OPTIMAL MANAGEMENT OF LOWER POLE CALCULI

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LOWER POLE STONES

• Unique location in terms of stone management
• Differences in outcome of SWL depending on stone location
RESULTS OF SWL BY STONE LOCATION

88% 73%
80% 69%
63%

SWL FOR TREATMENT OF LOWER POLE CALCULI

- Non-invasive
- High patient acceptance
- Low complication rate
- Failures easily salvaged with PCNL or URS
MEASURES TO IMPROVE CLEARANCE

• Brownlee et al (J Urol 143, 1990):
  – Controlled inversion tx, percussion, hydration:
  – 88% SF w/ 2 wk IT vs 12.5% w/ single session

• Kosar et al (J Endourol 13, 1999):
  – Vibration massage daily x 14 d
  – 80% SF w/ vibration vs 60% w/o

• Nicely et al (J Urol 148, 1992):
  – Retrograde irrigation w/ a directed catheter during SWL
  – 71% w/ irrigation vs 54% in controls

• Graham and Nelson (J Urol 152, 1994):
  – Continuous saline irrigation via lower pole NT
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MEASURES TO IMPROVE CLEARANCE
Pace et al, J Urol 166, 2001

69 pts w/ <4 mm residual LP fragments 3 mo post-SWL randomized to MPI vs observation
• SFR 40% vs 3% for control group
• MPI safe and effective tx option for LP fragments
MEASURES TO IMPROVE CLEARANCE

Chiong et al, Urol 65, 2005

108 pts w/ LP stones Tx’d w/ SWL

SWL (n=49)
Mean 10 mm

SWL + PDI (n=59)
Mean 0.8 mm

3 months post-SWL

35%

63%

Stone Free Rates

MEASURES TO IMPROVE CLEARANCE

(Soygur et al, J Endourol 16: 149, 2002)

110 pts w/ LP stones Tx’d w/ SWL

Stone Free (n=56)

4 weeks post-SWL

Kcit
0% (n=34)

No drug
28% (n=38)

Resid. Frags. <5 mm

(n=34)

Kcit
44.5% (n=25)

No drug
12.5% (n=22)

Recurrence Rate at 1 yr

Resolution of frags at 1 yr
PCNL FOR TREATMENT OF LOWER POLE CALCULI

- SF rates location-independent
- Generally “easy” percs
- Lower pole access “safe” (below 12th rib)
- Highly effective

PCNL FOR NON-STAGHORN RENAL CALCULI

Influence of Stone Size

![Graph showing the influence of stone size on stone free rate. The x-axis represents cm, and the y-axis represents stone free rate (%). The graph shows a trend where stone free rate increases as stone size decreases.](image-url)
META-ANALYSIS: PCNL VS SWL FOR LOWER POLE STONES
Lingeman et al, J Urol 151, 1994

- 13 SWL studies with stratified lower pole stone data (2927 cases)
- 3 PCNL studies (101 cases)
- Overall stone free rates: 90% PCNL vs 60% SWL (p<0.0001)
- Controlling for stone size, pts w/ lower pole stones 6.27x more likely to be rendered SF w/ PCNL than SWL (p<0.0001)

META-ANALYSIS OF SWL VS PCNL FOR LOWER POLE STONES
Lingeman et al, J. Urol, 1994

- Stone Free Rate vs Stone Size
- PCNL vs SWL: p<0.001
PROSPECTIVE, RANDOMIZED TRIAL: PCNL VS SWL FOR LOWER POLE STONES
Lingeman and Lower Pole Study Group
(J Urol 166:2072, 2001)

• 14 institutions represented
• 160 pts w/ LP stones randomized to SWL vs PCNL, stratified by stone size
• 107 pts (88%) available for 3 mo. F/U
• Patients assessed for:
  - stone free status by nephrotomograms
  - hospital stay
  - complications
  - retreatments
  - Health status survey

