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The Robotic Intracorporeal Vesuvian Orthotopic Neobladder (VON)—A New Technique for Continent Urinary Diversion: Initial Experience and Description of the Technique

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Abstract: Orthotopic neobladder reconstruction is becoming an increasing option as a urinary diversion following cystectomy for bladder cancer. The purpose of the following article is to describe, step-by-step, our technique for the robotic intracorporeal neobladder, the Vesuvian Orthotopic Neobladder. The primary aim of this new surgical procedure is to simplify and speed up the reservoir reconstruction, while at the same time obtaining an appropriate reservoir capacity. The Vesuvian Orthotopic Neobladder was performed employing an intestinal tract of 36 cm which was successively shaped in order to form a reservoir with three horns (left, right, and caudal), formed via the use of a mechanical stapler. Both ureters were stented and anastomosed to the left and right horn while the urethral-neobladder anastomosis was performed with the caudal horn. In this initial experience, two male patients with non-metastatic muscle-invasive bladder cancer underwent radical cystectomy followed by Vesuvian Orthotopic Neobladder reconfiguration. The mean age was 58.5 ± 3.53 years while the mean overall operative time was 435 ± 35.35 min, with an average neobladder reconstruction time of 59 ± 4.24 min. No intraoperative or postoperative complications were reported. The new intracorporeal Vesuvian Orthotopic Neobladder technique is a feasible and good alternative to traditional robotic intracorporeal orthotopic bladder procedures, permitting us to reduce operative time and obtain a neobladder with a fair reservoir capacity.

Keywords: neobladder; robotic surgery; bladder cancer; urinary diversion; Vesuvian Orthotopic Neobladder

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1. Introduction

Bladder cancer (BC) is the 11th most common cancer worldwide and the second most common urologic malignancy, accounting for 81,200 new cases and 17,100 deaths per year, representing, alone, 3% of global cancer diagnoses [1]. BC shows a marked male predominance, being over four times more common in men than in women and accounting as the seventh most common cancer worldwide in men [2]. Although the incidence of this disease seems to have decreased in recent years due to lower exposition to well-known occupational factors (such as toluene, chloroaniline, and polyaromatic hydrocarbons), it still remains higher and growing in smokers and the elderly. Indeed, up to 50–65% of BC cases are estimated to be attributable to tobacco smoke, which represents the most established risk factor, while over 90% of cases are diagnosed in people over 55 years, with an average age of diagnosis of 73 years [3–5]. The vast majority of BCs are of urothelial origin (90%) while other subtypes such as the squamous cell and adenocarcinoma are uncommon

and account for 2–5% and <2%, respectively, of the remaining cases [6]. According to the degree of invasion of the muscle layer, BC can be broadly divided into non-muscle-invasive bladder cancer (NMIBC) and muscle-invasive bladder cancer (MIBC), with the first one representing up to 75% of diagnosed bladder tumors [7]. If transurethral resection of the bladder (TURB) represents the standard treatment of NMIBC, radical cystectomy (RC) with urinary diversion and lymph node dissection is instead the recommended treatment recommended for patients with non-metastatic MIBC or for selected patients with high-risk NMIBC [8,9]. Open RC with extended pelvic lymph node dissection is the most commonly used approach, albeit the procedure is associated with high morbidity, increased blood loss, and longer recovery time, even at high-volume centers [10]. In this panorama, laparoscopic and robot-assisted RC could reduce blood loss and hospital stay while contextually improving surgical vision and precision [11]. In particular, robotic surgery has become a mainstay of practice in urology in the last few years. The removal of the bladder is, however, a life-changing procedure that could severely impact the quality of life of patients affected [12]. As result, the subsequent step after RC is to determine the best way to divert urine, also taking into account the quality of life of patients affected, which could be either non-continent or continent [13]. The type of urinary diversion performed depends on the patient's and surgeon's preference as well as the characteristics of the first, and has to consider a series of variables which could influence the reconstructive surgery of the urinary tract [14]. Patient-unique and disease-specific factors have to be analyzed in order to ensure the best and most appropriate urinary diversion, performing a thorough counseling aimed to assess the patient's desire, expectations, dexterity, and motivation [15]. In the last years, a wider evolution of surgical techniques, as well as technological innovations (such as the increasing use of robot-assisted surgery), have permitted us to diversify the reconstruction following RC from simple means of diverting urine to techniques allowing normal and continent voiding patterns through the intact native urethra, considerably improving the outcomes on patients' quality of life [16]. Among continent urinary diversions, the orthotopic urinary neobladder is becoming an increasingly common choice after RC, in recognition of several benefits related to the presence of a continent, intracorporeal, urinary reservoir. As reported by several studies, the quality of life of patients with orthotopic urinary neobladder is higher than those with other types of non-continent urinary diversions (such as the ileal conduit or the ureterocutaneous stomy) yielding an improved self-confidence and restoration of professional, leisure, and social activities [17,18]. Nevertheless, patients desiring an orthotopic neobladder have to be motivated and conscious that a timed voiding regimen is needed after surgery and that clean intermittent catheterization could be necessary if needed (up to 10% of patients requires intermittent catheterization to adequately empty their neobladders), as well as of other potential complications ranging from electrolyte disorders to metabolic disorders [19]. Due to these premises, relatively few contraindications are reported for the construction of an orthotopic urinary neobladder after RC, such as chronic renal insufficiency, extensive pelvic involvement of the disease, urethral stricture, or involvement with cancer, enteric disease, neurological disease, hepatic dysfunction, and impaired dexterity, while the suitability of the procedure has to be considered in patients with advanced age or prior pelvic radiotherapy [20,21]. Since the first totally intracorporeal robot-assisted ileal orthotopic neobladder performed by Beecken et al. in 2003, the use of the ileum or colon for continent urinary diversion have become a mainstay technique with several surgical variants that have been developed, such as the FloRIN, the intracorporeal Padua Ileal neobladder, the Hautmann neobladder, the Studer pouch, and the "Y" pouch [22–26]. All those techniques had a similar goal: exploit the possibility to detubularize and successively shape the interested bowel for the reconstruction of a spherical reservoir, which permits lowering the intraluminal pressures and obtaining a good capacity reservoir, in accord to the Laplace law [27]. Furthermore, the reservoir should also have the capability to expand to allow volitional emptying in intervals short enough to avoid metabolic consequences (related to the reabsorption of urine) but long enough to permit social continence [28]. Nevertheless, despite the variety

