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Operative Techniques in
General Surgery

Management of Ureteral Injury

Paul LaFontaine, MD

Injury to the ureter may occur as a result of civilian or military trauma, as well as in the conduct of elective surgery. The anatomic location of the injury, degree of devascularization, and tissue damage are all determinants of the most appropriate reconstructive procedure.

Uretero-Ureterostomy

Uretero-ureterostomy repairs discrete short strictures of the midureter or intraoperative injury to the mid or upper ureter above the bifurcation of the iliac vessels. A number of incisional approaches permit access to the ureter and ipsilateral kidney; midline abdominal, Pfannanstiel, Gibson, or flank incisions have all been used. The ureter can normally be identified reliably as it crosses over the bifurcation of the iliac vessels to enter the pelvis. It should be dissected free proximally and distally for as short a length as possible to permit a tension free anastomosis. Care should be taken to not skeletonize it, but to mobilize the peri-advential tissue with it to preserve its blood supply. Access to the kidney allows renal mobilization if required to avoid anastomotic tension. To avoid anastomotic stricture, the ureteral ends are first spatulated proximally and distally and then oriented with the spatulations 180 degrees apart from each other. The anastomosis is performed with multiple interrupted 4-0 or 5-0 vicryl sutures with the knots tied so that they rest outside of the ureteral lumen. The anastomosis is facilitated by placing the sutures through the apex of each spatulated end initially. After placement of the apical suture, the remainder of the interrupted sutures are placed to complete the repair. Care is taken not to pick up the back wall of the ureter with these sutures. Before anastomotic completion, a 6FR ureteral stent is guided with a wire to a position where its proximal end rests in the renal pelvis and its distal end rests in the bladder.

Transuretero-Ureterostomy (TUU)

A TUU is utilized for management of long defects of the lower and mid ureter where adequate proximal ureteral length exists on the injured side to reach the recipient contralateral ureter without tension.

The injured donor ureter is identified by incising the posterior peritoneum above the level of the iliac vessels. The donor ureter should be dissected for a length sufficient to allow it to reach the recipient ureter without tension. When dissecting out the donor ureter, it is important to dissect a generous amount of peri-ureteral advential tissue to assure its blood supply.

The contralateral recipient ureter is identified by incising the posterior peritoneum above the iliac vessels. The recipient ureter should be dissected for as short a length as will permit a well-visualized anastomosis (Fig 1).

A retroperitoneal tunnel anterior to the great vessels is created between the two incisions. It should accommodate passage of the surgeon's finger and pass cephalad to the IMA to prevent compression of the ureter between the IMA and aorta. The donor ureter is then passed atraumatically through the retroperitoneal tunnel and spatulated. Caution must be exercised so as not to twist or kink the donor ureter as it is passed through the retroperitoneal tunnel. Ureterotomy is then created on the medial aspect of the recipient ureter. Placement of fine stay sutures on the recipient ureter proximal and distal to the ureterotomy will allow elevation of the ureteral wall and facilitates successful completion of the anastomosis. The uretero-ureterostomy is created with interrupted 4-0 or 5-0 vicryl sutures. Knots are tied extramurally so that they rest outside of the lumen (Fig 2). Ideally, both ureters should be stented to prevent obstruction. Multiple side holes are then created in two ureteral stents. Before completion of the anastomosis, at least one stent is placed over a guide wire. If the diameter of the recipient ureter below the anastomosis prevents its stenting, only the donor ureter should be stented.

