Changing incidence and etiology of iatrogenic ureteral strictures
Assimos et al, J Urol 152:2240, 1994

• From 1980 to 1984 we treated 8 patients with such injuries compared to 19 patients treated from 1985 to 1989.
• Between 1985 and 1989 the incidence of injuries per total hospital admissions at risk increased from 4 to 11 per 10,000 (p = 0.0067), the incidence of urological injuries increased from 4 to 23 per 10,000 (p = 0.0071) and the incidence of injuries occurring in gynecologic patients increased from 13 to 41 per 10,000 admissions (p = 0.0385).
• From 1985 to 1989, 25% of gynecologic injuries occurred during laparoscopy and 70% of urological injuries were sustained during ureteroscopic procedures.

The Ureter in the Retroperitoneum

- Ureter is 28-34 cm long
- Lies on the Psoas muscle
- In line with ends of TP of lumbar vertebrae
- Adheres to the mesocolon

- Crosses:
  - over genitofemoral nerve
  - under gonadal vessels
  - over the common iliac vessels
  - under the vas deferens

The ureter in the male retroperitoneum

- Observe the course of the ureter:
  - From the UO posteriorly
  - Then anteriorly until crossing over the iliac vessels
  - Then posteriorly towards the renal hilum
Etiology of Ureteral Stricture

- Although the incidence of ureteral strictures in the general population is unknown, it is clear that the presence of ureteral calculi and associated treatment of stones are risk factors.
- Any ureteral instrumentation can lead to the development of a ureteral stricture.
- As advances in ureteroscopic technology have provided smaller, more flexible instruments with better optics these endoscopic procedures have become less traumatic and are now associated with a long-term complication rate of less than 1%.

Etiology of Ureteral Stricture

- Malignancy (e.g., transitional cell carcinoma, cervical)
- Ureteral calculus
- Radiation
- Ischemia
- Trauma due to surgical dissection
- Periureteral fibrosis due to abdominal aortic aneurysm or endometriosis
- Endoscopic instrumentation
- Infection (e.g., tuberculosis)
- Idiopathic

Imaging of Ureteral Strictures

- Intravenous pyelogram and retrograde pyelogram reliably define the location and length of the ureteral stricture.
- Subsequent ureteroscopy with biopsy or barbotage should be performed in any patient for whom the etiology of the stricture is not certain.
- Endoluminal ultrasound is an alternate approach that allows one to characterize a stricture and guide therapy, although it is not commonly utilized (Grasso et al, 1999).
- Diuretic renography will provide differential renal function and evaluate the renal unit for functional obstruction. (endourologic therapies generally require 25% function of the ipsilateral moiety to have reasonable success rates Wolf et al, 1997).

Flexible ureteroscopic endopyelotomy using holmium laser demonstrating endoscopic view of the UPJ (inset). A safety wire is in place, and the ureteroscope is passed through a ureteral access sheath as a lateral incision is being made under endoscopic view, using holmium laser fiber. A properly sited, complete incision is straightforward with this direct visualization technique.

Percutaneous nephroscopic view of "cold knife" endopyelotomy (inset). The line of incision is delineated by two guide wires, which have been passed across the UPJ in an antegrade fashion through a superior calyx using a rigid nephroscope through a No. 30 Fr sheath. The lateral incision is performed under direct visual control.