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<tbody>
<tr>
<td>SWL</td>
<td>37% (19/52)</td>
<td>0.55</td>
<td>12%</td>
<td>16% (10/64)</td>
<td>16% (10/64)</td>
</tr>
<tr>
<td>PCNL</td>
<td>95% (52/55)</td>
<td>2.67</td>
<td>23%</td>
<td>9% (5/58)</td>
<td>2% (1/58)</td>
</tr>
</tbody>
</table>
PROSPECTIVE, RANDOMIZED LOWER POLE STONE STUDY: RESULTS OF PCNL VS SWL

<table>
<thead>
<tr>
<th>Stone Size (mm)</th>
<th>PCNL</th>
<th>SWL</th>
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</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>100%</td>
<td>63%</td>
</tr>
<tr>
<td>&gt;10-20</td>
<td>93%</td>
<td>23%</td>
</tr>
<tr>
<td>&gt;20</td>
<td>86%</td>
<td>14%</td>
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</table>

Stone Free Rate

PCNL vs SWL:
- <10 mm: p<0.05
- >10-20 mm: p<0.05
- >20 mm: p<0.05

EFFICIENCY QUOTIENTS FOR PCNL VS SWL FOR LOWER POLE STONES

Lingeman and Lower Pole Study Group

EQ = %Stone Free/(100 + %Retx + %Auxiliary Proced)

<table>
<thead>
<tr>
<th>Stone Size (mm)</th>
<th>PCNL</th>
<th>SWL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10 mm</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>11-20 mm</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>21-30 mm</td>
<td>40</td>
<td>20</td>
</tr>
</tbody>
</table>
LOWER POLE STONES: ANATOMIC CONSIDERATIONS
Sampaio and Aragao, J Endourol 8, 1994

Methods
• Analysis of 146 endocasts of kidney collecting systems
• Assessed anatomic configuration of lower pole calyceal system

SPACIAL ANATOMY OF THE LP CALYX
(Elbahnasy et al, J Endourol 12, 1997)

Infundibulopelvic angle
>90°

Infundibular length
<3 cm

Infundibular width
>5 mm
OUTCOME OF SWL BASED ON SPACIAL ANATOMY OF THE LOWER POLE
(Elbahnasy et al, J Endourol 12, 1997)

Infundibulopelvic Angle

<=40
(-) IL + (-) IW 16%

<70
(-) IL + (-) IW 14%
(-) IL 50%
(-) IW 60%
(+) IL + (+) IW 84%

>=70
(-) IL + (-) IW 75%
(-) IL 67%
(-) IW 80%
(+) IL + (+) IW 91%

>=90
(+) IL + (+) IW 100%

ALGORITHM FOR TREATMENT OF LP STONES 1-2 CM IN SIZE

Infundibulopelvic Angle

<40
PCNL

41-69
(-) IL + (-) IW
PCNL

>70
SWL

(-) IL or (-) IW
?PCNL

(+) IL + (+) IW
SWL
EFFECT OF CALYCEAL ANATOMY

• Gupta (JU 163, 2000) LIP angle and IW sig. influence stone clearance after SWL
• Keeley et al (Eur Urol, 36:371, 1999) LIP angle only factor that significantly influences SF rates
• Sumino et al (J Urol 168, 2002) Independent predictors of SF state: infund. length-to-diameter ratio (<7 mm), diameter (>4 mm) and no. of calyces (single)
• Symes et al (Urol Res, 33, 2005) Pelvi-caliceal height significantly lower in stone free group
• Ghoneim et al (Eur Urol, 48: 2005) LIP angle and infundibular length significant factors influencing SF rates

EFFECT OF CALYCEAL ANATOMY

• Madbouly et al (J Urol 165: 1415, 2001) LP anatomy does not affect stone clearance
• Sorensen and Chandhoke (J Urol 168, 2002) Only stone size, not calyceal anatomy, was predictive of stone free state
REPRODUCIBILITY OF MEASUREMENTS
Knoll et al, J Endourol 17: 447, 2003

• 40 RU on IVP analyzed by 5 observers, 3x each on different days
  – Interobserver correspondence poor
  – Intraobserver variability better
• Might explain variability among studies

