Innovations in upper tract reconstruction

Lee C. Zhao
New York University

• Focus:
  – Urethral reconstruction
  – Prosthetics (IPP/AUS)
  – Urinary diversions
  – Upper tract reconstruction
  – Transgender surgery

• Co-Director, Reconstructive Urology & Prosthetics Fellowship

• Practice from 4/2017-4/2018
  – Urethroplasty (non-robot): 105
  – Gender affirming surgery (primary + revisions): 109
  – Robotic reconstructive procedures: 157
My practice

- Ureteral reconstruction
  - Pyeloplasty
  - Ureteroneocystotomy
  - Boari flap
  - BMG ureteroplasty
  - Ileal ureter
  - Appendix onlay
  - Ureteroenteric anastomotic revision
- Posterior urethral reconstruction
  - Radiation stenosis
  - Pelvic fracture urethral injury
  - Vesicourethral anastomotic revision
- Bladder reconstruction
  - Diverticulectomy
- Urinary diversion
  - Conduit
  - Neobladder
- Transgender surgery
  - Vaginoplasty
  - Vaginectomy
Robotic reconstructive urological surgery

• Ureteral reconstruction
  – Pyeloplasty
  – Ureteroneocystotomy
  – Boari flap
  – BMG ureteroplasty
  – Ileal ureter
  – Appendix onlay
  – Ureteroenteric anastomotic revision

• Bladder reconstruction
  – Diverticulectomy

• Posterior urethral reconstruction
  – Radiation stenosis
  – Pelvic fracture urethral injury
  – Vesicourethral anastomotic revision
  – Bladder neck contracture
  – Rectourethral Fistula

• Urinary diversion
  – Conduit
  – Neobladder
  – Indiana Pouch

• Transgender surgery
  – Vaginoplasty
  – Vaginectomy
Why Robotic Surgery in Reconstructive Urology?

• Post-op pain
  – Small differences in pain matter--reduce opioids

• Long term sequelae from incision
  – Bowel obstruction, adhesions

• **Visualization & Reach**
  – Surgical vision beyond the naked eye
  – Less limitations due to inaccessibility of the anatomy
  – Operations based on principles of reconstruction

• **Training & Quality Improvement**
  – Record Cases, Peer/Expert Review, Surgical Simulation
Outline

• 1. Identify indications for robotic reconstructive surgery
• 2. Describe advantages of robotic surgery for reconstructive urology
• 3. Understand the techniques for robotic surgery of the upper tract
  – buccal mucosa ureteroplasty
  – Appendix onlay
Why Robotic Surgery in Reconstructive Urology?

- Visualization
- Reach
- Post-op pain
- Long term sequelae from incision
How can we make reconstruction better?

• Less morbid
  – Improve analgesia
  – Decrease wound complications
  – Lower incisional hernia risk
  – Decrease LOS
• Identify ureter within reoperative field
• Recognize strictured ureter from normal ureter
• Evaluate ureteral blood supply
Robotic Surgery in 2018
“If I had asked people what they wanted, they would have said faster horses.”

—Henry Ford
Behavioral economics

My mantra is if you want to help people accomplish some goal, make it easy.

Richard Thaler
How did we get here?

- Laparoscopic Nephrectomy—Kavoussi, Clayman in 1991
- Robotic Prostatectomy—Guillonneau, Menon, others In 2001
- Urethroplasty using buccal mucosa graft—Morey and McAninch 1991
- Davis Intubated Ureterostomy—Davis
- Ureteral reconstruction using buccal mucosa graft--1989
Use of Indocyanine Green During Robot-assisted Ureteral Reconstructions

Ziho Lee, Blake Moore, Laura Gusto, Daniel D. Eun *

Department of Urology, Temple University School of Medicine, Philadelphia, PA, USA
Near Infrared Fluorescence
Near-infrared Fluorescence Imaging: Emerging Applications in Robotic Upper Urinary Tract Surgery

