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ORIGINAL ARTICLE

Totally intracorporeal 3D laparoscopic orthotopic neobladder reconstruction following radical cystectomy for infiltrative bladder tumors: the experience of modified Studer and modified Y-shaped ileal reconstruction techniques

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Summary

Purpose: *We report our experience with 23 cases in utilizing ileum to perform totally intracorporeal 3D laparoscopic neobladder reconstruction using two different surgical techniques.*

Methods: *Patients candidates for reconstructive surgery were in a good biological status with a body mass index (BMI) in the range of 18.5-25 and presented a muscle-infiltrative bladder tumor with negative nodal frozen sections performed during the operation. Twenty-one modified Studer neobladder and 2 modified Y-shaped neobladder techniques for totally intracorporeal 3D laparoscopic ileal neobladder cases were performed using drawings and intra-operative images. An emphasis was made on different tips and tricks that can be applied when using ileum for the neobladder reconstruction, to avoid surgical complications and obtain optimal functional results.*

Results: *The operations were performed in a mean time of 5 h, with a mean blood loss of 350 ml and grade II postoperative Clavien Dindo complications. The 23 patients were discharged after a mean hospital stay of 21 days and had a functional ileal neobladder after a mean of 30 days. The results were monitored also on the long-term, taking into account functional results and possible complications from utilizing ileum as a urinary reservoir.*

Conclusion: *Resecting a digestive segment and using it as a urinary reservoir may lead to multiple complications. Therefore, laparoscopic technical adaptations and highly skilled surgical teams are required for performing a totally intracorporeal 3D laparoscopic orthotopic ileal neobladder reconstruction.*

Key words: *cystectomy, digestive anastomosis, laparoscopic approach, lymph node dissection, orthotopic ileal neobladder*

Introduction

There are different urinary diversion techniques available for patients presenting muscle-infiltrating bladder carcinoma with orthotopic neobladder reconstructions, bringing technical challenges for minimal invasive approaches, as the intestinal surgery requires skills of general surgery and urology. Therefore, different reconstruction techniques have been described depending on the material used for the urinary pouch: gastric, ileal or sigmoid [1]. It is known that older age, long

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operative time, lack of effective supplement of albumin and diabetes mellitus are risk factors for life-threatening perioperative complications [2]. Nevertheless, renal deterioration, dysfunctional voiding, intestinal obstruction, metabolic imbalances, urolithiasis and absorption defects can occur on the longer term [3].

Although these techniques are evolving and surgeons are acquiring the needed skills for optimal outcomes, the literature is still scarce in reporting criteria for selecting the ileal segment for orthotopic neobladder reconstruction, with emphasis on possible short and long-term implications avoiding digestive complications. We report our experience

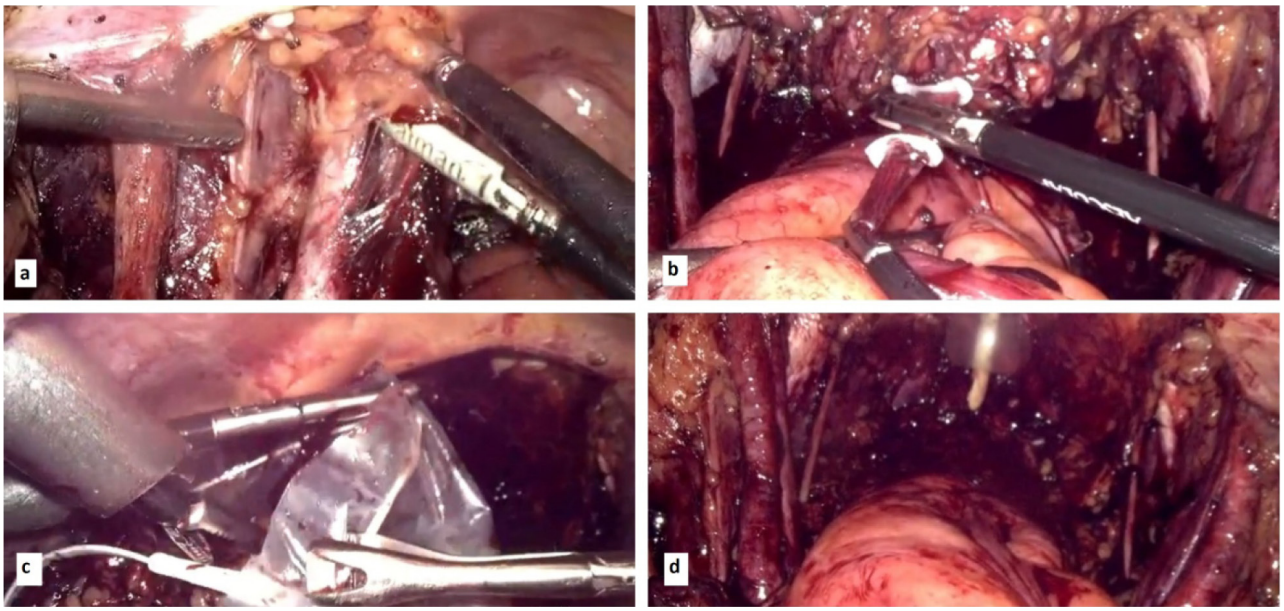

Figure 1. Intraoperative images with the 3D laparoscopic radical cystectomy and pelvic lymph node dissection. **a:** lymph node dissection is performed on the left side; **b:** the right ureter is identified, clipped and sectioned; **c:** the cystectomy specimen and excised bilateral lymph nodes are placed in an Endobag; **d:** the aspect of the pelvis after the radical cystectomy and the pelvic lymph node dissection were performed.