Uretero-Neocystostomy

If an injury to a ureter is distal enough to allow the proximal ureter to be brought to the dome of the bladder without tension, uretero-neocystostomy without psoas hitch may be the appropriate procedure. There is rarely a need to create a tunneled, or nonrefluxing, uretero-neocystostomy as reflux of urine in the adult patient is rarely of clinical significance. After determining that adequate ureteral length is present for a tension-free direct anastomosis to the bladder, the bladder is distended with saline infused through an indwelling urethral catheter. A 1 to 2 cm incision is made transversely on

Department of Surgery, Harvard Medical School, Cambridge Urological Associates, Cambridge, MA.
Address reprint requests to Paul LaFontaine, MD, Clinical Instructor in Surgery, Harvard Medical School, Cambridge Urological Associates, 300 Mount Auburn Street, Suite 519, Cambridge, MA 02138. E-mail: paullafontaine@comcast.net

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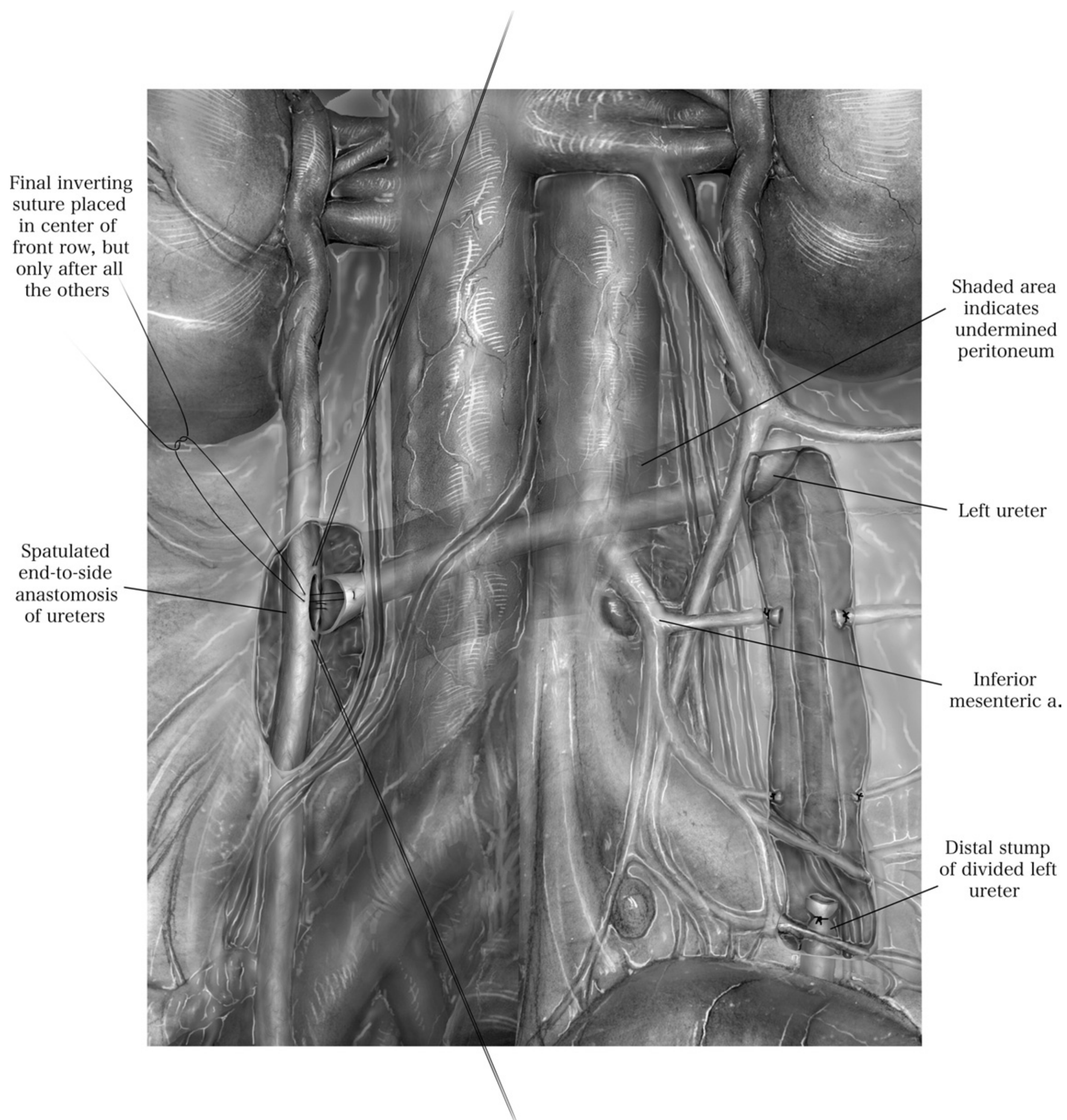

