Chapter

Robotic Orthotopic Neobladder: The Two Chimney Technique

Panagiotis Pardalidis, Nikolaos Andriopoulos and Nikolaos Pardalidis

Abstract

Bladder substitution following radical cystectomy for urothelial cancer (transitional cell carcinoma) has become increasingly common and in many centers has evolved to become the standard method of urinary diversion. Orthotopic neobladder has been a commonly used option for urinary diversion since the 1980s. Advantages of this type of diversion are the ability to avoid an ostomy, voiding function similar to the native bladder, and improved cosmesis. Robotic intracorporeal neobladder creation has demonstrated similar outcomes to open technique and represents a promising minimally invasive diversion for the future. The Studer pouch is widely used nowadays, yet there are still some drawbacks. Therefore, we designed a technique that would offer an orthotopic ureteroileal anastomosis by using a two chimney modification. This modification is simple to handle, safe and free of ureteric stricture or reflux. With low stricture rates, this modified procedure of ureterointestinal anastomosis, is worthy of further promotion.

Keywords: urothelial bladder cancer, urinary diversion, bladder substitution, robotic orthotopic neobladder, ureteroileal anastomosis

1. Introduction

Indications for orthotopic diversion are: absence of malignancy of the prostatic urethra in men or the bladder neck in women, adequate renal function (GFR >35–40), normal liver function, absence of severe urethral stricture disease, absence of inflammatory bowel disease (IBD) and a reliable patient with good mental status and dexterity. Drawbacks unique to a neobladder include urinary incontinence, incomplete emptying, need for self-intermittent catheterization (SIC) and longer operative times. Many viable surgical techniques exist and offer good functional and oncological outcomes. In determining the best type of urinary diversion for a specific patient, consideration must be given to both the morbidity associated with surgery and the potential positive impact on the patient's quality of life.

Kock demonstrated the importance of complete detubularization of the bowel segment and the double-folding technique that creates the most spheric shape possible (Kock, 1982). These concepts are the cornerstone of current cutaneous and orthotopic reservoirs [1].

In 1979, Camey and Le Duc reported their pioneering clinical experience with orthotopic substitution to the native urethra in male bladder cancer patients (Camey and Le Duc, 1979). The initial Camey diversion used an intact segment of ileum,

resulting in a high-pressure reservoir. Subsequently the Camey II detubularized reservoir (Camey, 1990); Hautmann W-neobladder (Hautmann, 1988); "hemi-Kock" neobladder (Skinner, 1991); Studer pouch (Studer, 1989); extraserosal-lined ureteral tunnel (Abol-Enein and Ghoneim, 1993); T pouch (Stein, 1998); stomach neobladder (Hauri, 1998); cecal and ileocecal neobladders (Light and Engelmann, 1986; Mansson and Colleen, 1990); and sigmoid reservoir (Reddy and Lange, 1987) have all been described [1]. All those techniques of urinary diversion have been evaluated through time, providing good renal preservation as well as functional and oncologic outcomes. Orthotopic diversion quickly surpassed continent cutaneous diversion in popularity for both patients and physicians because it allows natural voiding, is simpler to construct and is less likely to require revision surgery at a later date.

Although the ideal bladder substitute remains to be developed, the orthotopic neobladder most closely resembles the original bladder in both location and function. This form of lower urinary tract reconstruction relies on the intact external rhabdosphincter continence mechanism, seldom requires intermittent catheterization and avoids the difficulties associated with the efferent continence mechanism of continent cutaneous reservoirs. Voiding is accomplished by relaxation of the pelvic floor musculature (as in normal voiding) along with a concomitant increase in intra-abdominal pressure (Valsalva maneuver).

It is estimated that approximately 80–90% of male patients and 75% of female patients undergoing cystectomy are potential candidates for neobladder construction from a purely medical standpoint.

2. Historic evolution of orthotopic urinary diversion

Three types of urinary diversion have been developed until now: conduit diversion, continent cutaneous diversion and the latest orthotopic diversion (**Figure 1**).

Both ileal and colon conduits present with long term complications such as peristomal hernia, pyelonephritis, stomal stenosis and renal deterioration. Likewise, continent cutaneous diversions relate with malfunction of the efferent continence mechanism and therefore, open surgical revision is often required.

