Natural Orifice: The Next Frontier in Urology?

Matthew T. Gettman, MD
Associate Professor of Urology

The Next Frontier?

- Dependent on:
  - Novel instrumentation
  - Safe procedural development

Advancing Minimally Invasive and Natural Orifice Surgery

- 1874: Nitze: Operating cystoscope
- 1877: Nitze cystoscope introduced
- 1878: Edison: Light bulb
- 1925: Stern: 1st resectoscope
- 1931: McCarthy: Improved resectoscope

Advancing Minimally Invasive and Natural Orifice Surgery

- 1960s: 1st flexible ureteroscopes
- 1975
- 1980s: Introduction of percutaneous surgery and SWL
- 1991: Clayman: Lap nephrectomy
- 1990s: robotic surgery
- 2000

Novel Instrumentation

NOTES Instrumentation: Technical Challenges

- Tissue handling
  - Triangulation
  - Force transmission
  - Poor haptics
- Clip & suturing devices
- Spatial orientation

Instrumentation Goals

- Smaller
- Stronger
- Smarter
- Automated (robotics)
- Multipurpose
NOTES Instrumentation

- Endoscopes
- Access sheath & overtubes
- Operative platforms
- Tools

From concept...

To reality

"R" Scope (Olympus)

Role for enteric and vaginal NOTES approaches

NOTES & Gastroscopes

Courtesy of N Reddy, Hyderabad India 2005

Courtesy: G Box
### GI Endoscopes (Gastroscopes)

<table>
<thead>
<tr>
<th></th>
<th>Dual Channel</th>
<th>Single Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>11.5 - 13</td>
<td>4.9 - 11</td>
</tr>
<tr>
<td>Working channels (mm)</td>
<td>2.0 – 3.8</td>
<td>2.0 -3.7</td>
</tr>
<tr>
<td>Working length (m)</td>
<td>1 – 1.1</td>
<td>1 – 1.1</td>
</tr>
<tr>
<td>Flexibility</td>
<td>↔ ↓</td>
<td>↔ ↓</td>
</tr>
</tbody>
</table>

**NOTES: Standard vs. Video Laparoscopes**

- Cobra Scope (USGI Medical)
- EndoSamurai (Olympus)
Operative Platforms

From the drawing board.....

Courtesy of R. Satava and N. Reddy, 2005

TransPort Device

Operative Platform: TransPort Device

Courtesy: G. Box
TransPort™ Multitasking Platform (USGI Medical)

Length: 100cm
Diameter: 20mm

Operative Platforms: Magnetic Anchoring and Guidance (MAGS)

- Developed at UTSW and UT Arlington
- Cutaneous magnets anchor instruments placed in situ
- Anchor 147 g of equipment across 2.5 cm abdominal wall thickness
- Eliminates fixed trocar positions
- Can be deployed via natural orifice or single incision

Magnetic Anchoring & Guidance System
Scott et al. Surg Endosc 2007

ROBOTIC ARM
CAUTERIZER
CAMERA

MAGS
Zeltser et al: J Urol 2007; 178:288
Direct Drive Endoscopic System

Instrument Improvements
- G-prox open
- G-prox closed
- Sphincterotomy

Suture Devices
- Eagle Claw, Apollo Group
- Olympus, Tokyo

Endoscopic Clips
- Quick clip
  - Olympus
- TriClip
  - Cook
- Resolution clip
  - Boston Scientific

Courtesy Chris Gostout
Power Medical

• Drive motors
• Articulation

NOTES: Role in Urology (to date)

• Kidney
• Bladder
• Other (unconventional ideas)
NOTES: Kidney

Prelude to Urologic NOTES: Natural Orifice Organ Extraction

- General surgery: transvaginal extraction of gall bladder, rectal & gastric tumors
- Urology:
  - Transvaginal bladder extraction:
    - Tuerk et al. (Urology 64:935, 2004)
  - Transvaginal kidney extraction:
    - Breda et al. (Eur Urol 24:116, 1993)

INITIAL NOTES EXPERIMENT 2002: Porcine Transvaginal Nephrectomy
- Overtubes: modified Amplatz sheaths
- Laparoscopes and flexible cystoscope
- Instruments: standard, articulated, and needlescopic

