Evidence Based Management of Pediatric Stones

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Epidemiology

Urolithiasis in children is on the rise
Epidemiology

• Rochester Epidemiology Project
• All patients 18 years or younger diagnosed with kidney stones

- 4% increase in the incidence of stones in children/year
- 6% increase in the incidence of stones in children/year ages 12-17

Dwyer et al 2012
Epidemiology

Emergency Room Visits
Incidence rate
1996  7.9 /100 000
2007  18.5/100 000
(p < .0001)

Hospital Admissions

Number of pediatric urolithiasis patients annually before (broken line) and after (solid line) correcting for hospital volume.

\(^2\) Sas et al 2010
\(^3\) Routh et al 2009
Epidemiology: Sex and Race

### Table 1: Age and gender distribution among pediatric stone formers

<table>
<thead>
<tr>
<th>Age quartile (years)</th>
<th>1997</th>
<th>2000</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male n (%)</td>
<td>Female n (%)</td>
<td>Male n (%)</td>
</tr>
<tr>
<td>0–5</td>
<td>98 (60)</td>
<td>66 (40)</td>
<td>111 (54)</td>
</tr>
<tr>
<td>6–10</td>
<td>136 (57)</td>
<td>101 (43)</td>
<td>208 (53)</td>
</tr>
<tr>
<td>11–15</td>
<td>213 (44)</td>
<td>275 (56)</td>
<td>327 (45)</td>
</tr>
<tr>
<td>16–20</td>
<td>299 (26)</td>
<td>852 (74)</td>
<td>954 (27)</td>
</tr>
<tr>
<td>Total</td>
<td>746 (37)</td>
<td>1294 (63)</td>
<td>1600 (32)</td>
</tr>
<tr>
<td>p value</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

The numbers in parentheses represent the percentages of male and female stone patients in each age group. The p value represents the difference in age distribution between males and females for the given year.

- **Ages 0-10**: Males > Females
- **Ages 11-20**: Females > Males
- **Age > 16**: Females 3X > Males

### Race:

- **White (88%)** > **Hispanic (15%)** > **Black (6%)** > **Asian (1%)**

*Bush et al. 2010*

*Matlaga et al. 2010*
Economic Impact: Pediatric Stones

- **KID Database**: 7,348 Hospital admissions
- **NEDS Database**: 33,038 ED encounters

  - Median charges/admission: $13,922 for a total of $229 million/yr
  - Median charges/ ED encounter: $3,991/ for a total of 146 million/yr

Total Cost for Pediatric Stone admissions and ED evaluation ~ $375 million per year

Wang et al. 2015
Clinical Presentation: Age Dependent

- **Premature/Very Low Birth Weight Infants**
  - 102 very low birth weight infants
    - 6% had renal calcification
      - 100% incidentally found

- **Infants (<1 year)**
  - **UTI**
    - Males (34%) Females (21%)
  - **Restlessness**
    - Males (17%) Females (17%)
  - **Hematuria**
    - Males (10%) Females (14%)
  - **Incidental discovery**
    - Males (22%) Females (29%)

Change et al. 2011

Aypay et al. 2013
Clinical Presentation: Age Dependent

Younger Children and Adolescents

<table>
<thead>
<tr>
<th></th>
<th>&lt; 10 years</th>
<th>&gt; 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>63%</td>
<td>82%</td>
</tr>
<tr>
<td>Hematuria</td>
<td>13%</td>
<td>11%</td>
</tr>
<tr>
<td>UTI</td>
<td>23%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Valentini et al. 2011, Kalorin et al 2009
Diagnosis: Symptomatic Patient

**Labs**
- Urinalysis
  - Microscopic hematuria
  - Sterile Pyuria
- Urine culture
- CBC
- BMP

**Radiological Imaging**
- CT
- KUB
- Sonography
- MRI
Radiological Imaging: CT

• Migliorei et al. 2013
    • Doubled in children < 5 years of age
    • Tripled in children >5 years and < 14 years
    • Radiation effective dose for abdominopelvic CT
      – ~ 10.6 mSV
      – 14% > 20 mSv

TABLE 7
Estimated Lifetime Risk of Radiation-Associated
Solid Cancer Deaths in the LSS after
Exposure to 0.1 Sv