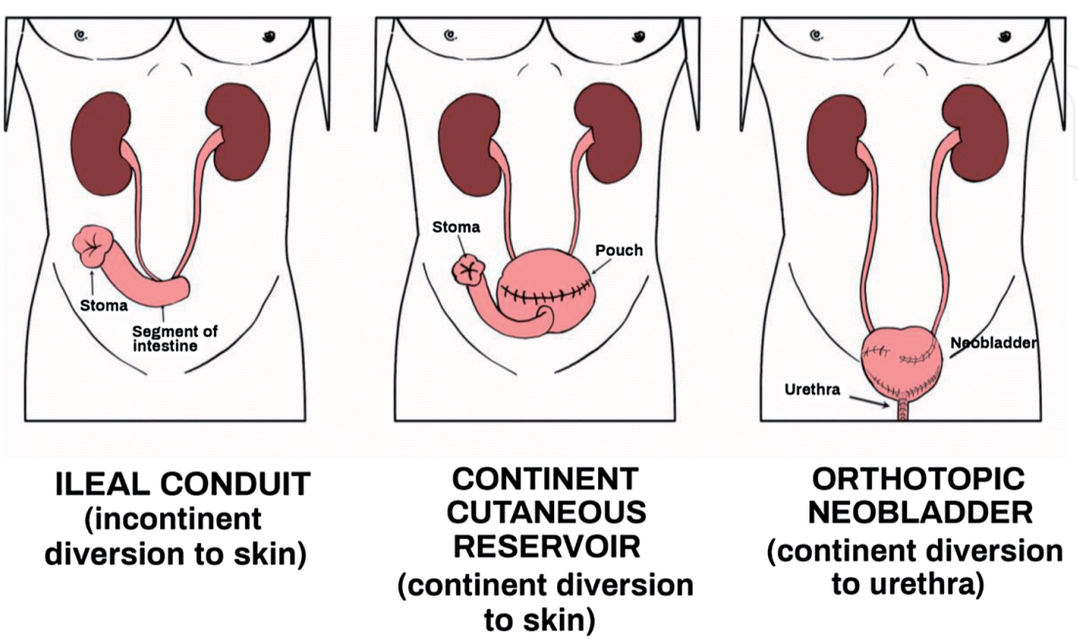

Figure 1.
Types of urinary diversion.

On the contrary, patients with orthotopic neobladder formation are able to void to completion without the need of intermittent catheterization, because the mechanism of continence relies on the rhabdosphincter.

3. Basic principles of continent orthotopic urinary diversion

In order to construct a functional orthotopic neobladder using intestinal segment, three basic principles must be satisfied.

First of all, the urethra of the patient must not be obstructed and must have adequate external sphincter mechanism.

Second, the reservoir must be sufficiently compliant to maintain a low pressure during the filling phase. This is best achieved by opening the bowel segment longitudinally to completely detubularize it and folding it to create a spheric shape.

The shape of the neobladder is of great importance. The sphere seems to be the best choice as it has the greatest internal volume and therefore the greatest capacity.

In addition, the Kock pouch and also S and W shaped reservoirs maintain low internal pressures throughout the filling phase, due to low pressure contractions of the bowel wall.

All current continent diversion techniques use detubularized bowel to construct the reservoir.

Third, the reservoir must have adequate volume to allow for reasonable voiding intervals. In general, this should be at least 300 to 500 mL once the pouch is mature.

The standard 44-cm length of ileum formed into a double-folding reservoir by the Kock technique (also used for both the Studer and T pouch neobladders) has an initial capacity of less than 200 mL but within the first year stretches to hold 500 to 600 mL at low pressure [1].

In general, small bowel, when available, has advantages over colon in terms of wall compliance and ability to stretch, as well as reduced mucous formation.

4. Techniques for orthotopic bladder substitution

Reservoirs made of detubularized ileum or ileum and colon together, appear to have the greatest compliance and lowest likelihood of generating intermittent high-pressure contractions.

The circular muscle layer of ileum was found to be most distensible, and the urodynamic characteristics of the ileum appear to be superior to those of the colon.

According to Schrier, ileum neobladders have the larger capacity, lower pressures and better compliance. Likewise, small bowel mesentery has the greatest mobility and can reach to the urethra without much tension [1].

Furthermore, another advantage of the ileum is the intestinal mucosa atrophy, due to the chronic exposure to urine. As a result, mucous production is decreased as well as reabsorption of urinary electrolytes. Mucosal atrophy appears to be more frequent in small bowel reservoirs.

Isolation of the segment of bowel to be used for the diversion must be performed carefully to preserve blood supply to the pouch, as well as to the bowel anastomosis.

The addition of an antireflux mechanism does not appear to be necessary for preservation of the upper tracts and prevention of infections, at least in the intermediate term [2].

5. Surgical techniques

5.1 Ileal reservoirs

For the creation of most ileal reservoirs a 60–75 cm of terminal ileum is used. The segment is detubularized and folded in various ways to create a sphere shape. Several modifications exist regarding the folding technique and variations in the placement of the ureters (with or without antireflux mechanism).

Of the two most popular configurations around the world are the Hautmann W-neobladder (and its various modifications) and the Studer pouch neobladder. Both are relatively simple constructions and allow direct ureteroileal anastomosis, which has been shown to have the lowest risk of subsequent stricture.

