of all patients
  – Of those with 2 hours pain duration, 5% had moderate or severe stranding, compared to 51% in those with 7-8 hours pain duration

Time of occurrence of pain (e.g. 15.30) should be stated on the request form for patients with acute renal colic!
Right flank pain, suspected ureteric stone

Intravenous contrast series should be added if diagnosis is in doubt

What about the radiation dose?

- Stone-CT can be performed with low dose radiation
- Poletti et al AJR April 2007:
  - 125 patients with renal colic
  - 30 mAs + 180 mAs MDCT same day

42 y old man with right flank pain

Stone size underestimated
43 year old over-weight BMI = 30
Intense left flank pain and hematuria

Poletti et al AJR 2007;188:927-933

Stone??

30 mAs

Poletti et al AJR 2007;188:927-933

4.5 mm stone

30 mAs

180 mAs

Poletti et al AJR 2007;188:927-933

Poletti et al, AJR April 2007

<table>
<thead>
<tr>
<th>N=125 patients with renal colic</th>
<th>30 mAs BMI&lt;30</th>
<th>30 mAs BMI&gt;30</th>
<th>30 mAs All pat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculi Sensitivity</td>
<td>99% (77/78)</td>
<td>50% (3/6)</td>
<td>83% (79/95)</td>
</tr>
<tr>
<td>Calculi Specificity</td>
<td>97% (70/72)</td>
<td>89% (7/8)</td>
<td>85% (68/80)</td>
</tr>
<tr>
<td>Indirect signs Sensitivity</td>
<td>96% (84/87)</td>
<td>100% (7/7)</td>
<td>98% (91/93)</td>
</tr>
<tr>
<td>Indirect signs Specificity</td>
<td>100% (28/28)</td>
<td>100% (6/6)</td>
<td>100% (32/32)</td>
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</tbody>
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180 mAs as reference standard

N=125 patients with renal colic

<table>
<thead>
<tr>
<th>30 mAs</th>
<th>180 mAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>1.6 ±0.2 mSv</td>
</tr>
<tr>
<td>Women</td>
<td>2.1 ±0.3 mSv</td>
</tr>
</tbody>
</table>

Poletti et al AJR 2007;188:927-933

Low-dose CT

- Low-dose CT (30 mAs) did not miss any calculus ≥3 mm in patients with BMI <30
- Smaller calculi (<3 mm) may be missed (83% sensitivity)
- Exact stone size measurements less reliable, may vary by ±20%

Remember

Add intravenous contrast when in doubt!

Thank you