- Procedures: 1 pure, 5 hybrid
- All dissection performed via vagina
- 1 major hemorrhage secondary to stapler length

Conclusion:
- Feasible
- Cumbersome, instrument clashing
- Need new instruments & platforms
MAGS Nephrectomy (Porcine)

- Performed via single 15 mm trocar
- Successfully performed in 2 pigs
- Pedicle controlled with conventional stapler via the trocar
- Technically feasible and readily adaptable to NOTES
- Platform has been used for NOTES cholecystectomy in pigs

TransPort Transvaginal Nephrectomy (Porcine)

- Hybrid procedure (n=1): 10 mm abdominal port
- Mostly transvaginal dissection
- Hilar control (stapler) via abdominal port
- Operative time: 300 minutes
TransPort Hybrid Transvaginal Nephrectomy Clayman et al

- Lack of triangulation
- Poor grasping and retraction

Robotic Transvaginal Nephrectomy

Experimental Robotic Hybrid Transvaginal NOTES Nephrectomy

- Pig model (n=1)
- Hybrid procedure
- Required hand held robotic optic
- Operating time: 150 minutes
- No complications


- Poor triangulation
- Instrument collisions
Robotic NOTES: Pyeloplasty, Partial Nephrectomy & Nephrectomy

- All experiments in 10 farm pigs
- Hybrid approach: camera and 1st arm via umbilicus, 2nd arm via vagina
- Mean operative time: 154 minutes
- Mean blood loss: 72 cc
- Mean ischemia time for LPN: 25 min
- No complications

Haber et al. Urology 71: 996, 2008

Rationale for Combined NOTES

<table>
<thead>
<tr>
<th>Procedures that use 2 or 3 ports in laparoscopy</th>
<th>Procedures using 4 or 5 ports in laparoscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less important for traction and triangulation</td>
<td>Traction and triangulation are very important</td>
</tr>
</tbody>
</table>

Single access

Combined access


Combined NOTES Nephrectomy: Transvesical and Transgastric

- 6 procedures
- Combined dissection methods
- No complications
- Hilar control with ultrasonic device
- However, specimen extraction issue


Combined NOTES Nephrectomy: Transvaginal and Transgastric

- Transgastric access for optics
- Novel vaginal port / overtube for laparoscopic tools
- Operative time: left, 20 min; right, 40 min
- No complications

Isariyawongse et al. J Endo 2008
**CLINICAL: Hybrid Transvaginal NOTES Nephrectomy (Branco et al.)**

- 23 year old with symptomatic nonfunctional right kidney
- Endoscope via vagina
- Two 5 mm abd trocars
- Operative time: 170 minutes

*Eur Urol 2007, epub*

**NOTES: Bladder**

**Experimental Transvesical NOTES**

- Initial evaluation in 2006 by Lima et al.
  - Peritoneoscopy
  - Thoracoscopy
- Combined procedures with transgastric access as well:
  - Cholecystectomy
  - Nephrectomy

**Endoscopic Closure of Bladder Perforations**

- Experimental experience in farm pigs
- Full thickness incision in bladder dome
- Sutured closure with endoscopic device
- No acute leaks, normal 2 week survival, no leaks at sacrifice

*Lima et al Eur Urol, epub 2008*
CLINICAL Transvesical Peritoneoscopy (Gettman & Blute)

- 56 year old robotic prostatectomy patient
- IRB protocol involving SP tube, endoscopy to confirm position
- Operative time: 40 minutes
- No complications

Mayo Clinic Proc 82:843, 2007

Transvesical Peritoneoscopy: Summary

- Pneumoperitoneum maintained via ureteroscope
- Visualization and illumination poor
- Flexible scope alone: unstable platform
- Closure of cystotomy required

Mayo Clinic Proc 82:843, 2007

NOTES: Other Ideas

Pure and Combined NOTES Procedures

- Appendectomy
- Cholecystectomy

Fresh Human Cadaver Experiments
Summary

• New technologies are facilitating next era in minimally invasive surgery
• Boundaries of surgical specialties becoming blurred
• Momentum is building for surgical approaches using natural orifices
• Approaches are now experimental but ongoing development will likely force clinical application