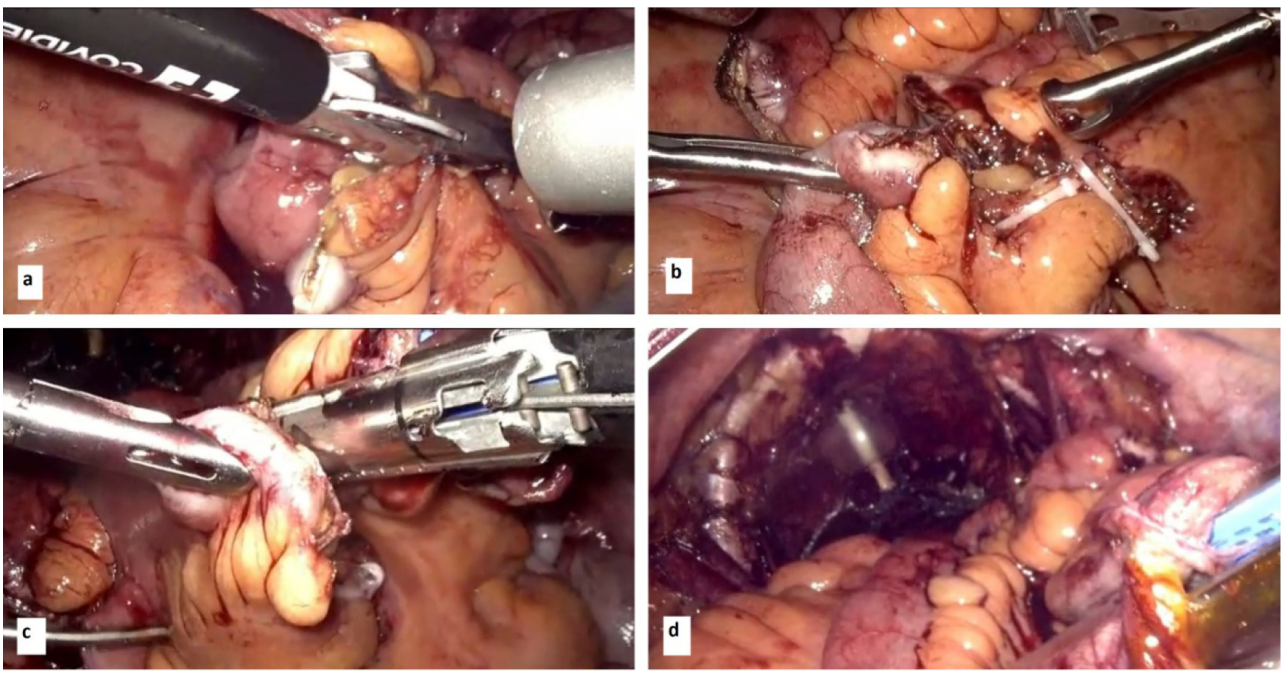

Figure 2. Intraoperative images with the ileal segment selection for the orthotopic neobladder and restoration of the intestinal tract. **a:** the ileal segment that will form the neobladder is selected and taken out of the intestinal tract; **b:** the intestinal margins are prepared for the digestive tract restoration; **c:** the ileal margins are prepared for the latero-lateral anastomosis performed with Endo GIA; **d:** the digestive anastomosis is performed with Endo GIA.

with 23 cases utilizing ileum to perform totally intracorporeal 3D laparoscopic neobladder reconstruction highlighting ileal management, as the selected ileal segment has profound implications in avoiding important digestive tract-related complications.

Methods

Between January 2015 and July 2019, 23 patients (21 male and 2 female) with totally 3D intracorporeal ileal neobladder reconstruction were operated by the same surgeon. All patients were candidates for reconstructive surgery, had good biological status with a BMI in the range of 18.5-25 and presented a muscle-infiltrative bladder tumor. Also, nodal frozen sections taken during the operation were negative for disease. Regarding the surgical technique, 21 cases were subjected to a modified laparoscopic Studer technique and 2 to a modified laparoscopic Y-shaped neobladder technique.