Marc A. Bjurlin a,y, Melanie Gan b,y, Tyler R. McClintock a, Alessandro Volpe b,c, Michael S. Borofsky a, Alexandre Mottrie b,d, Michael D. Stifelman a,*

a Department of Urology, New York University, Langone Medical Center, New York, NY, USA; b O.L.V. Vattikuti Robotic Surgery Institute, Aalst, Belgium; c Department of Urology, University of Eastern Piedmont, Novara, Italy; d Department of Urology, O.L.V. Hospital Aalst, Aalst, Belgium
Surgical Techniques in Urology

Robot-Assisted Ureteral Reconstruction Using Buccal Mucosa

Lee C. Zhao, Yuka Yamaguchi, Darren J. Bryk, Sarah A. Adelstein, and Michael D. Stifelman
Lymphatic mapping
Long-term sequelae

- Hernia
- Bowel obstruction
Effect of Minimally Invasive Surgery on the Risk for Surgical Site Infections
Results From the National Surgical Quality Improvement Program (NSQIP) Database

Giorgio Gandaglia, MD; Khurshid R. Ghani, MD; Akshay Sood, MD; Jessica R. Meyers, MD; Jesse D. Sammon, MD; Marianne Schmid, MD; Briony Varda, MD; Alberto Briganti, MD; Francesco Montorsi, MD; Maxine Sun, BSc; Mani Menon, MD; Adam S. Kibel, MD; Quoc-Dien Trinh, MD

<table>
<thead>
<tr>
<th>SSI</th>
<th>Approach, No. (%) of Patients</th>
<th>OR (95% CI)(^a)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall</td>
<td>Open Surgery</td>
<td>MIS</td>
</tr>
<tr>
<td>Radical Prostatectomy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial</td>
<td>62 (1.1)</td>
<td>43 (1.5)</td>
<td>19 (0.7)</td>
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<tr>
<td>Deep</td>
<td>9 (0.2)</td>
<td>9 (0.3)</td>
<td>0</td>
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<tr>
<td>Organ space</td>
<td>28 (0.5)</td>
<td>19 (0.7)</td>
<td>9 (0.3)</td>
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<tr>
<td>Overall</td>
<td>99 (1.7)</td>
<td>71 (2.4)</td>
<td>28 (1.0)</td>
</tr>
</tbody>
</table>
Incisional hernias after open versus laparoscopic surgery for colonic cancer: a nationwide cohort study

Kristian K. Jensen¹ · Peter-Martin Krarup¹,² · Thomas Scheike³ · Lars N. Jorgensen¹ · Tommie Mynster¹,²

- Elective colon cancer in Denmark
Decreased risk of surgery for small bowel obstruction after laparoscopic colon cancer surgery compared with open surgery: a nationwide cohort study

Kristian Kjim Jensen¹ · Peter Andersen² · Rune Erichsen² · Thomas Scheike³ · Lene Hjerrild Iversen²⁴ · Peter-Martin Krarup¹⁴
Why Not Robotics in Reconstructive Urology

- Previous surgery—intraperitoneal access
- Gas leak
- Inadequate retraction
- Learning curve
Intraperitoneal Access after Prior Surgery
Rectus flap harvest
Hasson access, creative port placement
Airseal—mitigates gas leak
Intracorporeal
Passive retraction: Novattract™ Surgical

Intracorporeal Ileal Conduit with Novagrasp Retractor

Lee C. Zhao, MD
Positioning for ureteral reconstruction

- Low Lithotomy
- Lateral Decubitus
- Nephrostomy tube exposed
- Benefits
  - one position
  - access to kidney, bladder and ureter
Technique is based on location, mechanism and pre-op evaluation