Figure 1 Transureteral ureterostomy. The retroperitoneum over each ureter is incised longitudinally. The distal end of the donor ureter is ligated. The proximal end of the donor ureter is passed through the retroperitoneal tunnel cephalad to the inferior mesenteric artery.

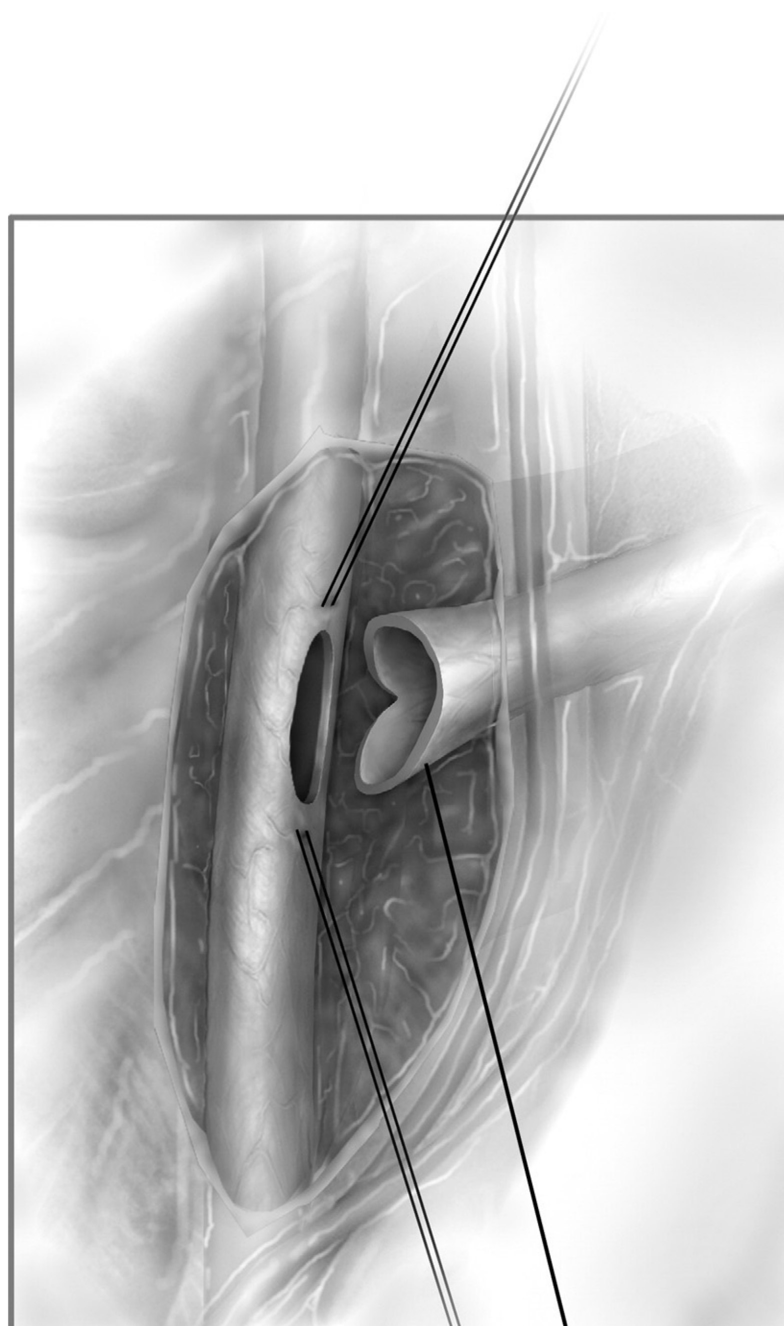

Figure 2 Transureteral ureterostomy. The donor ureter is spatulated, and end-to-side anastomosis is created.