52 year old man with long hx of stones underwent URS for large distal stone that was basketed with subsequent injury and stricture.
ENDOURETEROTOMY: Results

<table>
<thead>
<tr>
<th>Author</th>
<th>N</th>
<th>Modality</th>
<th>F/U</th>
<th>Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schneider, 1991</td>
<td>12</td>
<td>cold knife</td>
<td>15 mo</td>
<td>67% (8/12)</td>
</tr>
<tr>
<td>Meretyk, 1991</td>
<td>13</td>
<td>electrified cut</td>
<td>20 mo</td>
<td>62% (8/13)</td>
</tr>
<tr>
<td>Yamada, 1995</td>
<td>20</td>
<td>cold knife</td>
<td>18 mo</td>
<td>85% (17/20)</td>
</tr>
<tr>
<td>Cornud, 1996</td>
<td>31</td>
<td>electrified cut</td>
<td>&gt;12 mo</td>
<td>71% (22/31)</td>
</tr>
<tr>
<td>Preminger, 1997</td>
<td>40</td>
<td>Acucise</td>
<td>8.7 mo</td>
<td>53% (21/40)</td>
</tr>
<tr>
<td>Singal, 1997</td>
<td>12</td>
<td>Ho:YAG</td>
<td>&gt;9mo</td>
<td>75% (9/12)</td>
</tr>
<tr>
<td>Wolf, 1997</td>
<td>38</td>
<td>Variety</td>
<td>28 mo</td>
<td>82% (31/38)</td>
</tr>
<tr>
<td>Hibi, 2001</td>
<td>11</td>
<td>Ho:YAG</td>
<td>20 mo</td>
<td>91% (10/11)</td>
</tr>
<tr>
<td>Lane, 2006</td>
<td>19</td>
<td>Ho:YAG</td>
<td>36 mo</td>
<td>68% (13/19)</td>
</tr>
<tr>
<td>Total</td>
<td>196</td>
<td>-</td>
<td>-</td>
<td>71% (139/196)</td>
</tr>
</tbody>
</table>

ENDOURETEROTOMY FOR URETEROENTERIC STRICTURES

<table>
<thead>
<tr>
<th>Author</th>
<th>N</th>
<th>Modality</th>
<th>F/U</th>
<th>Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meretyk</td>
<td>14</td>
<td>electrified cut</td>
<td>29 mo</td>
<td>57% (8/14)</td>
</tr>
<tr>
<td>Babayan</td>
<td>9</td>
<td>Acucise</td>
<td>-</td>
<td>33% (3/9)</td>
</tr>
<tr>
<td>Cornud</td>
<td>31</td>
<td>electrified cut</td>
<td>&gt;12 mo</td>
<td>71% (22/31)</td>
</tr>
<tr>
<td>Wolf</td>
<td>30</td>
<td>variety</td>
<td>23 mo</td>
<td>50% (15/30)</td>
</tr>
<tr>
<td>Singal</td>
<td>9</td>
<td>Ho:YAG</td>
<td>3-21 mo</td>
<td>78% (7/9)</td>
</tr>
<tr>
<td>Lin</td>
<td>10</td>
<td>Acucise</td>
<td>24 mo</td>
<td>30% (3/10)</td>
</tr>
<tr>
<td>Watterson</td>
<td>24</td>
<td>Ho:YAG</td>
<td>22 mo</td>
<td>71% (17/24)</td>
</tr>
<tr>
<td>Laven</td>
<td>16</td>
<td>Ho:YAG</td>
<td>35 mo</td>
<td>50% (8/16)</td>
</tr>
<tr>
<td>Total</td>
<td>143</td>
<td>-</td>
<td>-</td>
<td>57% (81/143)</td>
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Bridging Various Ureteral Defect Lengths with Different Reconstructive Surgical Techniques

<table>
<thead>
<tr>
<th>Technique</th>
<th>Ureteral Defect Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ureteroureterostomy</td>
<td>2-3</td>
</tr>
<tr>
<td>Ureteroneocystostomy</td>
<td>4-5</td>
</tr>
<tr>
<td>Psoas hitch</td>
<td>6-10</td>
</tr>
<tr>
<td>Boari flap</td>
<td>12-15</td>
</tr>
<tr>
<td>Renal descensus</td>
<td>5-8</td>
</tr>
</tbody>
</table>