<table>
<thead>
<tr>
<th>PRIMARY PROCEDURES</th>
<th>ADJUNCT PROCEDURES</th>
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</thead>
<tbody>
<tr>
<td>Pyeloplasty</td>
<td>Renal pelvis/spiral flap</td>
</tr>
<tr>
<td>U-U</td>
<td>Downward nephropexy</td>
</tr>
<tr>
<td>U-calycostomy</td>
<td>Omental wrap</td>
</tr>
<tr>
<td>Buccal mucosa</td>
<td>Autotransplant</td>
</tr>
<tr>
<td></td>
<td>Bowel interposition</td>
</tr>
<tr>
<td><strong>Proximal</strong></td>
<td></td>
</tr>
<tr>
<td>U-U</td>
<td>Downward nephropexy</td>
</tr>
<tr>
<td>Ureterolysis</td>
<td>Omental wrap</td>
</tr>
<tr>
<td>Buccal mucosa</td>
<td>Bowel interposition</td>
</tr>
<tr>
<td></td>
<td>Extended Boari</td>
</tr>
<tr>
<td><strong>Mid</strong></td>
<td></td>
</tr>
<tr>
<td>Reimplant</td>
<td>Psoas hitch</td>
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<tr>
<td>Extravesical</td>
<td>Boari flap</td>
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<tr>
<td>Intravesical</td>
<td>Omental wrap</td>
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<tr>
<td>Reflux/Anti-Reflux</td>
<td></td>
</tr>
<tr>
<td>U-U</td>
<td></td>
</tr>
<tr>
<td>Ureterolysis</td>
<td></td>
</tr>
<tr>
<td><strong>Distal</strong></td>
<td></td>
</tr>
</tbody>
</table>
Remove stent pre-op

Why:
- Less inflammation
- Ureter more supple
- Easier to identify area and extent of stricture
- Absolute indication (Transected ureter or unable to pass stent)

When:
- 1 week prior to surgery
  - Do Ucx and start antibiotics prior to stent removal
- Make sure patient ensure negative urine culture prior to removing
- If fails, worsening pain or fever, place NT
When not to remove stent

- Easier identification extrinsic compression (RPF)
- Surgeon Preference
- Solitary Kidney
- If patient has pain/symptomatic and patient does not want NT
Ureteroureterostomy

- For short strictures
- Spatulate on opposite sides
- If very proximal—pyeloplasty/spiral flap
- Downward nephropexy as an adjunct
Downward Nephropexy

Pre Op

Post Op
Ureterocalycostomy

- Best for failed pyeloplasty
- Absence of extrarenal pelvis
- Hydronephrosis
- Lower pole partial nephrectomy
Ileal Ureter

Right side
- single dock
Left side
- supine and reposition into flank
Ileal ureter
Ileal Ureter

Long-term complications

<table>
<thead>
<tr>
<th>Clavien Grade(\text{a} ) (complication)</th>
<th>No. Pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation induced stricture disease (17 pts)</td>
<td></td>
</tr>
<tr>
<td>II:</td>
<td></td>
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<tr>
<td>Recurrent urinary tract infections</td>
<td>2</td>
</tr>
<tr>
<td>Hyperchloremic metabolic acidosis</td>
<td>1</td>
</tr>
<tr>
<td>IIIb:</td>
<td></td>
</tr>
<tr>
<td>Incisional hernia</td>
<td>1</td>
</tr>
<tr>
<td>Small bowel obstruction with adhesiolysis</td>
<td>3</td>
</tr>
<tr>
<td>Anastomotic stricture</td>
<td>1</td>
</tr>
<tr>
<td>Ileal ureteroenteric fistula</td>
<td>2</td>
</tr>
<tr>
<td>Enterovaginal fistula</td>
<td>2</td>
</tr>
<tr>
<td>IVa (ipsilat nephrectomy)</td>
<td>1</td>
</tr>
<tr>
<td>Other indications (74 pts)</td>
<td></td>
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<tr>
<td>II:</td>
<td></td>
</tr>
<tr>
<td>Femoral nerve palsy</td>
<td>1</td>
</tr>
<tr>
<td>Hyperchloremic metabolic acidosis</td>
<td>2</td>
</tr>
<tr>
<td>IIIb:</td>
<td></td>
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<tr>
<td>Incisional hernia</td>
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<tr>
<td>Anastomotic stricture</td>
<td>2</td>
</tr>
<tr>
<td>Ileal ureteroenteric fistula</td>
<td>1</td>
</tr>
<tr>
<td>Enterocutaneous fistula</td>
<td>1</td>
</tr>
<tr>
<td>IVa:</td>
<td></td>
</tr>
<tr>
<td>End stage renal disease</td>
<td>1</td>
</tr>
<tr>
<td>Short gut syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Ipsilat nephrectomy</td>
<td>1</td>
</tr>
</tbody>
</table>
Robotic assisted laparoscopic buccal mucosa ureteroplasty
Buccal Mucosa Graft