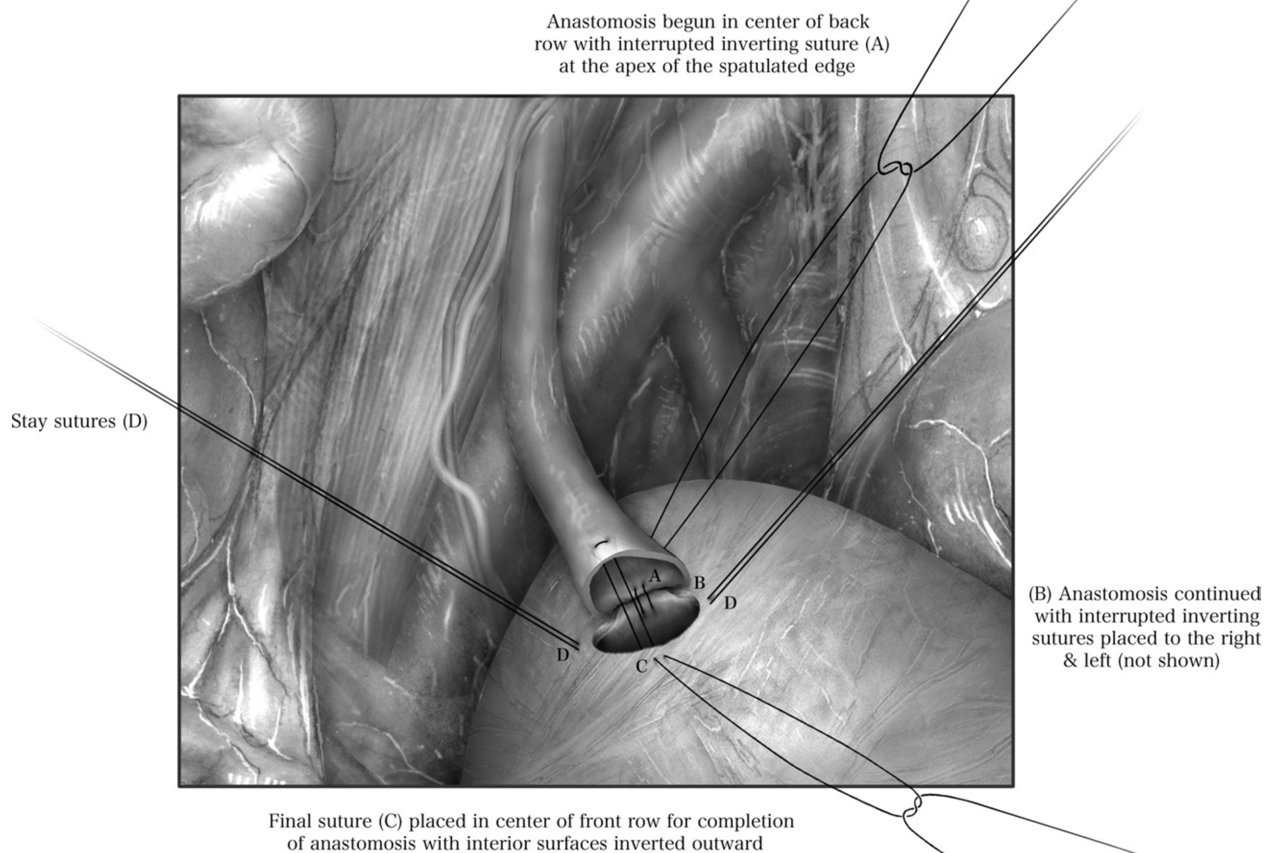

Figure 3 Ureterocystostomy. The bladder is distended with saline and a cystotomy is made. The ureter is spatulated and the anastomosis is created.