The totally ileal neobladder reconstruction was performed with a 3D transperitoneal laparoscopic approach, using 5 trocars, with the patient placed in dorsal decubitus and a 30 degrees Trendelenburg position. The sealing devices that were used were both ultrasound and radiofrequency diathermia-based devices.

After bilateral pelvic lymphadenectomy (Figure 1a) and cystectomy (Figure 1b) were performed "en block", the excision material was placed in the abdominal cavity in an Endobag (Figure 1c) and exteriorized at the end of the operation. The histologically negative nodal frozen sections allowed the continuation of reconstructive surgery. The aspect of the pelvis after the radical cystectectomy and the pelvic lymph node dissection can be observed in Figure 1d. The 25-30 cm of ileal segment that further formed the new urinary reservoir was selected and excluded from the intestinal tract (Figures 2a, 2b), respecting the last 30 cm of the ileum. Parameters such as mesenteric vascularization, length and mobility of the ileal loop were evaluated as criteria for selecting the proper ileal segment. The latero-lateral anastomosis of the remnant ends of the ileum was performed with Endo GIA (Figure 2c) to restore the continuity of the intestinal tract (Figure 2d). From this step on, the ileal neobladder reconstruction was performed using different laparoscopic techniques. Different laparoscopic tips and tricks are exemplified using intraoperative images (Figures 4, 6) along with drawings (Figures 3,5), depending on the surgical technique: modified Studer or modified Y-shaped totally intracorporeal laparoscopic neobladder technique.

Totally intracorporeal 3D laparoscopic modified Studer neobladder technique (Figures 3,4)

The selected ileum is opened and prepared for the tailoring (Figures 3a,3b,3c). The urethral-ileal anasto-

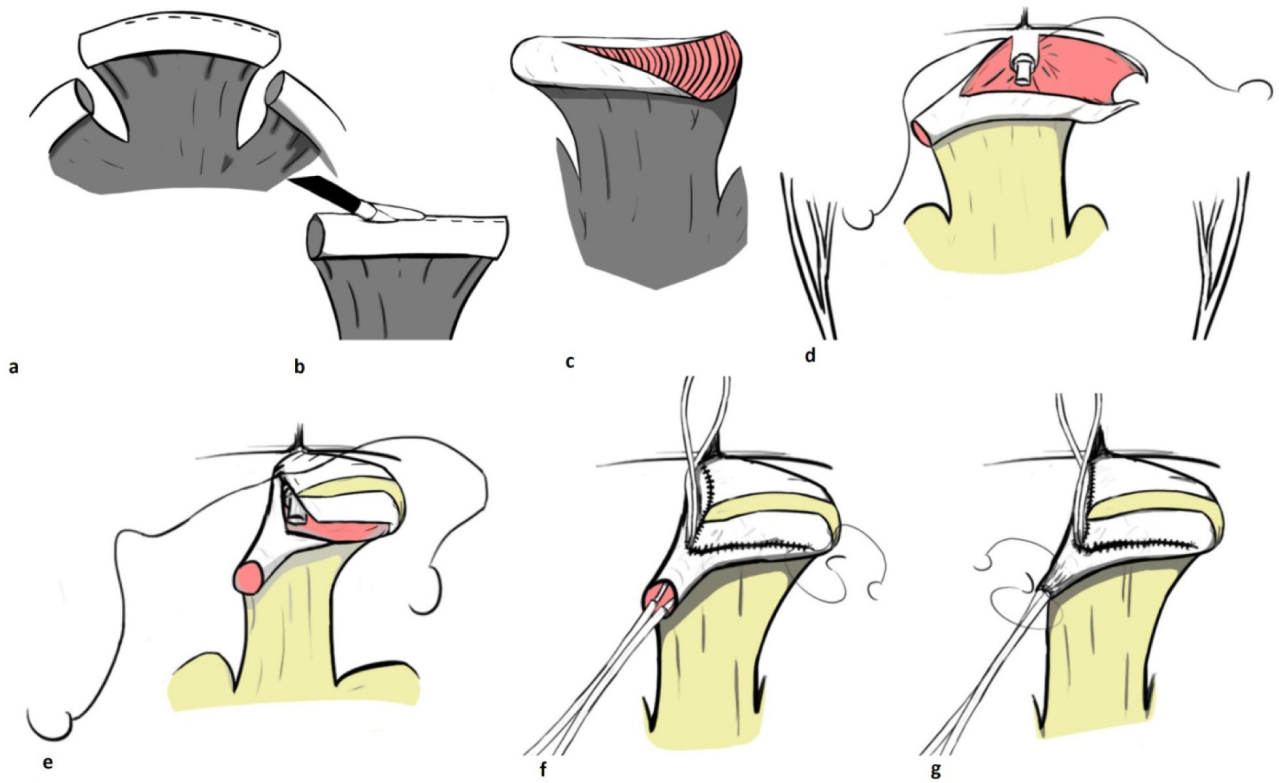

Figure 3. Drawings of totally intracorporeal modified Studer ileal neobladder laparoscopic technique. **a:** the ileal segment that will form the neobladder is taken out of the intestinal tract; **b:** the antimesenteric opening of the selected ileal segment is performed; **c:** the opened ileal segment; **d:** the urethral-neobladder anastomosis is performed; **e:** the urethral-neobladder anastomosis continues cranially, shaping the urinary pouch; **f:** the mono J catheters are passed through the abdominal wall, the urinary pouch and the ureters; **g:** the final aspect of the modified Studer ileal neobladder after the ureteral-neobladder anastomosis is performed.