5.2 Studer pouch

Studer and colleagues initially described an ileal bladder substitute, as a long, afferent, isoperistaltic, tubular ileal segment. It is believed that the long segment functionally prevents vesicoureteral reflux when the patient voids by Valsalva maneuver (Studer, 1996) [1]. It is straightforward to construct and has become one of the most popular form of orthotopic diversion in the Urological community. The advantages of this bladder substitute include the simplicity of construction, the lack of a requirement for surgical staples and the ability to accommodate short ureters. The reservoir portion uses the optimal double-folded U configuration as originally described by Kock (Kock, 1989). Studer's group reported on 480 of these procedures performed from 1985 through 2005 with excellent long-term results in terms of continence, preservation of renal function and a ureteroileal stricture rate of less than 3% (Studer, 2006). The original description used a 20-cm afferent segment with 40 cm used for the reservoir. In more recent years Studer has advocated using a somewhat shorter afferent ileal segment with similar results (Studer, 2006) [1].

For Studer reservoir creation, a 54 cm of the terminal ileum is isolated, approximately 15-20 cm from the ileocecal valve. The distal and proximal segments are divided in an avascular plane, with staplers, ensuring mobility of the pouch and small bowel anastomosis to the urethra. In the process the Studer pouch is formed in a U shape using 40-44 cm of distal ileum with each limb measuring 20 cm and a proximal 15 cm segment is used as the afferent limb. The proximal end is closed with absorbable sutures, whereas the distal ileal segment is opened 2 cm away from the mesentery and the incised ileal mucosa is oversewn in two layers, using a running 3–0 polyglycolic acid suture for the creation of the sphere.

The rate of ureteroileal stricture is influenced by the type of anastomosis. The direct end-to-side Leadbetter or the combined Wallace anastomoses with interrupted fine absorbable sutures have been shown to have the lowest risk of stricture, approximately 3–6% (Pantuck, 2000; Hautmann, 2011) [1].

Common observations from series of patients undergoing orthotopic diversion include a gradual period of improvement in daytime continence over the first 6 to 12 months with a slower improvement in night-time continence even into the second year.

The evaluation and management of urinary incontinence after orthotopic diversion should be delayed until the neobladder has had time to expand. This may take 6 months to a year after surgery.

6. The robotic cystectomy and two chimney approach

The robot-assisted surgical approach for pelvic urologic oncology has existed since the mid-2000s and the technique for robot-assisted radical cystectomy (RARC) with lymph node dissection has been established. Early oncologic outcomes after RARC and lymph node dissection are safe and efficacious (Hellenthal, 2011) [1]. Moreover, we observed decreased robotic surgery-related complications and improved outcomes over time in our early series (Pardalidis 2011) [3]. Several perceived advantages of robot-assisted approaches for bladder cancer include less pain, minimal blood loss and earlier return of bowel function, which ultimately help in a quicker return to previous quality of life (Challacombe et al., 2011) [1]. Despite smaller incisions and advances in extirpation, recovery has relied mainly on return of bowel function. More than 1700 cases of RARC have been registered in the International Robotic Cystectomy Consortium database (IRCC). Based on data published in 2013 from the IRCC, approximately 18% of procedures have been performed with the complete intracorporeal approach (Ahmed, 2014) [1]. Two commonly performed procedures with the complete intracorporeal approach include the ileal conduit and a modified Studer neobladder.

When constructing orthotopic bladder substitution, a design with features similar to that of a normal bladder must be adopted, including creating a low pressure pouch with adequate capacity and effective preservation of renal function. Controversy still remains regarding the optimal mode of ureteroileal anastomosis. Anti-reflux techniques can be harmful to renal function due to the development of anastomotic strictures at a higher rate than with refluxing techniques (9–20% vs. 1–6%). Refluxing techniques, are easier to perform with a lower stenosis rate in the long-term follow-up period; but these techniques also have drawbacks for renal function, including recurrent pyelonephritis and hydronephrosis caused by vesicoureteral reflux, especially during voiding due to increasing bladder luminal pressure.

ICUD-EAU International Consultation on Bladder Cancer 2012 does not recommend applying antireflux anastomosis in orthotopic bladder substitutions. Studer