the side of the bladder ipsilateral to the injury. The detrusor is divided with electrocautery until the bladder mucosa is indentifiable by its shiny appearance. The bladder mucosa is then incised sharply and everted in a rosebud technique with multiple interrupted 5-0 chromic sutures. The distal end of the ureter is then spatulated and anastomosed to the bladder using 4-0 or 5-0 vicryl sutures, beginning the anastomosis at its apex (Fig 3). The sutures on the nonapical portion of the ureter may incorporate detrusor muscle. Before completion of the anastomosis, the ureter is stented with a 6FR stent placed over a guidewire and passed proximally to the level of the renal pelvis. The detrusor muscle is then loosely reapproximated over the anastomosis to avoid obstruction of the ureter.

Psoas Hitch

A psoas hitch provides mobilization and elevation of the bladder to a level above the bifurcation of the common iliac artery. It is used for repairing injuries to the lower ureter where a direct uretero-ureterostomy is not feasible or where inadequate ureteral length does not permit a tension free uretero-neocystostomy to a bladder left in its pelvic location.

The initial maneuver used to begin mobilization of bladder is incision of the peritoneum posterior to it. The space between the bladder and the rectum is then developed using blunt dissection. On the noninjured side, the superior vesical artery is ligated and divided in the lateral bladder pedicle. After mobilizing the bladder's attachments in the pelvis on the noninjured side, the bladder is filled through a urethral catheter. A transverse cystotomy is then made in the anterior wall of the bladder at its point of widest diameter. The cystotomy should be extended for at least half the circumference of the bladder. A shorter cystotomy may not provide enough cephalad displacement of the dome of the bladder.

Using two fingers in the bladder, the dome of the bladder is elevated to a point above and lateral to the iliac artery on the psoas major muscle. The injured ureter can then be proximally freed to ensure enough length is available for a tension-free anastomosis. If enough mobility of the bladder has not been achieved with this maneuver for its cephalad mobilization to a point above the iliac vessels at the psoas major muscle on the injured side, the contralateral inferior vesical artery is ligated and divided and the contralateral endopelvic fascia is divided. It is rarely necessary to divide the superior vesical artery on the injured side. If necessary, the ipsilateral