PREDICTION OF LP STONE CLEARANCE USING ARTIFICIAL NEURAL NETWORK
Poulakis Et al, JU 169: 1250, 2003

• 680 pts (701 RU) w/ LP stones tx’d w/ SWL: SF rate of 68%
• Assessed impact of variety of pt, stone and anatomic characteristics on SFR
• Neural network created using 101 cases for training, then used 600 cases for testing
• Relative importance of each variable determined
PREDICTION OF LP STONE CLEARANCE USING ARTIFICIAL NEURAL NETWORK
Poulakis Et al, JU 169: 1250, 2003

<table>
<thead>
<tr>
<th>Univariate Analysis</th>
<th>ANN-assigned relative wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>• BMI</td>
<td>• Urinary transport</td>
</tr>
<tr>
<td>• Urine transport type</td>
<td>• IUPA</td>
</tr>
<tr>
<td>• Infundibular diameter</td>
<td>• Caliceal-pelvic height</td>
</tr>
<tr>
<td>• IPA</td>
<td>• BMI</td>
</tr>
<tr>
<td>• Infunduloureteropelvic angle (IUPA)</td>
<td>• Stone size</td>
</tr>
</tbody>
</table>

- ANN 92% accurate in predicting LP stone fragment clearance after SWL
- Dynamic urinary transport most important factor in predicting stone clearance
- Anatomic measurements highly reproducible w/ low intra- and inter-observer variability
- Need for prospective trial
LOWER POLE STONES
Calyceal Anatomy

• Challenge is to predict likelihood of success for individual w/ known anatomic factors
• Need larger data base accumulation and multivariate analysis to construct tables that relate SFR to easily measurable anatomy

URETERORENOSCOPIC APPROACH

Advantages
• Generally performed on outpt basis
• Highly effective
• Minimal morbidity
• Works well for small stones and SWL failures and avoids PCNL
URS FOR INTRARENAL CALCULI
(Grasso, Urol Clinic N Am, 27, 2000)

• Multicenter: Grasso and Bagley
• 1000 procedures using ≤8F flexible ureteroscope
• Access to entire collecting system in 93% of cases; in 7% of cases the lower pole could not be accessed
• Need for secondary deflection to access the lower pole in 57% of cases

URETERORENOSCOPIC APPROACH
Improvements in Ureteroscope Design

2-way deflection and active and passive deflection facilitate access into virtually every calyx
ACCESSING THE LOWER CALYX

Small, nondilated collecting system with shallow infundibular/pelvic angle: Direct access with active deflection

Dilated collecting system with sharp infundibular/pelvic angle: Combination active and passive deflection
EFFECT OF PATIENT POSITION
Bercowsky et al, J Endourol 13, 1999

- Based on IVU views in various positions
- Broadest angle of entry into lower pole was with patient prone, 20° head down
- Right side angle increased by 16°, left side by 25°

ACCESSING THE LOWER POLE CALYX
Afane et al, J. Endourol., 1999

- Reviewed 24 pts who underwent prone URS for lower pole stones (17 pts)
- Stone free rate of 88%
ACCESSING THE LOWER CALYX
Improvements in Ureteroscope Design

Duel active 1° and/or 2° deflection

Lower Pole Stones
Passage of Instruments

- From 104°-175° of deflection is required to access lower pole calyces
- Passage of instruments may result in loss of up to 86° of deflection
OPTIMIZING DEFLECTION

• Keep shaft of scope as straight as possible
  – Access sheath prevents buckling in bladder
  – Do not pass ureteroscope thru cystoscope sheath
• Gentle back tension on shaft of scope provides additional angulation of tip
• Placement of superstiff guidewire through working channel provides additional maneuverability
• Straighten scope to <30° deflection to pass instruments

NITINOL RETRIEVING DEVICES

• Tipless Nitinol basket
  – Works best in calyces
  – Causes only 10° loss of deflection w/ 7.5F flex ureteroscope (D’Honey, J. Endourol, 12, 1998)
• Combination grasper/basket
  – Easy to disengage
  – Minimal loss of deflection
# RETRIEVAL AND LITHOTRIPSY DEVICES
Effect on Deflection of DUR8-E