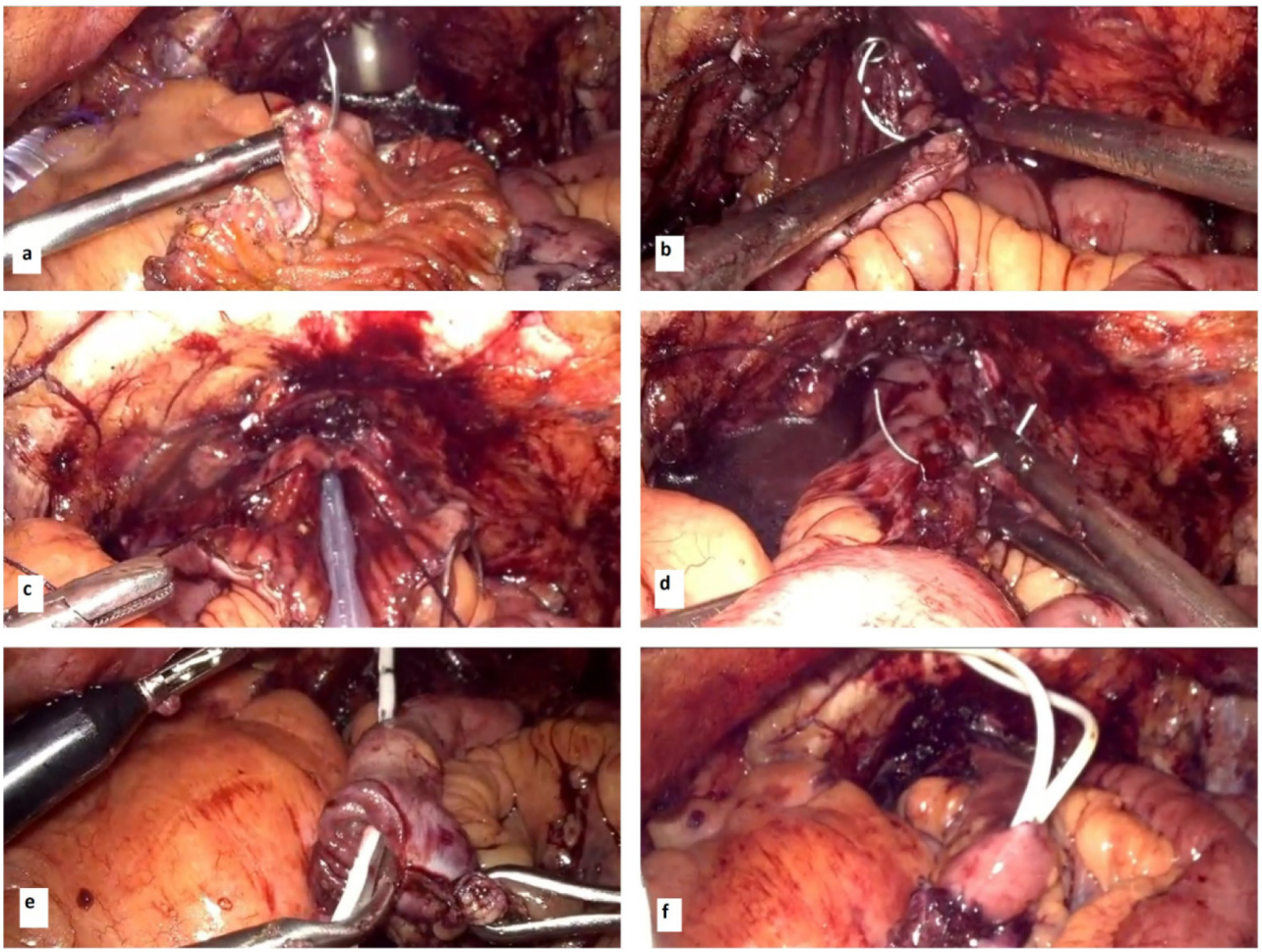

Figure 4. Intraoperative images of totally intracorporeal modified Studer ileal neobladder laparoscopic technique. **a:** the opened ileum starts to be sutured to the urethra using a V-loc filament; **b:** the urethral-neobladder anastomosis is performed from posterior with the running suture; **c:** the Van Velthowen technique offers a perfectly sealed urethral-neobladder anastomosis; **d:** the selected ileum continues to be modeled forming a pouch as the suture advances cranially; **e:** a mono J catheter is passed through the abdominal wall, the urinary pouch and the right ureter; **f:** the final aspect of the modified Studer neobladder after the ureteral-neobladder anastomosis is performed.