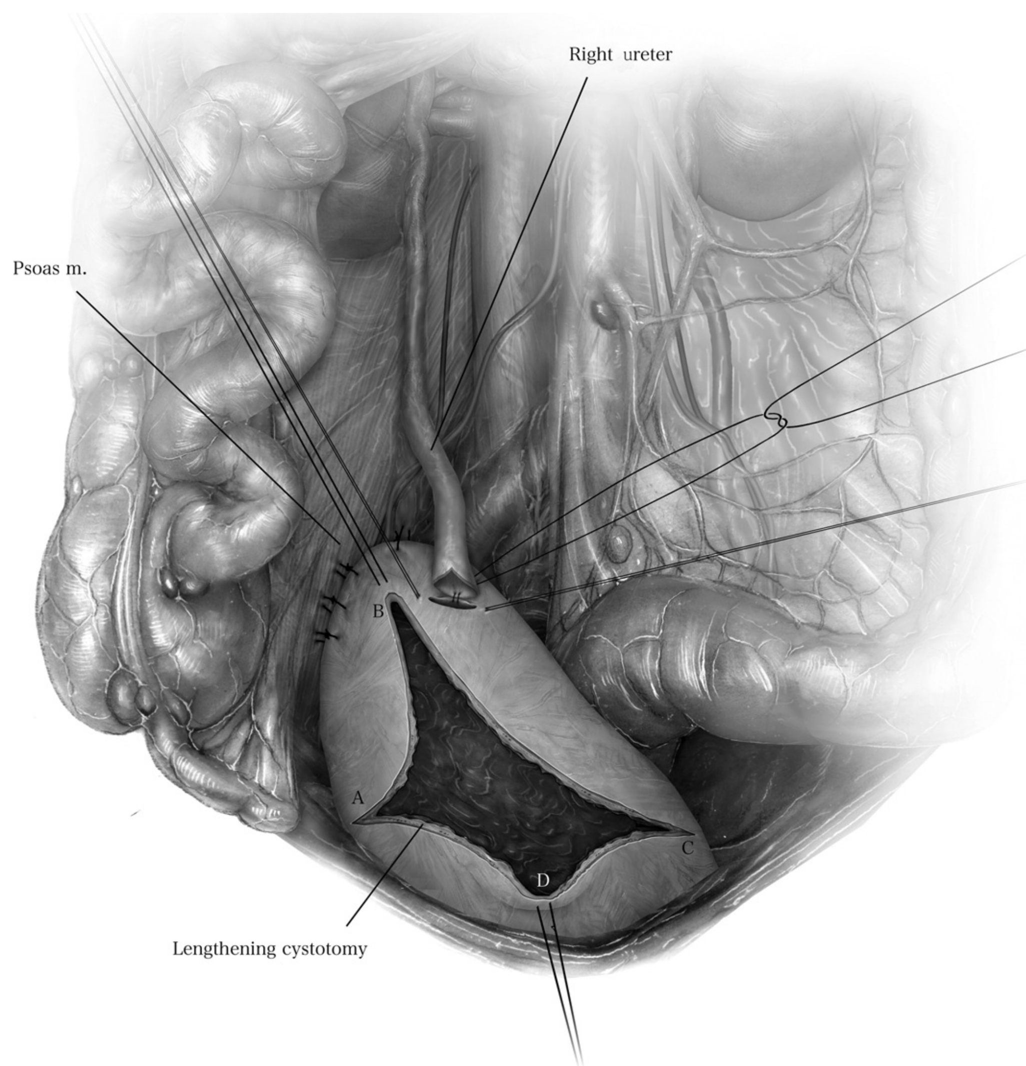

Figure 4 Psoas hitch. The large incision in the bladder permits the cephalad mobilization of the bladder, whose superior aspect is secured to the psoas muscle before creating the anastomosis between ureter and bladder. The cystotomy is then closed.