Management of ureteral injuries Depending on location

Elective open ureteroureterostomy

- Upper ureter: flank
- Middle or lower ureter: Gibson or lower midline
- Extended to a hockey stick
- Penrose drain or vessel loop around ureter to minimize handling
- Debride, trim to healthy tissue
- Spatulate >5 mm both ends
- 180 degrees opposite
- Absorbable suture in both corners, run both sides
- Double J stent
- Drain
- Success rate should be 90%
Psoas Hitch

- Turner WarwickL *Br J Urol* 41:701, 1969
- Suitable for lower third defect distal to the pelvic brim
- Pfannenstiel or Gibson or lower midline incision
- Free up the bladder, divide contralateral superior vesical artery for mobility
- Anterior cystotomy vertical/oblique

In psoas hitch, an anterior cystotomy is performed after bladder mobilization. The bladder dome is fixed to the ipsilateral psoas tendon, and the ureteral reimplantation is completed in a tension-free manner.

- Ipsilateral bladder dome secured to psoas minor tendon or muscle using absorbable sutures (or prolene but stay outside of mucosa)
- A small contracted bladder is a contraindication (gravity cystogram should be part of surgical planning)
- Avoid injury to genitofemoral nerve and the femoral nerve in vicinity
- Gain in lengths about 5 cm
- Success rates reported 85% in adults and children
Psoas Hitch

Pre- and postoperative imaging

Fig. 25.16 (a) and (b) Psoas hitch: oblique placement of anterior bladder incision facilitates ureteric replacement.
Boari (Ockerblad) Flap

- Boari described canine model in 1894
- Ockerblad: J Urol 57:845, 1947
- Suitable for defects of 10-15 cm or in some cases up to renal pelvis (spiral flap)
- Pfannenstiel or midline incision
- Freeing up the bladder circumferentially, divide contralateral superior vesical artery
- Flap base 4 cm wide, tip 3 cm

- Length = diseased ureter plus 3-4 cm for anastomosis
- Ratio flap length to base width no greater than 3 : 1 to avoid ischemia
- Spatulated end to end or antirefluxive anastomosis (uses more length!)
- Secure flap to psoas muscle or tendon
- High success rates reported
- Recurrent stricture most common complication
In Boari flap, the intended flap is first marked on the anterior and lateral aspects of the mobilized bladder. B. The flap is created, ensuring good vascular

Preoperative nephrostogram of a patient with left proximal ureteral injury after aortobifemoral bypass surgery. Postoperative VCUG after a Boari flap procedure.
Ureterocalicostomy

- Usual indication is a very proximal or UPJ stricture with intrarenal or scarred renal pelvis
- Often the result of multiple prior endoscopic surgeries for stone disease
- Often had multiple prior procedures to correct the stricture
Ureterocalicostomy

- Extensive mobilization of the kidney, which usually has the worst scarring/adhesions medially
- Mobilization of the midureter respecting its blood supply
- Assuring the proximal end of healthy ureter reached the lowermost calyx
- Peel back the renal capsule, amputate the lower pole of the kidney generously to expose the lower calyx
- Stented anastomosis of ureter to calyx
URETEROCALICOSTOMY: A CONTEMPORARY EXPERIENCE
BRIAN R. MALAGA, OJAS D. SHAR, DINESH SINGH, STEVAN B. SREEM, AND DEAN G. ASSIMOS

Objectives. To report our contemporary experience with ureterocalicostomy to determine whether the indications or results have changed in modern practice. Ureterocalicostomy is a well-established treatment for patients with complicated ureteropelvic junction (UPJ) obstruction and other forms of proximal ureteral obstruction. Although both retrograde and antegrade endourologic interventions have become accepted forms of management, the success rates do not approach those of open or even laparoscopic interventions, potentially leading to a greater number of patients with treatment failure and the need for more complicated reconstruction.