mosis starts from posterior (Figures 3d,4a,4b) and it is performed with a running suture with a V-loc filament. The Van Velthowen technique offers a perfectly sealed anastomosis (Figure 4c). The ileum continues to be molded as the suture advances cranially towards the ureters (Figures 3e,4d). 2 Mono J stents are placed through the ureters in the kidneys (Figures 3f,4e), exteriorized to the abdominal wall through the neobladder. The urinary pouch is sealed after each of the ureteral-neobladder anastomosis is performed (Figures 3g, 4f). In case of dilated ureters, the ureteral terminal reimplantation is performed to an unopened ileal segment. The final modified Studer orthotopic neobladder will have 2 Mono J stents passing through, a suprapubic catheter and an urethro-neobladder catheter.

Totally intracorporeal 3D laparoscopic modified Y-shaped neobladder technique (Figures 5,6)

The selected ileum (Figures 5a,5b) is opened approximately 50% of its length, respecting the afferent and efferent extremities (Figure 5c,6a). The urethral- ileal anastomosis starts from posterior (Figure 6b) and is performed with a running suture with a V-loc filament (Figure 6c). The Van Velthowen technique offers a perfectly sealed anastomosis. The ileum continues to be modeled forming a pouch as the suture advances cranially (Figure 6d). 2 Mono J stents are placed through the ureters into the kidneys, exteriorized to the abdominal wall through the neobladder (Figure 5d). The ureteral terminal reimplantation is performed to each end of the unopened ileal segment. The urinary pouch is sealed after each of the ureteral-ileal anastomosis is performed (Figure 5e,6e). The final modified Y-shaped orthotopic neobladder (Figure 6f) will have 2 Mono J stents passing through, a suprapubic catheter and an urethro-neobladder catheter.

Results

Our results are presented briefly in Table 1. The operations were performed in a mean time of 5 h, with a mean blood loss of 350 ml and grade II postoperative Clavien-Dindo complications. We