<table>
<thead>
<tr>
<th>Age at exposure</th>
<th>Sex</th>
<th>Lifetime risk (%)</th>
<th>Years of life lost per excess death</th>
<th>Background risk (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>M</td>
<td>2.1</td>
<td>13.0</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>2.2</td>
<td>13.3</td>
<td>20</td>
</tr>
<tr>
<td>30</td>
<td>M</td>
<td>0.9</td>
<td>12.7</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1.1</td>
<td>14.4</td>
<td>19</td>
</tr>
<tr>
<td>50</td>
<td>M</td>
<td>0.3</td>
<td>10.2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>0.4</td>
<td>11.2</td>
<td>16</td>
</tr>
</tbody>
</table>

Preston et al 2003

All comers, not just stone patients
Radiological Imaging: CT

Projected lifetime risk of solid cancer

30 cases of radiation induced solid cancer/10,000 CT scans in girls
15 cases of radiation induced solid cancer/10,000 CT scans in boys

4.25 million CT scans in children/year

4870 Future Radiation Induced Cancers/year in Children

Migliorei et al. 2013
Radiological Imaging: CT

1999-2008

6318 children

1999
26% CT

2008
45 % CT

79%

2 or more CTs

med 2 per child

range 1-8

Routh et al 2010
Radiology Imaging: CT

Do we need CT imaging in Children with Symptomatic Stones?

Johnson et al. 2011

- 42 children treated for stones
  - ~11 years
  - All had an US and/or KUB
    - 90% had a stone seen on KUB and/or US
    - 76% (32) had a CT scan
      » All stones missed on US were distal stones
        • May have been seen if KUB was obtained
      » No change in management even with CT

90% of pediatric patients treated for symptomatic urolithiasis could have completed their evaluation and treatment without a CT scan.

Johnson et al. 2011
Radiological Imaging

Boston Children's 2009

US vs CT

50 consecutive patients
CT and US

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>94-99%</td>
<td>95-98%</td>
</tr>
<tr>
<td>US</td>
<td>76%</td>
<td>100%</td>
</tr>
</tbody>
</table>

16 discrepancies between CT and US.
3 cases long term management changes were recommended
All others management was not altered

Missed stones were small, no changes in immediate management of the stone.

Passerotti et al 2009
CT Imaging: Decreasing Radiation

<table>
<thead>
<tr>
<th>Tube Current</th>
<th>25%</th>
<th>50%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Dose</td>
<td>1.9mSv</td>
<td>3.8mSv</td>
<td>7.3mSv</td>
</tr>
</tbody>
</table>

Niemann et al. 2008
Radiological Imaging: KUB

Advantages
- Low radiation (0.05 mSv)
- No pain
- No sedation

Disadvantages
- Sensitivity 60%
- May miss small stones
- Will miss radiolucent stones
Radiological Imaging

KUB + US

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>US + KUB</td>
<td>71-97%</td>
<td>85-92.7%</td>
<td>95%</td>
<td>46-68%</td>
<td>87.5%</td>
</tr>
<tr>
<td>CT</td>
<td>92-93%</td>
<td>96%</td>
<td>98%</td>
<td>86%</td>
<td>93.7%</td>
</tr>
</tbody>
</table>

Stones missed by Ultrasound and KUB passed spontaneously without complications

Conclusion: US + KUB adequately identified clinically significant stones with minimal loss of diagnostic accuracy

Radiological Imaging: Urolithiasis

- KUB and US first line evaluation in children with suspected urolithiasis

- Low dose CT scanning protocols should be requested when evaluation of children with CT is deemed necessary.

- KUB and or ultrasound should be the imaging modality of choice for post-operative follow-up
Expectant Management of Pediatric Nephrolithiasis

Group 1  0-5 yrs
Group 2  6-10yr
Group 3  11-18yr
Medical Expulsion Therapy

Table 1. Patient demographics and clinical data

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (n)</td>
<td>21</td>
<td>24</td>
<td>.31</td>
</tr>
<tr>
<td>Age (y)</td>
<td>7.2 ± 3.5</td>
<td>6.0 ± 3.5</td>
<td>.31</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>23.3 ± 9.7</td>
<td>23.5 ± 13.3</td>
<td>.55</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td>.47</td>
</tr>
<tr>
<td>Boys</td>
<td>10</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>11</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Stone size (mm)</td>
<td>4.45 ± 1.5</td>
<td>4.58 ± 1.7</td>
<td>.61</td>
</tr>
</tbody>
</table>

Data presented as mean ± standard deviation or n.