Methods. Between July 1991 and February 2004, 11 patients (4 women and 7 men), aged 19 to 68 years (mean 58), underwent open surgical ureterocalicostomy. The indications for surgery were primary UPJ obstruction in 4, failed cutting balloon incision for UPJ obstruction in 3, proximal ureteral stricture after antegrade stone removal in 2, and obliterated UPJ after percutaneous nephrolithotomy and failed antegrade endopyelotomy in 1 patient each.

Results. Hospitalization ranged from 4 to 7 days (mean 5.1). No patient experienced a significant perioperative complication. With follow-up ranging from 2 to 32 months (mean 10.11), relief of obstruction was evident in all patients as documented by intravenous urography or nuclear renography. Furthermore, differential function on the involved side improved from a mean of 54.6% preoperatively to 66.1% postoperatively (p < 0.05).

Conclusions. The spectrum of indications for ureterocalicostomy has changed, although excellent results can still be achieved. Although laparoscopic approaches are currently being evaluated, most patients currently undergoing this reconstructive procedure still require open operative intervention.


Transureteroureterostomy

- Insufficient length of ureter for anastomosis to bladder using Psoas hitch or Boari flap
- Absolute contraindication: insufficient length to reach across
- Relative contraindication: any bilateral disease process (urolithiasis, RF, malignancy, s/p XRT)
- Midline incision
- Mobilize donor ureter and tunnel under sigmoid colon mesentery, DO NOT MOBILIZE RECIPIENT URETER
- Stented end to side anastomosis
- High success rates in properly chosen adult and pediatric patients reported
ILEAL URETER SUBSTITUTION: A CONTEMPORARY SERIES

Objectives. To review our contemporary experience with ileal ureter reconstruction. Despite advancements in surgical technology and technical expertise, ureteral injuries continue to occur. These injuries can be extensive, and ileal ureter reconstruction may be necessary.

Methods. A total of 18 ileal ureter substitutions were performed in 16 adults (10 men and 6 women) by a single surgeon during a 6-year period. The mean patient age was 49.4 years (range 25 to 72). The mean follow-up was 18.6 months (range 7 to 50). All ileal ureter substitutions were performed in an isoperistaltic, refluxing fashion. Follow-up included clinical evaluation, nuclear renography, intravenous urography, and serum chemistry testing.

Results. Postoperative nuclear renography demonstrated no relative loss of function of the affected renal unit and no evidence of functional obstruction. An unabstructed state was also confirmed with intravenous urography. No statistically significant metabolic changes were found in any patient, as assessed by serum chemistry testing. None of the patients had evidence of new stone formation. Two patients developed an isolated, symptomatic urinary tract infection during follow-up, and one had recurrent urinary tract infections, a problem that was present preoperatively.

Bridging long ureteral defects using the Yang-Monti principle.

- Partial replacement of the ureter using the Yang-Monti principle with open surgery and laparoscopic approaches
- A 5–7.5 cm ileal segment is divided into three equal 2.5 cm parts, which subsequently are incised paramesenterically along their longitudinal axis.
- Each segment is then tubularized as described by Monti *et al.* [3].
- In 10 patients, detubularization with subsequent reconstruction produced a 12–18 cm ileal strip.

The laparoscopic Monti procedure for long strictures of the proximal ureter: a novel technique
B.R. LEE et al, BJU Int 93:1396, 2003

The laparoscopic Monti procedure for long strictures of the proximal ureter: a novel technique
B.R. LEE et al, BJU Int 93:1396, 2003
THE APPENDIX AS RIGHT URETERAL SUBSTITUTE IN CHILDREN

Richter et al, J Urol 163:1908, 2000

ABSTRACT

Purpose: The appendix has occasionally been used to replace sections of the right ureter. We reviewed the literature of the last 25 years on the use of the appendix as right ureteral replacement and report our experience with right ureteral substitution using the appendix.

Materials and Methods: We retrospectively reviewed the charts of 3 children who underwent appendical replacement of the right ureter. The appendix replaced the upper third of the ureter and the lower ureter in 1 and 2 cases, respectively.