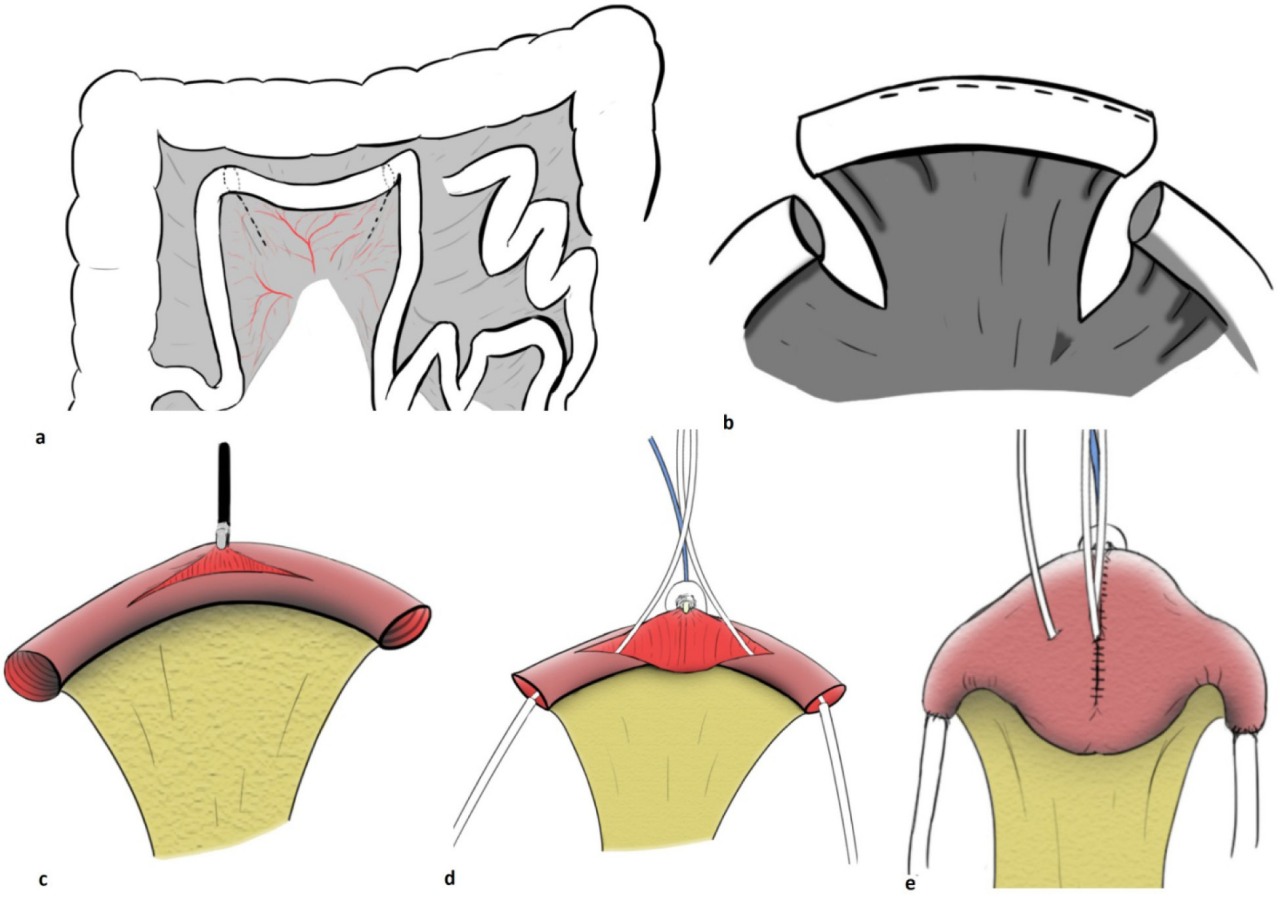

Figure 5. Drawings of totally intracorporeal modified Y-shaped ileal neobladder laparoscopic technique. **a:** the selection of the ileal segment that will form the urinary pouch is performed; **b:** the selected ileal segment is taken out of the intestinal tract; **c:** the selected ileum is opened approximately 50% of its length, respecting the afferent and efferent extremities; **d:** the urethral-neobladder anastomosis is performed and, as the suture advances cranially, mono J stents are placed through the abdominal wall, neobladder and ureters into the kidneys and the ureteral terminal reimplantation is performed to each end of the unopened ileal segment; **e:** the final aspect of the modified Y-shaped neobladder.

report one case of Clavien-Dindo grade III in the first postoperative day: the patient ripped off his left mono J stent and we had to place aSnother one within an open intervention. Nevertheless, the evolution of this case was favorable with no further differences compared to the others. As for the gender, one female patient had already a hysterectomy with bilateral adnexectomy 2 years prior to our surgical intervention and one male patient had radical cystectomy with pelvic lymphadenectomy and bilateral ureterostomy performed with minimally invasive method 3 years prior to our modified Y-shaped orthotopic ileal reconstruction for a non-malignant pathology (granulomatous cystitis).

After the first 48 h the neobladder was washed with small quantities (20-40 ml) of a mixture of a mucolytic agent and saline solution through the urethro-neobladder and suprapubic urinary catheters during the whole hospital stay. Patients were discharged after a mean of 21 days of hospitalization when the Mono J ureteral stents were suppressed, to be able to assure an optimal care of the stents in our department. They were also discharged with the suprapubic urinary catheter that was suppressed a week after and a urethral-neobladder urinary catheter suppressed after another week. A degree of incontinence was present after the urinary catheters were suppressed but the patients had a functional ileal neobladder after a mean of 30 days with a capacity reaching around 450 ml. All patients received orally mucolytics for the next 12 months after surgery to ensure a good adaptation of the ileal conduit to its new function as a urinary reservoir.

The results were monitored also on the long-term, taking into account functional results and possible complications from utilizing ileum as an urinary reservoir. Regarding this, one patient developed disease recurrence with bilateral hydronephrosis expressed through renal insufficiency and a non-functional neobladder. Another male patient presented an acute urine retention 6 weeks postoperatively because of mucus clogging even if he was on oral intake of mucolytics. An endoscopic