Table 2. Follow-up results

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (n = 21)</th>
<th>Group 2 (n = 24)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall expulsion rate</td>
<td>6 (28.6)</td>
<td>17 (70.8)</td>
<td>.005</td>
</tr>
<tr>
<td>Expulsion rate by stone size (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5 (n = 21)</td>
<td>5/12</td>
<td>9/9</td>
<td>.007</td>
</tr>
<tr>
<td>5-10 (n = 24)</td>
<td>1/9</td>
<td>8/15</td>
<td>.008</td>
</tr>
<tr>
<td>Expulsion rate by age (y)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-6 (n = 23)</td>
<td>4/11</td>
<td>11/12</td>
<td>.009</td>
</tr>
<tr>
<td>≥7 (n = 22)</td>
<td>2/10</td>
<td>6/12</td>
<td>.204</td>
</tr>
<tr>
<td>Interval to expulsion (d)</td>
<td></td>
<td></td>
<td>.001</td>
</tr>
<tr>
<td>Median</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Interquartile range</td>
<td>7.58-8.25</td>
<td>5.5-6</td>
<td></td>
</tr>
<tr>
<td>Interval by stone size (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5</td>
<td>8</td>
<td>6</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Interquartile range</td>
<td>7.58-8.25</td>
<td></td>
</tr>
<tr>
<td>5-10</td>
<td>9 [9-9]</td>
<td>6</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Interquartile range</td>
<td>6-7</td>
<td></td>
</tr>
<tr>
<td>Daily pain episodes (n)</td>
<td></td>
<td></td>
<td>.023</td>
</tr>
<tr>
<td>Median</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Interquartile range</td>
<td>1-2</td>
<td>1-1</td>
<td></td>
</tr>
</tbody>
</table>

NA, not available.

Lower Ureteral Stones

Group 1
- Ibuprofen 10mg/kg BID

Group 2
- Ibuprofen 10 mg/kg/d
- Doxazosin 0.03 mg/kg/d

4 weeks F/U
Medical Expulsive Therapy

Group 1
- Tamsulosin 0.2mg/day < 4 years old
- Tamsulosin 0.4mg/day > 4 years old
- Ibuprofen 10 mg/kg BID

Group 2
- Placebo
- Ibuprofen 10 mg/kg BID

All stones < 12 mm

Follow-up = 4 weeks

Stone Free Rate
- Tamsulosin  88%
- Placebo  64%

Table 2: Overall results in both groups.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expulsion Rate</td>
<td>87.8%</td>
<td>64.2%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Days to expulsion</td>
<td>8.2 ± 3.4</td>
<td>14.5 ± 4.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pain episodes</td>
<td>1.4 ± 1.2</td>
<td>2.2 ± 1.4</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Need for analgesia</td>
<td>0.7 ± 0.9</td>
<td>1.4 ± 1.1</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Side effects (n)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>postural hypotension</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>syncope</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>palpitations</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>somnolence</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>headache</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>nasal congestion</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Mokhless et al, 2011
Surgical Intervention

• Failure of stone passage
  – 2-4 week trial +/- $\alpha_1$-antagonist

• Uncontrolled pain

• Vomiting
  – Inability to tolerate oral intake

• Development of urinary tract infection
  – Drainage of obstructed system
    • JJ Stent or PCN
  – Appropriate antibiotic treatment
    • 2 weeks (?)
Pre-Operative Considerations

- Urine Culture prior to intervention
- Antibiotics
  - Ureteroscopy
    - Cefazolin
  - PCN
    - Ampicillin and Gentamycin
    - Fluoroquinolone
  - Indwelling stent or PCN
    - Ampicillin and Gentamycin
    - Fluoroquinolone
**Surgical Intervention**