- BMG: first described 1941 for urethroplasty by Humby.
- An ideal urethral substitute
  - easy to harvest
  - easy handling characteristics
  - early in-growth and graft survival

- Concept adopted for ureteroplasty

Case series of buccal graft ureteral reconstruction and omental wrap
- 6 patients
- 5 mucosal patch grafts, 1 tubularized interposition

Technique:
- buccal graft measured, harvested in standard fashion
- Sutured with 4-0 polyglycolic acid
- wrapped in omentum
- JJ or endopyelotomy stent
### Buccal mucosal grafts in the treatment of ureteric lesions

J.H. Naudé  
Department of Urology, University of Cape Town and Groote Schuur Hospital, Cape Province, South Africa

<table>
<thead>
<tr>
<th>Case</th>
<th>Graft type</th>
<th>Stent duration</th>
<th>Imaging</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Patch graft</td>
<td>2 weeks</td>
<td>CTU 3 months</td>
<td>6 years (patent)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>URS 14 weeks</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Patch graft</td>
<td>2 weeks</td>
<td>CTU</td>
<td>4.5 years (mild dilation, good drainage)</td>
</tr>
<tr>
<td>3</td>
<td>Patch graft</td>
<td>2 weeks</td>
<td>Nephrostogram</td>
<td>Died 8 months, ESRD (patent)</td>
</tr>
<tr>
<td>4</td>
<td>Patch graft</td>
<td>2 weeks</td>
<td>Nephrostogram 2 weeks, 6 weeks</td>
<td>2 years (patent)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CTU 6mo, 2y</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Patch graft</td>
<td>2 weeks</td>
<td>CTU</td>
<td>2 years (patent)</td>
</tr>
<tr>
<td>6</td>
<td>Tubularized graft interposition</td>
<td>4 weeks</td>
<td>Nephrostogram 2 mo, RPG 3 mo</td>
<td>3 mo</td>
</tr>
</tbody>
</table>
Step by step

- Stricture localization
- Ureteral dissection
- Incision of the ureteral stricture
- Harvest of buccal mucosa graft
- Harvest of omental flap
- Anastomosis of graft to ureterotomy
- Stent placement
- Omental flap fixed to graft
1 month retrograde stent removal
Ureteroscopy
Buccal for Augmentation Ureteroplasty

- 22 y/o male
- MVA
- Ureteral avulsion
- Urinoma
- NT
- 3 Failed Endoscopic procedures
- 1 Failed pyeloplasty
Augmented Anastomotic Ureteroplasty
Omentum flap
Dorsal onlay onto Psoas
BMG ureteroplasty papers:
Buccal Mucosa Graft Ureteroplasty

- Typically for >2 cm strictures
- Consider for very fibrotic <2cm strictures
- Don’t need 360° mobilization (complete ureterolysis not needed)
- Need backwall for BMG onlay (Don’t tubularize BMG)
- Fit to size using sterile ruler: avoid a redundant, floppy BMG
- 1.5 cm width is adequate
- 6” 5-0 PDS or 4-0 PGA on RB: Crotch stitches most important
- Stitch difficult side first → 6 Fr stent → close easy side
# Robot-Assisted Ureteral Reconstruction Using Buccal Mucosa

