UPDATE ON LASER LITHOTRIPSY

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OBJECTIVES

- Mechanisms of laser lithotripsy
- Clinical results
- Limitations of fibers
- Ureteronephroscopy?

PULSE DURATION

*J Endourol 2001; 15: 257*
SHORT PULSE LASERS

PULSED DYE LASER

- 504 nm
- Safe
- 64% effective solo
- Effective for dihydrate, struvite
- Ineffective for monohydrate, brushite, cystine (FREDDY same)
- LEP induces color vision deficits

Fig. 6. Comparison of the pressure transients induced by a 135 ns Nd:YAG laser and a 2.5 µs flashlamp pumped dye laser. (a) During plasma expansion for the 2.5 µs and 60 mJ FPDL irradiation; (b) during plasma expansion for the 135 ns and 30 mJ Nd:YAG irradiation; (c) at the bubble collapse for the 2.5 µs and 60 mJ dye irradiation.
ALEXANDRITE, Q-SWITCH
LSM 1997; 20: 433, Urol 1998; 51: 33

- 810-850 nm
- Ultrashort pulse (500 ns)
- High peak power
- No more effective than pulsed dye
- Fiber problems

HOLMIUM:YAG LASER

- 2100 nm
- 250 usec
- Near-infrared spectrum H2O absorption
- Low OH- silica fibers (200 – 1000 um)
PULSE DURATION AND VAPOR BUBBLE DYNAMICS

PHOTOTHERMAL MECHANISM
J Endourol 1999; 13: 181
BEAM PROFILE
J Endourol 2003; 17: 63

- Fragmentation = fluence

ENERGY DENSITY
J Urol 1998; 160: 471-6

- symmetric craters
- Energy efficient up to 1 J
- 365 um fiber
FRAGMENT SIZE
J Urol 1998; 159: 17-25

- Smaller fragments
- All compositions

RETROPULSION
J Urol 2003; 169: 881-5
PULSE DURATION
Lasers Surg Med 2006; 38: 762

FWHM 120-190 μsec vs. 210-350 μsec

RETROPULSION VS. ENERGY
Lasers Surg Med 2006; 38: 762

P<0.05
ABLATION VS. ENERGY
Lasers Surg Med 2006; 38: 762

RETROPELUSION NORMALIZED FOR ABLATION
Lasers Surg Med 2006; 38: 762

P<0.05
PRESSURE
Lasers Surg Med 2006; 38: 762

P<0.05

URETERAL STONES

• 94% stone-free J Urol 1997; 158: 1357
• 86% stone-free J Urol 1996; 156: 912
• 90% stone-free UROLOGY 1996; 48: 199
• 92% stone-free BJU 1999; 84: 1
• 84% stone-free > 2 cm J Endourol 2005; 19: 780
• HM-3 J Urol 1997; 158: 1915-21
LOWER POLE NEPHROSCOPY

- Extend holmium fiber PRIOR to ureteroscope deflection
- Deflect ureteroscope after fiber tip is seen beyond scope

LOWER POLE 2


- N=78 (67)
- LP stones < 1 cm
- Comparable preop

OR time (min) stone-free %
P=0.01
P=0.82

SWL scope
ACCESS SHEATH

• Decreases OR time
• Increases irrigation
• Decreases RPP
• Protects scope
• Stent!
• 54% stone-free

STENT?

• J Urol 2001; 166: 1651
• J Endourol 2002; 16: 9
• J Urol 2002; 167: 1977
• J Urol 2001; 165: 1419
• J Urol 2001; 166: 1252
• J Urol 2003; 169: 1257
• BJU Int 2004; 93: 1032

![Graph showing ER return rate comparison between stented and unstented patients. P<0.05]
LIGHT TRAVELS STRAIGHT!

- Anecdotes of ureteroscope #
- Lower pole cases
- Maximal deflection

FIBER DESTRUCTION TESTING

- Lumenis
- Sharplan
- InnovaQuartz (IQ)
- Dornier
- Trimedyne
- Laser Peripherals
FIBER DEFLECTION

J Endourol 2004;18:818

URETEROSCOPE DEFLECTION
SMA CONNECTOR FAILURE

PROXIMAL FAILURE

- Fiber NA
- Refractive index
- Overfill
**FIBERS**

- Dornier Super 200 failed repeatedly (8 watts)
- Dornier DUR reusable failed at 20\textsuperscript{th} cycle (5 cycles)
- Trimedyne 200 fails with Lumenis
- BS AccuFlex does not couple well with Lumenis laser
- LP RBLF200 fractured once
- All other fibers tested well

**DISPLACE LP STONES**

*J Urol 2002; 168: 43*

- Tipless nitinol baskets, graspers
- Displace into upper pole or RP
- Work with ureteroscope straight
- Avoid fiber issues
- Stone-free 77% in situ vs. 89% displace
- > 1 cm, 29% vs. 100%, p<0.01
ERBIUM

- FEL 2.9 um
- Erbium 2.94 um
- 2-3 x
- Germanium / sapphire fibers

**Graph:**
- P<0.01
- COM and cystine

CYSTINE
LSM 2006; 38: 39

- Erbium
  - 1 x
- Holmium
  - 5 x
THULIUM

• 1.94 um
• Soft tissue
• Hard tissue
• Thulium laser
• Thulium fiber laser
• Diode

CONCLUSIONS

• Photothermal mechanism
• Ureteroscopy better and easier
• Ureteroscopy for ureteral stones (renal)
• Renal stones (UP, interpolar, renal pelvis)– ESWL?
• Lower pole (displace if possible)
• Future advances