1999-2008

7921 children with urolithiasis

1712 (22%)

Surgical intervention

<table>
<thead>
<tr>
<th>Procedure</th>
<th>1999</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ureteroscopy</td>
<td>6.4%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Stent Placement</td>
<td>12%</td>
<td>11%</td>
</tr>
<tr>
<td>PCNL</td>
<td>4.8%</td>
<td>2.5%</td>
</tr>
<tr>
<td>SWL</td>
<td>9.4%</td>
<td>4.4%</td>
</tr>
</tbody>
</table>

We are doing more ureteroscopy, less SWL and PCN

Routh et al 2010
Shockwave Lithotripsy

- Introduced in 1986 as treatment for pediatric stones

  - Treatment choice
    - Child’s size
    - Urinary tract anatomy
    - Small pediatric ureter and urethra favor SWL
    - SWL first-line treatment option for most upper tract stones

Preminger et al. 2007
Shockwave Lithotripsy

- **500 children treated with SWL**
  - **Age:** ~8 yrs
    - (9 months-17 years)
  - **Stone size:**
    - 4-20 mm (kidney)
    - 4-10 mm (ureter)
  - **Location:**
    - 90% Kidney
    - 10% Ureter
  - **Technique**
    - ~2500 shocks
    - 16-19 kvolts
    - 60-80 shocks/minute
  - **Follow-up**
    - 3 months
    - Stone free
      - No stone
      - No fragment

**Stone Free Rate at 3 months:**
- 90% Renal stones
- 77% Ureteral stones

Fig. 1 Stone-free rate and re-treatment rate based on stone location

Badawy et al 2012
Factors effecting the success of SWL

- **Stone Location**
  - **Kidney Lower pole**
    - Mandal et al 2012: SWL Children vs Adults for LP stones < 2.0 cm
      - Children: Higher success rate and fewer complications
  - **Ureteral**
    - Pirincci et al 2012: SWL for Children with Ureteral Stones
      - 62 children (50% proximal, 16% mid, 34% distal)
      - 93% stone free at 3 months with no differences in stone size/location

- **Stone Composition**
  - Brushite, Cystine and Calcium Oxalate monohydrate

- **Skin to stone distance**
  - McAdams et al 2010
    - SSD was not a significant predictor of successful SWL treatment
Factors effecting the success of SWL

- Stone Attenuation
  - McAdams et al 2010
    - < 1000 HU 77% stone free
    - >1000 HU 33% stone free

- Rate of shock wave delivery
  - Salem et al 2013
    - 60 children randomized to 80 s/min. or 120 s/min.
      - 80s/min. 90% stone free 120s/min. 74% stone free

- Stone Size and Number of stones
  - Stone Size
    - Landau et al 2009: SWL in Children with Renal Stones 6-24 mm
      - 80% stone free at 3 months with stone size most important factor
      - Best results at ≤ 11 mm
    - McAdams et al 2010
      - Only Stone diameter predicted SWL success
Complication of SWL in Pediatrics

- Pain (18%)
- Bleeding (5%)
- Sepsis (4%)
- Urinary Retention (2%)
- Ureteral obstruction (2%)
- UTI (2%)
- Stricture (1%)
Long-term Concerns after SWL

- Rinkmann et al 2001
  - 64 children
    - 80% stone free rate at 3 months
    - No:
      - Renal scarring
      - Change in renal function
      - Change in blood pressure
      - Growth difference in treated vs untreated kidney
    - Hematuria and proteinuria resolved in all stone free children
Ureteroscopy in Pediatrics

• 1st case of pediatric ureteroscopy: 1988
• SWL vs Ureteroscopy
  • 2000 to 2002
    – 24% ureteroscopy
    – 78% SWL
  • 2006 to 2008
    – 50% ureteroscopy
    – 50% SWL

Ureteroscopy in Pediatrics

• Ureteral Access
  ▪ Primary ureteroscopic access
  ▪ Semi-rigid ureteroscopy >>> flexible ureteroscopy
  ▪ Hand Irrigation Pump
  ▪ Ureteral dilation:
    • Passive dilation:
      – Ureteral stent
    • Active dilation
      – Ureteral dilation
        » 8 or 10 F ureteral coaxial dilator
        » Balloon dilation
Ureteral Dilation: Passive