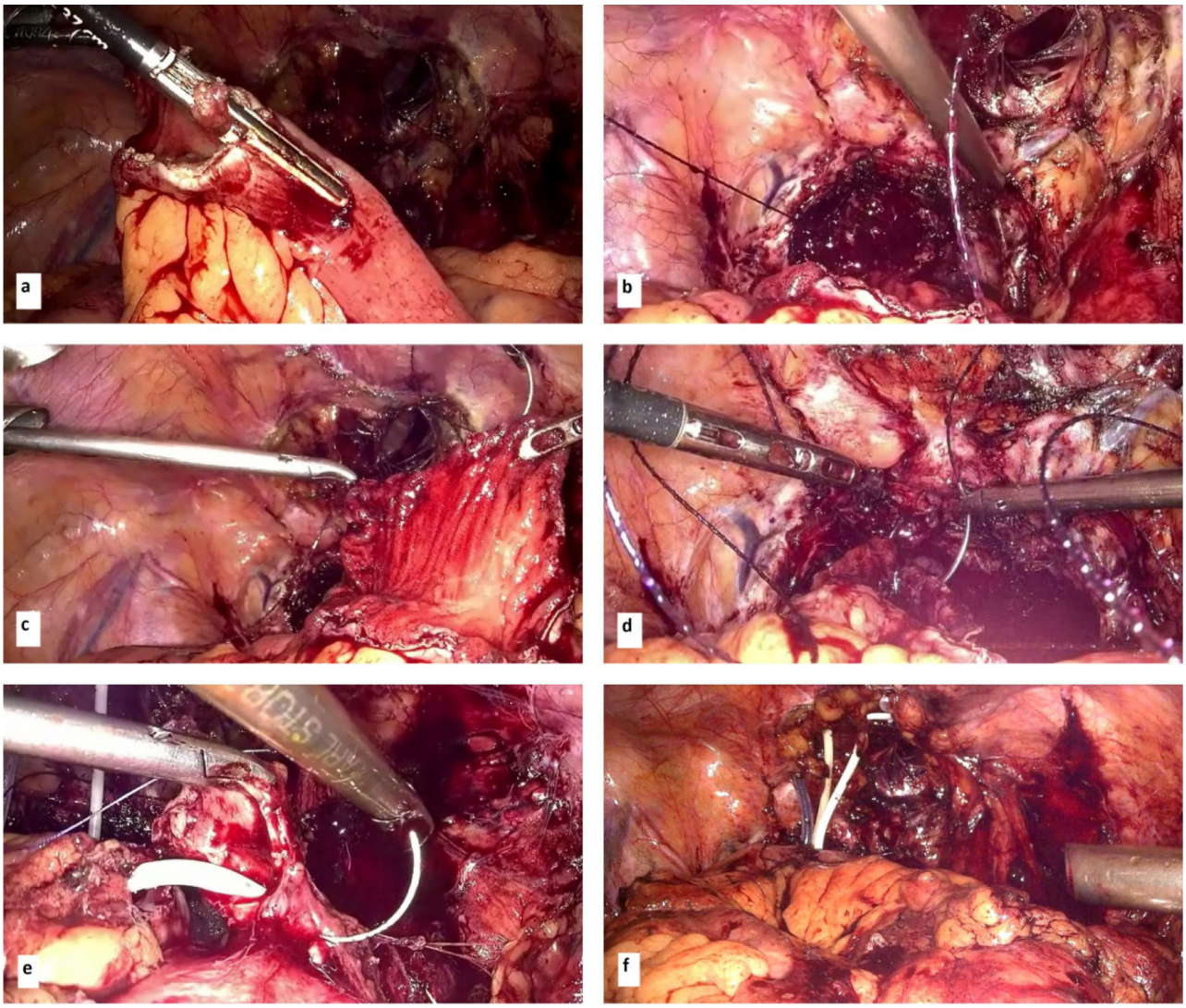

Figure 6. Intraoperative images of totally intracorporeal modified Y-shaped ileal neobladder laparoscopic technique. **a:** the selected ileum is opened; **b:** the opened ileum is prepared for the urethral-neobladder anastomosis; **c:** the urethral-neobladder anastomosis is performed with a V-loc filament from posterior; **d:** the continuous running suture is shaping the urinary pouch; **e:** the ureteral-neobladder anastomosis is performed after the mono J stent is placed; f: the final aspect of the modified Y-shaped ileal neobladder.

Table 1. Intraoperative and postoperative outcomes

	Number (%) or Mean ± SD
Mean cystectomy and pelvic lymphadenectomy time (min)	85± 12
Mean enterocystoplasty time	150 ± 7
Mean blood loss (ml)	350 ± 40
Clavien-Dindo complications, n (%)	
Grade I-II	22 (96)
Grade III	1 (4)
Grade IV	0 (0)
Mean number of days with pelvic drainages	7 ± 2
Mean hospital stay, days	21 ± 3
Tumor recurrence, n (%)	1 (4)

evaluation solved the clogging, the dosage of mucolytics was increased and continued to remain continent. Only one patient from our cohort died 10 months postsurgery and the cause of death was a bronchopneumonia. The rest of the patients in our cohort are followed by an oncologist and a CT or an MRI scan are performed every 6 months along with blood tests being taken.

Discussion

Different studies analyzed the use of gastric, ileal or sigmoid/colon material for the orthotopic neobladder reconstruction and their outcomes. Gastric neobladder is not recommended as a first choice in case of elderly patients [4]. The ileal and sigmoid neobladders bring different outcomes with

pros and cons. The rate of spontaneous voiders was better in the sigmoid group than in the ileal group [5] as the ileal neobladder tends to provide better continence [6]. Even if both types of orthotopic neobladder do not affect the renal function, the continence is a concept not clearly defined. Urodynamic studies show that a thicker wall offered by the sigmoid neobladder opposes itself to the hyperdistension with lower post-void residual, therefore providing a lower rate of continence. On the other hand, the greater volume and compliance of the ileal neobladder on the long-term could represent a predisposition to hyperdistension that may cause urinary retention [7]. Voiding dysfunction may be caused by a mechanical obstruction due to tumor recurrence, anterior vaginal wall prolapse, urethroenteric stricture, mucosal plug, stone and mucosal fold. These complications can be managed with endoscopic treatment [8,9], as it was performed for one patient presenting postoperative mucosa plug.