Lee C. Zhao, Yuka Yamaguchi, Darren J. Bryk, Sarah A. Adelstein, and Michael D. Stifelman

<table>
<thead>
<tr>
<th>Patient</th>
<th>Laterality</th>
<th>Location</th>
<th>Etiology</th>
<th>Previous Intervention</th>
<th>Length</th>
<th>Size of Graft</th>
<th>Technique</th>
<th>Success</th>
<th>Follow Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Left</td>
<td>Proximal</td>
<td>Ureteroscopy</td>
<td>PCN</td>
<td>6</td>
<td>6</td>
<td>Posterior Onlay</td>
<td>Y</td>
<td>18.6 mo</td>
</tr>
<tr>
<td>2</td>
<td>Left</td>
<td>Proximal and Distal</td>
<td>Ureteroscopy</td>
<td>Dilation, Ureterotomy</td>
<td>1.5*</td>
<td>3</td>
<td>Distal Reimplant, Anterior Onlay</td>
<td>Y</td>
<td>15.6 mo</td>
</tr>
<tr>
<td>3</td>
<td>Right</td>
<td>Proximal</td>
<td>Nephrolithiasis</td>
<td>Stent</td>
<td>6</td>
<td>6</td>
<td>Posterior Onlay</td>
<td>Y</td>
<td>15.3 mo</td>
</tr>
<tr>
<td>4</td>
<td>Left</td>
<td>UPJ</td>
<td>Failed Pyeloplasty</td>
<td>PCN</td>
<td>2</td>
<td>2</td>
<td>Augmented Anastomotic</td>
<td>Y</td>
<td>10.7 mo</td>
</tr>
</tbody>
</table>

*Patient 2 had both distal and proximal stricture

Urol 2015, 86: 634
Appendix interposition

- Right side preferred
- Substitution or onlay
- Risks: inadequate appendix
Appendix onlay
Ileal Ureter: Reserve For Extensive Defects

• 80+% successful
• Contraindicated if renal compromise
• Risks: infection, mucus, fistula, stone, bowel complications
71yoM s/p cystectomy, ileal conduit

- Recurrent pyelonephritis
- Hydronephrosis on imaging
# Uretero-Enteric Anastomotic Stricture

<table>
<thead>
<tr>
<th>Institution</th>
<th>Reference</th>
<th>Series</th>
<th>N</th>
<th>Stricture</th>
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</thead>
<tbody>
<tr>
<td>Bern</td>
<td>Studer 2006</td>
<td>1985-2005</td>
<td>482</td>
<td>2.7%</td>
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<tr>
<td>Miami</td>
<td>Katkoori 2010</td>
<td>1992-2008</td>
<td>526</td>
<td>1.3%</td>
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<tr>
<td>Cairo</td>
<td>Nassar 2011</td>
<td>1999-2009</td>
<td>658</td>
<td>8.8%</td>
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<tr>
<td>Ulm</td>
<td>Hautman 2011</td>
<td>1986-2008</td>
<td>1540</td>
<td>11.1%</td>
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<tr>
<td>Mayo</td>
<td>Shimko 2011</td>
<td>1980-1998</td>
<td>1057</td>
<td>10.0%</td>
</tr>
<tr>
<td>U Chicago</td>
<td>Large 2013</td>
<td>2007-2010</td>
<td>258</td>
<td>10.3%</td>
</tr>
<tr>
<td>USC</td>
<td>Skinner 2013</td>
<td>1971-2008</td>
<td>1964</td>
<td>2.5%</td>
</tr>
<tr>
<td>Vanderbilt</td>
<td>Anderson 2013</td>
<td>2007-2011</td>
<td>478</td>
<td>9.4%</td>
</tr>
</tbody>
</table>
Diagnosis

• Hydronephrosis

• Evidence of obstruction
  – Occurs 7-18 months after cystectomy
  – Renal scan
  – Pyelonephritis
  – Renal function

• Absence of malignancy
  – Cytology
  – Endoscopic evaluation
Surgical Challenges