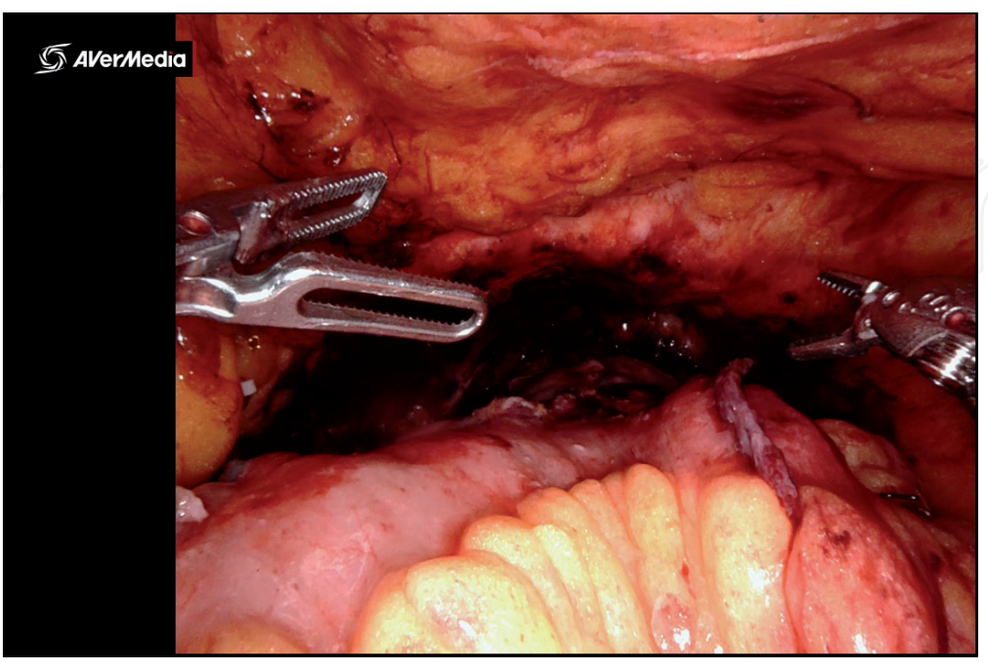

Figure 2.
Two chimney neobladder formation before ureteroneobladder anastomosis.

and Timmer recommend antireflux techniques only in cases where urine diversion can generate great intraluminal pressure and/or when there is a risk of permanent bacterial colonization [2]. Hence, we designed a technique that would resolve these problems by using a two chimney method of ureteroileal anastomosis in an ileal-modified orthotopic bladder substitution.

The Studer pouch is widely used these days, yet there are still some drawbacks. The afferent limb of the Studer pouch is anastomosed with the bilateral ureters together, either in a Wallace I or II fashion so as the left ureter should be tunneled under the mesosigmoid for anastomosis with the afferent ileal segment. This maneuver may be the cause of increased left stenosis occurred twice as frequently as on the right side because of extensive dissection and possible tension creating ischemia of the distal ureteral end. Our technique by formation of two chimneys on each neobladder lateral side and end to end ureteroileal anastomosis, effectively avoids these drawbacks because of the separate bilateral ureteroileal anastomosis. Each ureter is spatulated and anastomosed without tension and less ischemia, so the risk of stenosis is decreased (**Figures 2–11**).

This surgical modification seems to preserve ureteral vascularization, resulting to low stricture rate (4%). Additionally, in case of reintervention it is easier

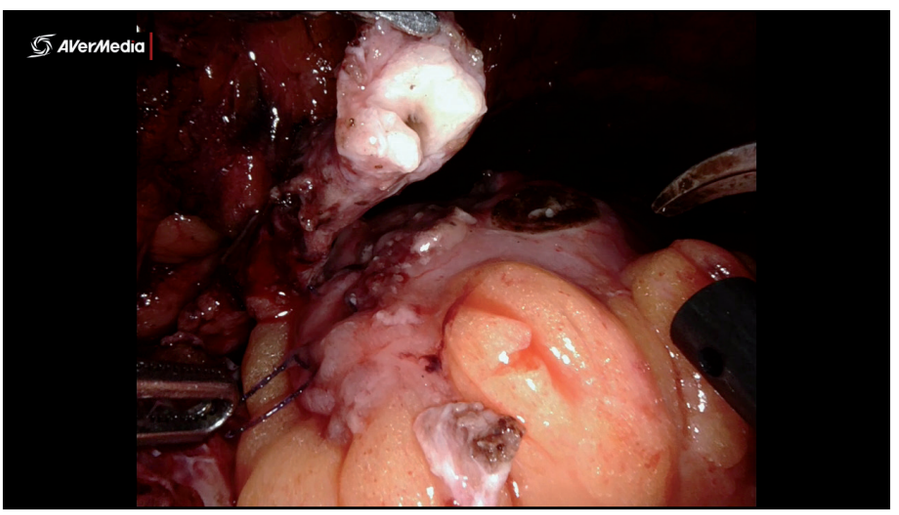

Figure 3.
Spatulation of the left ureter before ureteroneobladder anastomosis.