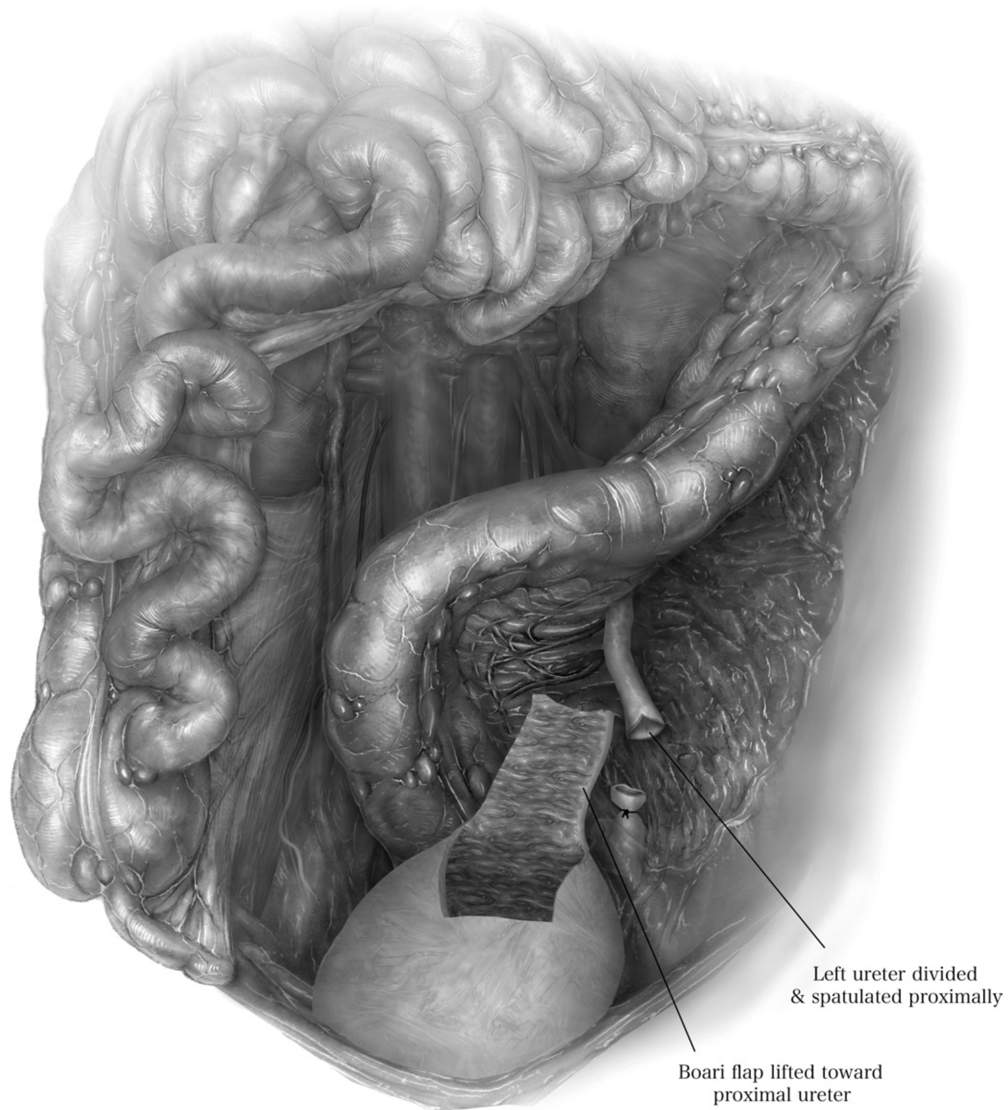

Figure 5 Boari flap. A proximally based flap is mobilized to bridge the gap between bladder and ureter.

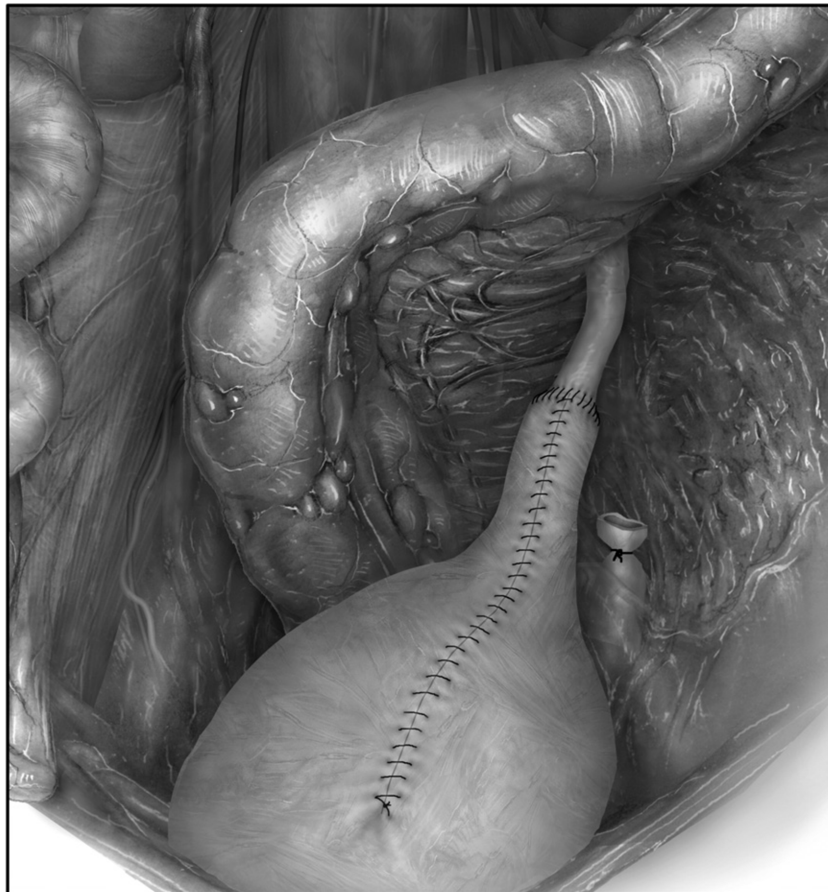

Figure 6 Boari flap. The flap is fashioned into a tube and an anastomosis is created between it and the proximal ureter.

kidney can be mobilized caudally to close the gap between ureter and bladder.