- Reoperative field
  - Adhesions

- Difficulty with identification of ureter
  - Ureter may be fused to great vessels
Treatment of ureterointestinal anastomotic stricture

- Endoscopic—antegrade > retrograde
  - Dilation
    - Serial, Balloon
  - Incision
    - Acucise, Cautery, Holmium,
  - Risk for failures
    - Strictures > 1cm
    - Prior failed endoscopic procedure

- Open
  - Difficulty identifying ureter
Positioning for endoscopic antegrade/retrograde access
## Endoscopic treatment

<table>
<thead>
<tr>
<th>Technique</th>
<th>N</th>
<th>Success</th>
<th>Follow up</th>
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</thead>
<tbody>
<tr>
<td>Wolf 1997</td>
<td>30</td>
<td>32%</td>
<td>36 months</td>
</tr>
<tr>
<td>Lin 1999</td>
<td>10</td>
<td>30%</td>
<td>18 months</td>
</tr>
<tr>
<td>DiMarco 2001</td>
<td>52</td>
<td>5%</td>
<td>36 months</td>
</tr>
<tr>
<td>Msezane 2008</td>
<td>41</td>
<td>41%</td>
<td>20 months</td>
</tr>
<tr>
<td>Nassar 2011</td>
<td>37</td>
<td>51%</td>
<td>18 months</td>
</tr>
<tr>
<td>Schöndorf 2013</td>
<td>96</td>
<td>25%</td>
<td>29 months</td>
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# Open reconstructive surgery

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Success</th>
<th>Follow up</th>
<th>Mean LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DiMarco 2001</td>
<td>27</td>
<td>76%</td>
<td>36 months</td>
<td>15 days</td>
</tr>
<tr>
<td>Laven 2003</td>
<td>15</td>
<td>80%</td>
<td>34 months</td>
<td>6 days</td>
</tr>
<tr>
<td>Nassar 2011</td>
<td>43</td>
<td>84%</td>
<td>47 months</td>
<td>8 days</td>
</tr>
<tr>
<td>Schöndorf 2013</td>
<td>35</td>
<td>91%</td>
<td>29 months</td>
<td>10 days</td>
</tr>
</tbody>
</table>
Nephrostomy access—prepped into field
Right side port placement
Left sided port placement
Robotic and uroteroscopy
Concurrent ureteroscopy
Dynamic ureteroscopy for ureteral identification
NYU experience: 10 patients from 7/2015 to 1/2017

<table>
<thead>
<tr>
<th>Type of urinary diversion</th>
<th>Median Time to Reconstruction (range)</th>
<th>Previous Management</th>
<th>Median stricture length (range)</th>
<th>Surgical Reconstruction</th>
<th>Median OR time (range)</th>
<th>Median length of stay (range)</th>
<th>Median time with stent (range)</th>
<th>Radiologic Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>60% Neo-bladder</td>
<td>8 month (5-29)</td>
<td>50% Balloon dilation</td>
<td>2.0 cm (1.0-3.0)</td>
<td>50% Bowel advancement</td>
<td>353 min (270-480)</td>
<td>3.0 days (2-5)</td>
<td>36 days (20-71)</td>
<td>80% Complete Resolution</td>
</tr>
<tr>
<td>40% Ileal conduit</td>
<td></td>
<td>20% Laser incision</td>
<td></td>
<td>50% Direct anastomosis</td>
<td></td>
<td></td>
<td></td>
<td>20% Mild residual hydro</td>
</tr>
</tbody>
</table>
Robotic ureterointestinal anastomotic stricture repair

- Excellent short-term outcomes
- Easy ureteral identification using ureteroscopy
- Decreased morbidity
All truth passes through three stages.
First, it is ridiculed.
Second, it is violently opposed.
Third, it is accepted as being self-evident.

- Arthur Schopenhauer (1788-1860)
Thank you

• Twitter: @lee_c_zhao
• Email: lee.zhao@nyumc.org