• Ureteral stent

  ➢ Kim et al. 2008
    • 57% of ureters could not be accessed via primarily
      – 83% were in children <10 years
    • 100% of stented ureters were accessible

  ➢ Corcoran et al 2008
    • 40% required ureteral stenting
      – Age, height, weight and BMI do not predict need for stent
    • 100% of stented ureters were accessible

No Significant Complications Long Term
Ureteral Dilation: Active

➢ Ureteral Coaxial Dilator
  • 100 children with stones
    – 70% ureteral dilation (8 or 10F ureteral coaxial dilators)
    – Mean follow up 10 months (median 2.6)
    – No major intraoperative complications
      » 5 post op stent for ureteral perforation
      » 1 post operative stricture

➢ Ureteral Balloon Dilator
  • 16 children (ages <7 years)
    – 30% ureteral balloon dilation
    – Mean follow up 10.3 months
    – No major complications
      » 1 case of perforation
      » No long term complications

Smaldone et al 2008, Unsal et al. 2011
Ureteral Access Sheath

- 96 children with stones
  - Stone size ~ 9.6 mm
  - Follow up ~ 11 months
  - 42% required ureteral access sheath
    - 7 intraoperative complications
      - 4 perforations
      - 2 submucosal wires
      - 1 stent migration
      - More common with sheath use (p=0.02)
  - No ureteral strictures

Wang et al 2011
Ureteroscopy in Pediatrics

• Stone Free Rates
  – Age:
    • < 7 years of age 93%
    • > 7 years of age 90%
  – Location
    • Kidney 81%
    • Ureter 100%
  – Size
    • < 10 mm 91%
    • > 10 mm 79%

Lower if stone in the kidney and/or larger than 1 cm

Uygim et al 2012
Ureteroscopy in Pediatrics

• Complications:
  – 0 to 8%
    • Renal colic
    • Gross hematuria
    • Febrile UTI
    • Ureteral stricture
    • Ureteral perforation

Predictive Factor for Complications
>> Increased operative time
PCN in Pediatrics

• **First reported use in Children:**
  – Woodside et al. 1985

• **Use has decreased with time**
  – Indications for PCN
    • Anatomic abnormalities
    • Known stone composition resistance to SWL
      – Brushite, Cystine, Calcium oxalate monohydrate
    • Struvite Infectious stone
    • Large Stone burden
PCN in Pediatrics

• PCN in infants:
  – 19 infants (7-36 months)
    • All Staghorn calculus
      – 100% ureteral catheter pre-op
      – 100% post op Nephrostomy tube
    • Stone Free:
      – 95%
  • Complications
    – 16% post operative fever
  • ~ 27 months
    – No long term complications noted.

Zang et al 2012
PCN in Pediatrics

- 10 years of pediatric PCNs
  - 95 patients
    - ~ age 12 years (3-17)
  - Indications
    - Stones > 2cm
  - Stone Free
    - 83% after 1 treatment
    - 91% after 2 treatments
  - Complications:
    - 16% post op fever (2 sepsis)
    - 9% transfusion
    - 3% hydrothorax (2 chest tubes)
PCN in Pediatrics: What’s Hot?

**Mini-PCN** (15-17F Nephroscope with ~ 20F sheath)

**Ultra Mini PCN** (9.5-11F Nephroscope with ~ 12F sheath)

**Micro PCN:** (16-guage “all-seeing needle”)
  - Not approved in the US
PCN in Pediatrics

• Mini-PCN vs Ureteroscopy
  – 201 children
    • 106 Mini-PCN
    • 95 Ureteroscopy
  – Stone burden 10-30mm
    • Smaller in Ureteroscopy (~14mm vs 12 mm)

– Outcomes
  • Ureteroscopy:
    – Less Floroscopy use
    – Shorter OR time
    – Shorter Hospitalization
  • Mini PCN
    – More Blood Loss

Resorlu e al. 2012
PCN in Pediatrics: Micro PCN

- 140 Procedures
  - 6-32 mm stones
  - Stone free 82%
  - 12 conversations to mini-PCN