Once this has been accomplished, the dome of the bladder is secured to either the psoas major muscle or the tendon of the psoas minor muscle using 4 to 6 interrupted 2-0 PDS sutures (Fig 4). Attention must here be paid to two nerves. First, the genitofemoral nerve coursing over the psoas muscle in this location should be identified, and care taken to not injure or incorporate it the sutures. Second, the femoral nerve runs posterior to the psoas major muscle. Care should be taken to avoid deep sutures in the psoas major so that this structure is not damaged.

A refluxing, nontunneled ureteroneocystoscopy is appropriate in most adults and technically easier to perform than a tunneled re-implant. After selecting a site on an immobile part of the bladder dome, a cystotomy is made. The ureter is then brought through the bladder wall, assessed to assure adequate length, and spatulated. An anastomosis is performed with interrupted 4-0 or 5-0 vicryl sutures starting at the apex. As the distal ureteral tip of the ureter is approached, sutures may incorporate both bladder detrusor and mucosa. A 6FR ureteral stent is guided with a wire to rest proximal to the renal pelvis. The bladder is then closed in a Henicke-Mickulicz fashion in two layers with a running inner layer of 3-0 chromic mucosa and a running 2-0 chromic for the detrusor. Placement of a supra-pubic tube before bladder closure may be appropriate in some patients but is not mandatory in all if the bladder suture lines are thought to be secure.

Boari Flap

A Boari flap is used for repair and reconstruction of long ureteral strictures in those rare clinical circumstances where a psoas hitch and renal caudal mobilization are insufficient to provide enough ureteral length for a tension free anastomosis. When doing a Boari flap a Psoas hitch should be performed concurrently. After dividing the contralateral superior and inferior vesical arteries and incising the contralateral endopelvic fascia, the surgeon pulls the bladder into a tube up to the psoas major muscle. If there is not enough ureteral length to reach the estimated position of the bladder with a psoas hitch and renal mobilization then a Boari flap should be considered. Instead of a transverse incision on the anterior wall of the bladder at its maximum diameter as for a psoas hitch, the Boari flap incision is marked out on the anterior wall of the bladder after filling the bladder to roughly half its volume through a urethral catheter. The length of the Boari flap should correspond to the distance between the distal end of the ureter and the psoas major muscle where a psoas hitch would place the bladder. This incision should be 4 cm wide at its base and 3 cm wide at its apex to ensure adequate vascularity of the flap (Fig 5). Longer flaps may require a wider base. Stay sutures are placed at the marked base and apex of the flap and the bladder is divided with electrocautery. The flap should then be elevated to reach the ureter so that are several centimeters of overlap between ureter and the flap. The ureter should be spatulated and then attached to the flap in a nontunneled refluxing end to end anastomosis with 4-0 or 5-0 vicryl sutures. The sutures on the distal aspect of the spatulated ureter should incorporate some detrusor muscle to prevent retraction of the ureter. A 6FR stent should then be placed over a guidewire proximally into the renal pelvis. The Boari flap should then be tubularized in two layers with running 3-0 vicryl mucosal suture and a running 2-0 vicryl detrusor muscle suture (Fig 6). The bladder cystotomy is closed in a similar fashion with running 3-0 vicryl mucosal sutures and running 2-0 vicryl detrusor muscle sutures after placement of a supra-pubic drain through a separate stab wound. A perivesical drain is left at the end of the procedure.