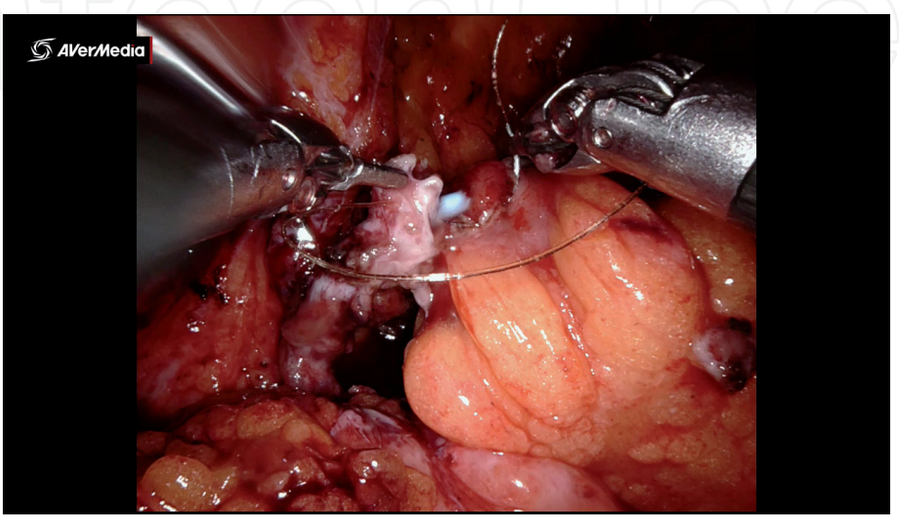

Figure 4.
Left end-to-end ureteroneobladder anastomosis.

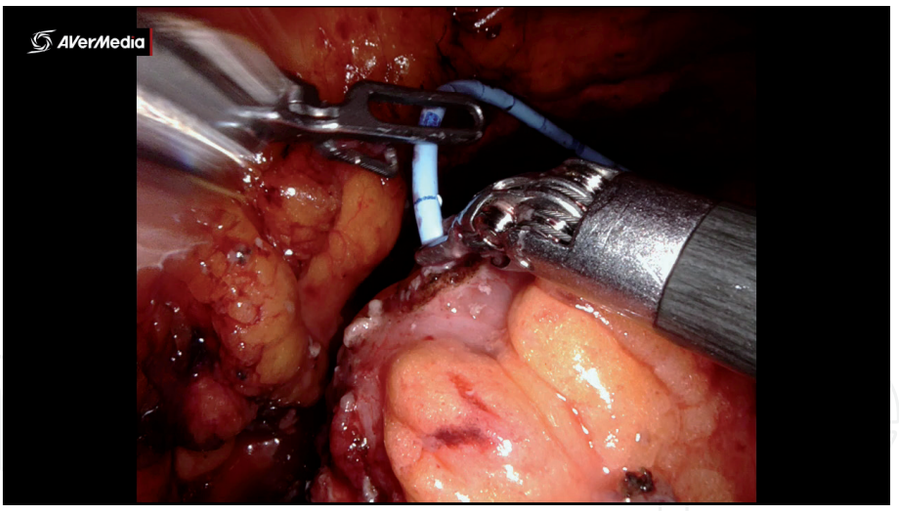

Figure 5.
Ureteral stent catheterization of the left ureter.

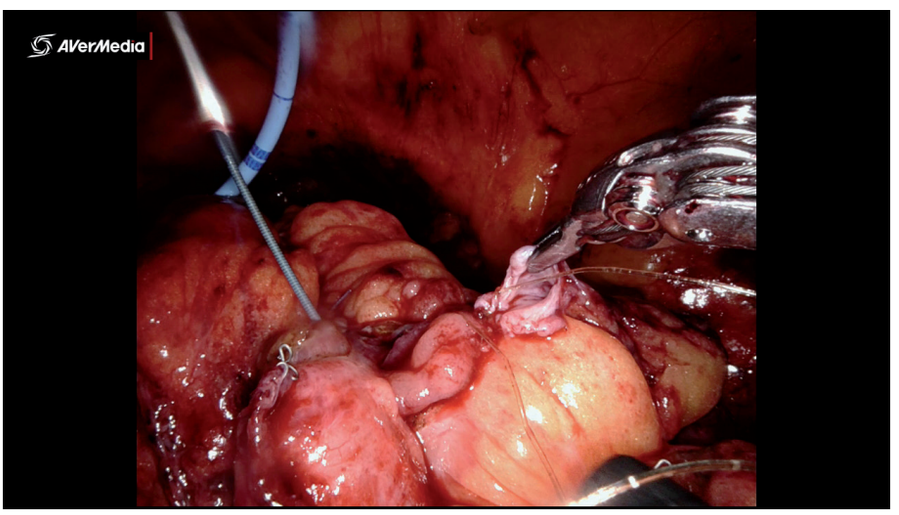

Figure 6.
Right chimney end-to-end ureteroneobladder anastomosis.