Desai et al. 2011  Haipoqlu et al. 2013
PCN in Pediatrics

• **Mini PCN vs Micro PCN:**
  – < 18 years of age
  – Stone size: 10-20 ~ 13 mm

• **Outcomes:**
  – No difference between groups:
    • Operative Time
    • Stone Free Rates
    • Success Rates
    • Complications
  – Micro Group:
    • Shorter:
      – Floroscopy time
      – Length of Hospitalization
    • Less Blood loss in Mini PCN Group

Karataget al 2015
Pediatric Nephrolithiasis

Asymptomatic Stones
• Kang et al. 2012 JUrol
  – 347 patients
    • ~ 4.4 mm (1-10mm)
    • All located in the kidney
  – 46% no stone related event
  – 54% had stone related event
    • 24% required intervention
      – 5% surgery

Residual Fragments
• Dincel et al. 2013
  – 85 children
    • SWL, URS or PCN
    • ~ 22 months (6-50 mths)
    • < 4mm

Table 2: Outcomes of residual fragments.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number</th>
<th>Percentage</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous passage (%)</td>
<td>22/85</td>
<td>25.8%</td>
<td>&lt;0.05 *</td>
</tr>
<tr>
<td>According to stone location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renal pelvis</td>
<td>4/7</td>
<td>57.1%</td>
<td></td>
</tr>
<tr>
<td>Mid/upper pole</td>
<td>9/26</td>
<td>34.6%</td>
<td></td>
</tr>
<tr>
<td>Lower pole</td>
<td>5/31</td>
<td>16.1%</td>
<td></td>
</tr>
<tr>
<td>Multi-caliceal</td>
<td>4/21</td>
<td>19.1%</td>
<td></td>
</tr>
<tr>
<td>IPA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥45°</td>
<td>7/15</td>
<td>46.7%</td>
<td>&lt;0.05 *</td>
</tr>
<tr>
<td>&lt;45°</td>
<td>0/11</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>According to no. fragments</td>
<td></td>
<td></td>
<td>&lt;0.05 *</td>
</tr>
<tr>
<td>Single (%)</td>
<td>15/50</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>Multiple (% [median, range])</td>
<td>7/35</td>
<td>20% [3, 2-4]</td>
<td></td>
</tr>
<tr>
<td>Growth in size (%)</td>
<td>18</td>
<td>21.2%</td>
<td></td>
</tr>
<tr>
<td>Stone related events (%)</td>
<td>34</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>Renal colic</td>
<td>21</td>
<td>24.7%</td>
<td></td>
</tr>
<tr>
<td>Hematuria</td>
<td>14</td>
<td>16.4%</td>
<td></td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>5</td>
<td>5.8%</td>
<td></td>
</tr>
</tbody>
</table>
Recurrence Rates

- Retrospective Review 1999-2007
  - 60 children < 18 years
    - Stone surgery and stone free
    - ~ age at surgery 5 years
      - Follow up 5 years
  - Overall recurrence rate 55%
    - Abnormal anatomy 65%
- 24 hour urine
  - Hypercalciuria and/or Hypocitraturia
- Conclusion
  - High recurrence rate in children with stones requiring surgical intervention
  - Aggressive evaluation and management

Lao et al. 2014
Post Intervention: Follow up

• Radiographic imaging:
  – Document clearance of stone/fragments
  – Resolution of hydronephrosis
  – Evaluate for possible stricture
    • Ultrasound +/- KUB

• 24 hour urine
  – 50% have an abnormality noted on 24 hour urine
  – Recurrence rates > 50%

• Serum Labs
  – Chem 7, PO3, Mg, UA, AlkPO4

Preminger et al 2007
Conclusion

• Pediatric Stone Disease is on the Rise
• Clinical presentation varies age
• US and KUB is the imaging choice for children
• Conservative management with medical expulsive therapy is beneficial
• Surgical Intervention requires special considerations
• Medical Evaluation and follow up is necessary
Thank You!
References


References


References


39. Karatağ T, Tepeler A, Silay MS, Bodakçı MN, Buldu I, Daggulli M, Hatipoglu NK, Istanbulluoglu MO, Armagan A


References