Results: Follow-up of 4, 7 and 15 years, respectively, demonstrated that the appendix transports urine satisfactorily and permits renal function to be maintained without evidence of obstruction.

Conclusions: We believe that our small series supports the use of the appendix as a right ureteral substitute in select cases.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Post. Age</th>
<th>Indication</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading et al</td>
<td>10-M</td>
<td>Subhydronephrotic + neuronal efflux</td>
<td>10 yrs, good renal function, no hydronephrosis</td>
</tr>
<tr>
<td>Kerner et al</td>
<td>5-M</td>
<td>Posterior ureterovesical reflux + urinary tract infection</td>
<td>5 yrs, good renal function, normal growth</td>
</tr>
<tr>
<td>de Graaf et al</td>
<td>40-F</td>
<td>Infected ectopic appendix</td>
<td>34 yrs, good renal function, normal growth</td>
</tr>
<tr>
<td>Jones et al</td>
<td>7-M</td>
<td>Repair bladder after renal/bladder/appendix graft</td>
<td>9 yrs, good renal function, normal growth</td>
</tr>
<tr>
<td>Monninger and Asszonyi</td>
<td>7-F</td>
<td>Obstructive uropathy + neuropathic bladder</td>
<td>7 yrs, good renal function, normal growth</td>
</tr>
<tr>
<td>Lloyd and Kennedy</td>
<td>38-M</td>
<td>Ureteroureterostomy + normal urine output</td>
<td>IP at 0 mmHg, patent appendicovesical吻合</td>
</tr>
<tr>
<td>MacGregor and Hunt</td>
<td>17-F</td>
<td>Ureteroureterostomy + normal urine output</td>
<td>IP at 0 mmHg, patent appendicovesical吻合</td>
</tr>
<tr>
<td>Gabler et al</td>
<td>23-M</td>
<td>IP at 21 mmHg, no reflux, normal growth</td>
<td></td>
</tr>
<tr>
<td>Kaltenbrunner et al</td>
<td>40-M</td>
<td>Ablative surgery wounds + rt. malrotated transverse colon</td>
<td>IP at 21 mmHg, normal growth</td>
</tr>
</tbody>
</table>

Fig. 2. Surgical repair
Laparoscopic advances

- Nearly all open procedures have been successfully duplicated using laparoscopic approaches
  - Lap ureteroureterostomy: Nezhat et al, 1992
  - Lap Psoas Hitch: Nezhat et al, 2004
  - Lap Boari flap: Fugita et al, 2001
  - Lap ileal ureteral substitution: Gill et al, 2000
  - No report on TUU yet

Renal descensus and other desperate measures

- Complete mobilization of the kidney with inferior-medial rotation
  - May gain up to 8 cm of length
  - Limited by vascular pedicle
- Creative use of different diversion techniques
- Renal autotransplantation with anastomosis of renal pelvis to bladder
- Nephrectomy

Percutaneous placement of permanent metal stents for treatment of ureterointestinal anastomotic strictures

Rapp et al, J Endourol 18:670, 2004

Ureteral reconstruction: small intestine submucosa for the management of strictures and defects of the upper third of the ureter.

Liatsikos et al, J Urol. 2001 May;165(5):1719-23

Summary

- The spectrum, incidence and etiology of ureteral stricture disease is changing
- The rate of iatrogenic urologists' induced strictures is increasing
- Complete preoperative imaging including gravity to capacity filling cystogram is imperative for surgical planning
- Reconstruction using urothelial lined tissue is possible in the vast majority of cases
- Ileal ureter replacement is a last resort procedure, but has adequate success rates
- Creative use of other partial or complete bowel substitution may be applicable to certain situations (Monti, appendix)
- Tissue engineering, various grafts, tissue expanders, and stents are techniques being explored with more or less success but are not ready for routine clinical use