Taking all these into account, our preferred surgical technique is a modified Studer orthotopic neobladder laparoscopic technique using ileum for reconstruction, as an ileal neobladder achieves better postoperative recovery results compared with a sigmoid one [11], with the ileal conduit being used more frequently with its urodynamic follow up showing a gradually improvement with acceptable storage and voiding functions [12,13]. The reported daytime and nighttime continence rates our patients report are satisfactory and increased over time as the ileal neobladder reaches a capacity of 450 ml.

Different studies have shown pitfalls of using ileum. Some authors reported that patients with ileal neobladder may develop easier metabolic acidosis compared with colon neobladder patients, observing a close association between serum creatinine level and the degree of metabolic acidosis, therefore suggesting the use of a colon segment for the neobladder in patients with higher creatinine serum levels [10]. Using the distal ileum for the neobladder reconstruction causes bowel disorders such as diarrhea and faecal urgency caused by decreased reabsorption of bile [14]. Specific techniques are described for using a shorter ileal segment with a functional urinary reservoir reconstruction [15], especially in young patients [16] where long-term complications are at stake. Even preserving the last 15 cm of ileum is not enough to ensure an adequate B12 absorption [17].

The ileal segment tailored with the Studer technique is a good option for a new urinary pouch, offering satisfying functional results [18], but the surgical team must pay attention to possible postoperative and long-term complications, such as urinary leakage, urinary tract infections, ileus, deterioration in renal function due to hydronephrosis secondary to uretero-ileal neobladder strictures or reflux of infected urine, calculi formation or metabolic complications. When selecting the ileal loop, we prefer the one with the highest mobility to the lower pelvis and arterial bleeding of the marginal cuts provides the best surgical results in reconstructing the digestive tract and neobladder as well. If arterial bleeding is not present, we continue the resection of small fragments of bowel until we encounter it, to make sure we have enough arterial influx. This is independent from the chosen ileal neobladder folding technique.

The surgical technique is important for surgical complications of the digestive tract and of the ileal reservoir, with possible implications in metabolic complications. The use of mechanical sutures for the digestive anastomosis and the barbed double layer continuous running suture, makes the radical cystectomy with complete laparoscopic ileal neobladder a feasible procedure that can be performed in less than 5 h with a safer restoration of the intestinal tract [19].

Even if we generally prefer a modified laparoscopic Studer technique, there are selected cases when we perform a modified laparoscopic Y-shaped neobladder technique with patients presenting shorter ureters, for example after cutaneous ureterostomy. When reimplanting the ureters to the ileal neobladder with a modified laparoscopic Y-shaped neobladder technique, the antiperistaltic portion is not terminal. Studies have shown that Hautmann ileal neobladder offers great urinary reservoir with a relatively high capacity, low pressure and adequate continence, offering comparable results with the other ileal neobladders regarding clinical, radiological and metabolic outcomes [20,21].

The intestinal mucosa undergoes significant atrophic changes when used for neobladder reconstruction, the ileal epithelium showing changes towards a colonic aspect with villous atrophy and increased number of goblet cells, with sialomucins being the most abundant secretory products as in normal ileum [22]. Therefore, progressive modifications occur in the cystoplasmatic structures involved in the absorptive processes, starting 3 months after surgery and almost totally completed after 1 year [23]. A study showed that N-acetyl-L-cysteine (NAC) could be useful to decrease the viscosity of the neobladder until the adaptation process to the urinary tract establishes, by facilitating the mucus evacuation [24]. For the patients in our cohort, washing the neobladder with mucolytics and the oral intake after they are no longer admitted in the hospital, helps the intestine to adapt to

the urine content and the suprapubic and urethral-neobladder catheters stay permeable. It is important to prevent clogging of the catheters as tension on the neobladder sutures is not desired. Even with these measures being taken, we had one case with mucus clogging of the ileal neobladder that was solved endoscopically. Anyhow, the postoperative use of mucolytics for washing the neobladder only after the first 48 h, may contribute to tightening the sutures of the neobladder.

The postoperative care and follow up, along with educating the patients about the implications of having a neobladder, contribute to obtaining the best oncologic and life quality results. The education of neobladder patients is an important factor for the complications that may appear. An active participation in treatment decision and a regularly follow up are connected to the patient quality of life with orthotopic neobladder [25].

In conclusion, a totally intracorporeal 3D laparoscopic approach raises the difficulty of the orthotopic ileal neobladder reconstruction, demanding a highly skilled and experienced surgical team. Choosing the optimal ileal reconstruction technique should be based on the gender and the surgical history of each patient, with modified Studer ileal neobladder being best suited for functional results and modified Y-shaped neobladder technique preferred in selected cases of shorter ureters. Selecting the ileal loop with the highest mobility to the lower pelvis, and also the optimal length which is longer than 20 cm and with arterial bleeding from the marginal cuts provides the best surgical results regarding minimal digestive tract related complications.

Conflict of interests

The authors declare no conflict of interests.

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