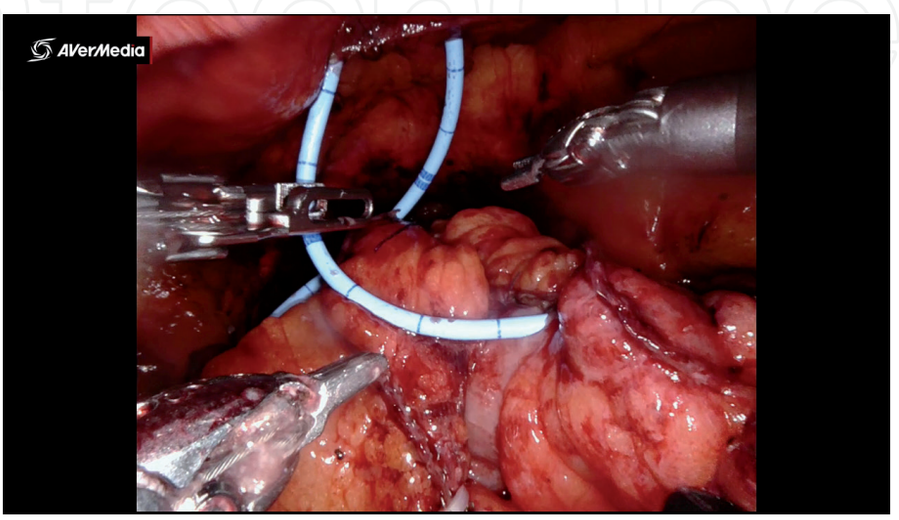

Figure 7.
Final two chimney neobladder formation with ureteral external stents.

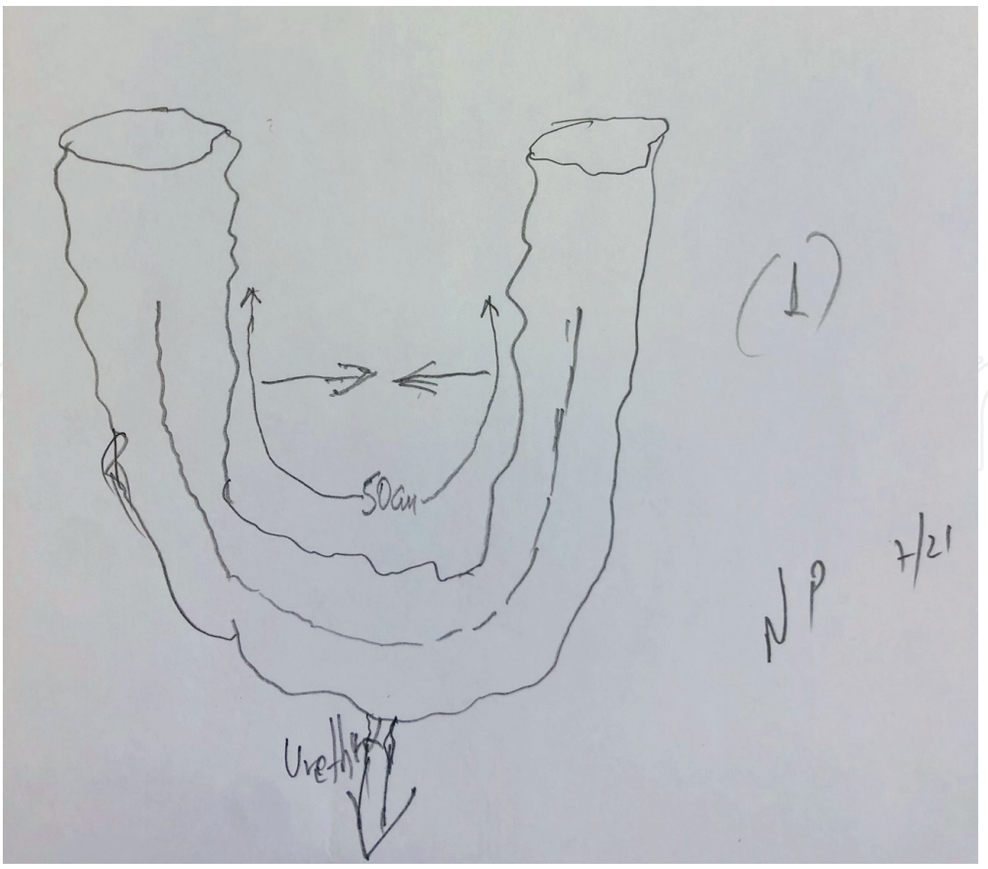

Figure 8.
Isolation of final ileal segment of 75 cm. A 12,5 cm part chimney is preserved in each side and the rest is detubularized.