Lobik et al, J Endourol 17, 2003

<table>
<thead>
<tr>
<th></th>
<th>Baseline deflection</th>
<th>Stiff Wire</th>
<th>1.6F EHL</th>
<th>3.0F EHL</th>
<th>2.4/3F basket</th>
<th>200µ laser</th>
<th>365µ laser</th>
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<td>Up 170°</td>
<td>5-23°</td>
<td>-6.5°</td>
<td>-20°</td>
<td>&lt;12°</td>
<td>-7-43°</td>
<td>-8-59°</td>
<td></td>
</tr>
<tr>
<td>Dwn 185°</td>
<td>2.4/3F basket</td>
<td>3.0F</td>
<td>1.6F</td>
<td>EHL</td>
<td></td>
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Baseline deflection
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If 1° deflection initiated first, get maximum 2° deflection compared with 2° first followed by 1°
LOWER POLE STONE REPOSITIONING
Tipless Nitinol Basket

- Kourambas et al (Urol 56, 2000):
  10 pts w/ LP stones not accessible by URS
  - Stone displaced w/ nitinol basket or grasper
  - 90% SF for displaced
  - 83% for in situ stones

- Schuster et al (J Urol 168, 2002):

<table>
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<th>In Situ N=59</th>
<th>Displaced N=19</th>
<th>P-value</th>
</tr>
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<tbody>
<tr>
<td>Overall</td>
<td>71%</td>
<td>94%</td>
<td>0.058</td>
</tr>
<tr>
<td>≤1 cm</td>
<td>77%</td>
<td>77%</td>
<td>ns</td>
</tr>
<tr>
<td>&gt;1 cm</td>
<td>29%</td>
<td>100%</td>
<td>0.005</td>
</tr>
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IMPROVING LOWER POLE STONE CLEARANCE WITH URS
Patel and Fuchs, AUA 2003

Displace stone from lower to upper calyx
Inject autologous blood into lower pole infundibulum
Fragment stone; clot prevents lower pole pooling

LOWER POLE STONE STUDY II
Pearle et al, JU 173, 2005

109 pts enrolled

Group 1 (≤1 cm) (n=67)
Group 2 (>1-2.5 cm) (n=42)

SWL (n=32)  URS (n=35)  URS (n=20)  PCNL (n=22)

1º outcome parameter: SFR using CT criteria
### LOWER POLE STONE STUDY II

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<tr>
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<th>≤1 cm N=72</th>
<th>&gt;1-2.5 cm N=42</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>SWL (n=32)</td>
<td>URS (n=35)</td>
</tr>
<tr>
<td>OR time (min)</td>
<td>66</td>
<td>90</td>
</tr>
<tr>
<td>Stone Free</td>
<td>35%</td>
<td>52%</td>
</tr>
<tr>
<td>2° proc</td>
<td>24%</td>
<td>7%</td>
</tr>
<tr>
<td>Intraop Complications</td>
<td>3%</td>
<td>20%</td>
</tr>
<tr>
<td>Postop Complications</td>
<td>23%</td>
<td>21%</td>
</tr>
<tr>
<td>LOS (days)</td>
<td>0</td>
<td>0.06</td>
</tr>
<tr>
<td>100% recovery time (d)</td>
<td>8</td>
<td>16</td>
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LOWER POLE STONE STUDIES I AND II

- For stones <1 cm, SWL and URS have poor SFRs
  - 2º outcome parameters favor SWL
- For stones >2 cm PCNL superior
- For stones b/w 1 and 2 cm, URS associated w/ relatively poor SFRs
  - PCNL has best outcomes

HOW ARE LP STONES TX’D IN PRACTICE?

- Internet and postal survey of American urologists regarding management of LP stones <1 cm, 1-2 cm, >2 cm (205 respondents)
CONCLUSIONS

• For LP stones < 1 cm, SWL and URS stone free rates are low
  – SWL favored for secondary outcomes
• For LP stones > 2 cm, PCNL is best
• For LP stones b/w 1 and 2 cm, SWL and URS stone free rates are poor
  – ? favorable anatomic subgroups for SWL
  – Measures to improve fragment clearance after URS (access sheaths, stone displacement, fragment retrieval)