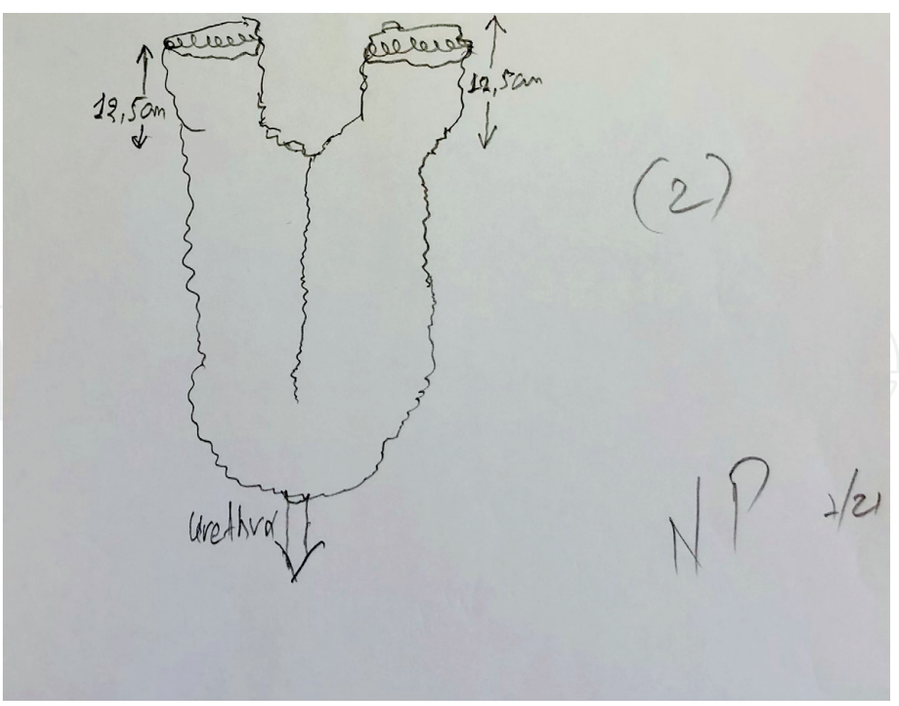

Figure 9.
The posterior part is anastomosed with 3.0 continuous sutures.

to access each anastomosis without damaging the other one [4]. We are using ureteral catheters on each side which are exteriorized to the skin and removed a week postoperatively. An ERAS protocol for quick recovery is a standard

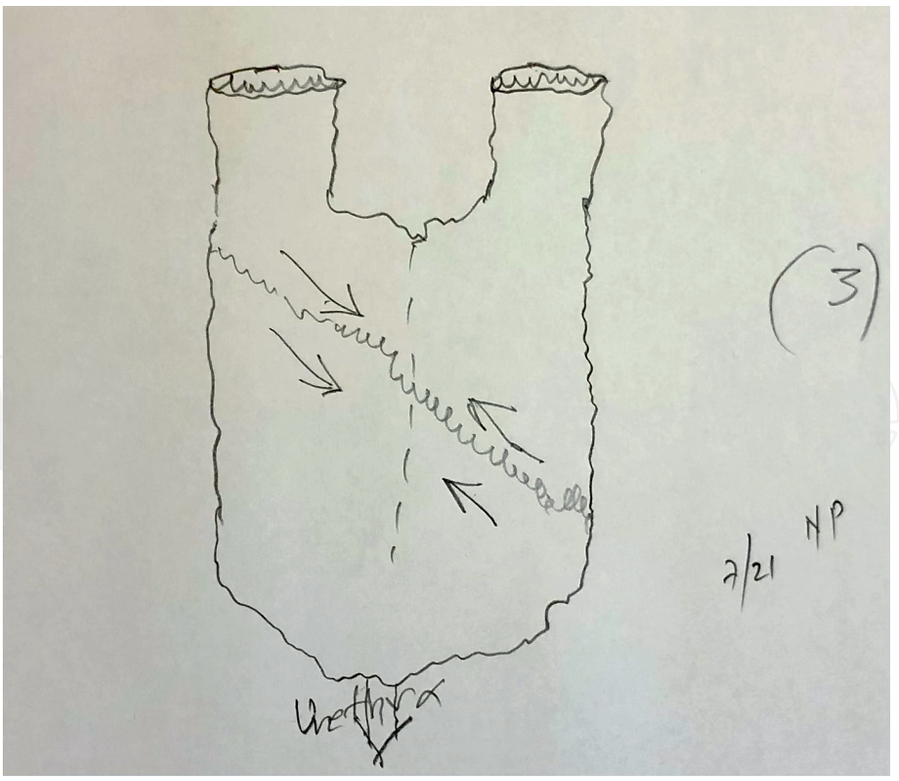

Figure 10.
The right upper part of the ileum is approached to the left lower part with continuous 3.0 sutures, creating a spheric neobladder.

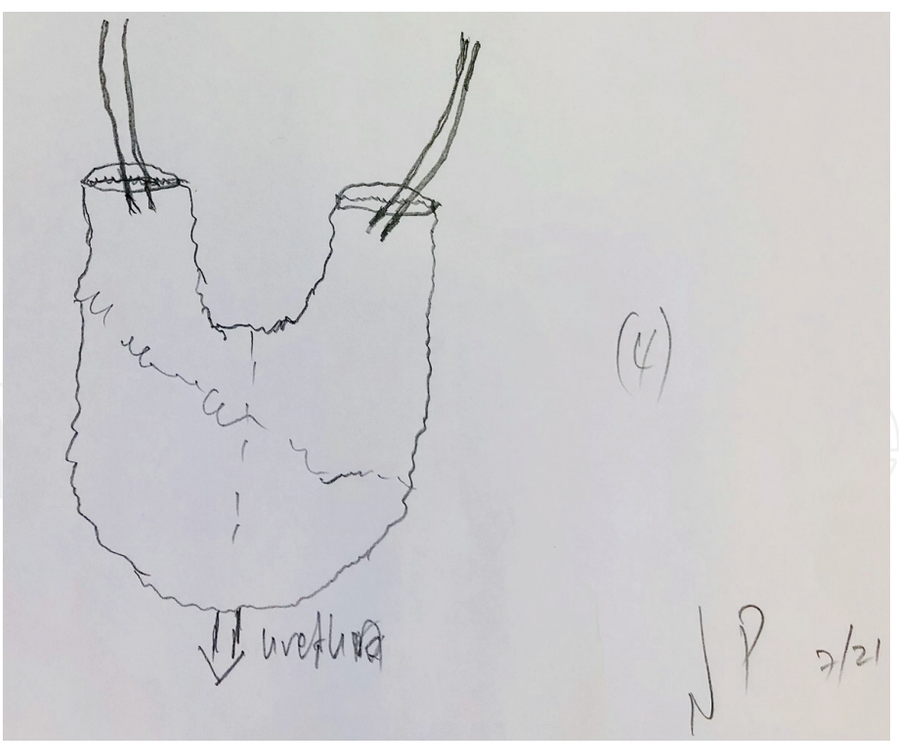

Figure 11.
The ureters are anastomosed with 4.0 sutures to each chimney seperately.

approach for the robotic cystectomy patients. In our last 5 patients we are performing a stentless watertight anastomosis with no stricture presence or hydronephrosis after a short of 18 months follow up time. These are very promising results.

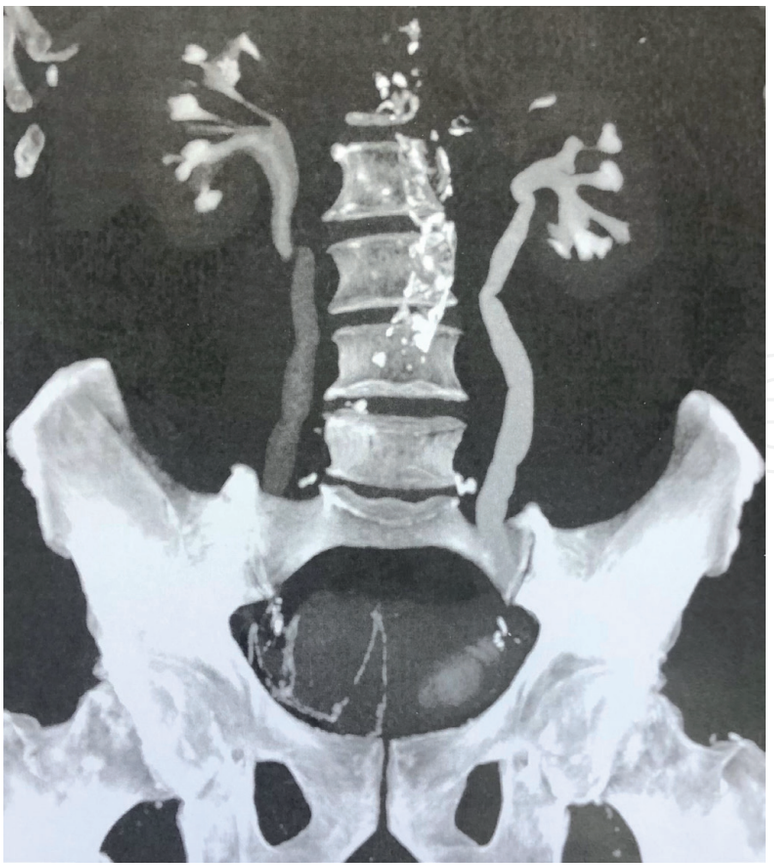

Figure 12.
CT urography follow up 2 years.

Figure 13.
CT urography follow up 10 years.

Urographic studies demonstrate no reflux or stricture in either of the implanted ureters (36 renal units in total), after 10 years of follow up (**Figures 12** and **13**) [5].

This modification of Studer neobladder with two chimneys is simple to handle, safe and free of ureteric stricture or reflux. With low stricture rates, this modified procedure of ureterointestinal anastomosis, is worthy of further promotion [6].

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