of surgical procedures for the construction of orthotopic urinary neobladders and the extensive experience with these techniques, there is no current consensus on which reservoir configuration provides the best results [29,30]. Furthermore, despite the advantages and the benefits associated with intracorporeal continent urinary diversions, the orthotopic neobladder remains a challenging and difficult procedure with its robotic counterpart, which is deemed among the most challenging, difficult, and time-consuming procedures, burdenend by a steep learning curve and potentially considerable complication rate [31,32]. For these reasons, as reported by the International Robotic Cystectomy Consortium, the use of intracorporeal urinary diversion has increased from 9% in 2005 to 97% in 2015 with, in particular, a significant increase for ileal conduits (2% in 2005 to 81% in 2016) compared to the intracorporeal neobladder (7% in 2005 to 17% in 2016) [33]. Due to these premises, the aim of our article is to describe, for the first time, a new robotic, totally intracorporeal orthotopic neobladder technique, which was inspired by a previously described open technique, aimed to simplify and speed up the reconstruction of the neobladder through a practical and easily reproducible procedure called Vesuvian Orthotopic Neobladder (VON) [34].

2. Materials and Methods

2.1. Preoperative Assessment and Inclusion/Exclusion Criteria

Patients affected by non-metastatic muscle-invasive or high-risk non-muscle-invasive bladder cancer and fit for orthotopic neobladder, considering age, life expectancy, comorbidities, and patient preferences, were considered suitable for the procedure. Exclusion criteria were locally advanced cancer, hydronephrosis, renal or liver function impairment, and inflammatory bowel disease. All patients had preoperatively assessed stage N0M0 BC and underwent a standard routine preoperative work-up, consisting of chest-abdominal CT scan, blood exams, and cardiological assessment. All cases were previously discussed by a multidisciplinary team which included a urologist, oncologist, and radiotherapist. Written informed consent was obtained from all patients involved in the study. All data were prospectively entered into an institutional database. Particularly, overall operative time, bladder reconfiguration time, and hospitalization were analyzed. All procedure-related complications were recorded and classified according to the Clavien–Dindo score. Neobladder reconstructions were performed by the same surgical team to avoid bias related to differences in surgical skill or learning curve.

2.2. Port Placement and Patient Positioning

Robot-assisted radical cystectomy and lymphadenectomy were performed using the four-arm configuration Da Vinci robot (Intuitive Surgical, Sunnyvale, CA, USA). A standard six-port transperitoneal approach was used, with the patients positioned in a 30° Trendelenburg during the demolitive phase, successively reduced to 20–10° during the reconstructive phase, in order to improve bowel handling and tension-free urethroileal anastomosis [35].

2.3. Surgical Technique

As for the extracorporeal version previously described, the VON is constructed with 36 cm of the ileum, isolated about 15–20 cm from the ileocecal valve [34]. The neobladder configuration takes shape through the following ten steps:

1. Identification of the ileocecal valve and subsequent selection and measurement of an intestinal tract of 36 cm, 20–25 cm from the ileocecal valve.
2. Placement of three Vicryl 3/0 stay sutures at 6 cm, 18 cm, and 30 cm on the antimesenteric side of the selected intestinal tract in order to shape the reservoir in three horns: left, right, and caudal (Figure 1A).
3. Isolation of the mesocolon and resection of the intestinal tract selected. A side-to-side anastomosis, for the restoration of the intestinal continuity, is performed using a 60 mm mechanical stapler (SureForm®, Intuitive Surgical, Sunnyvale, CA, USA) (Figure 1B–D).

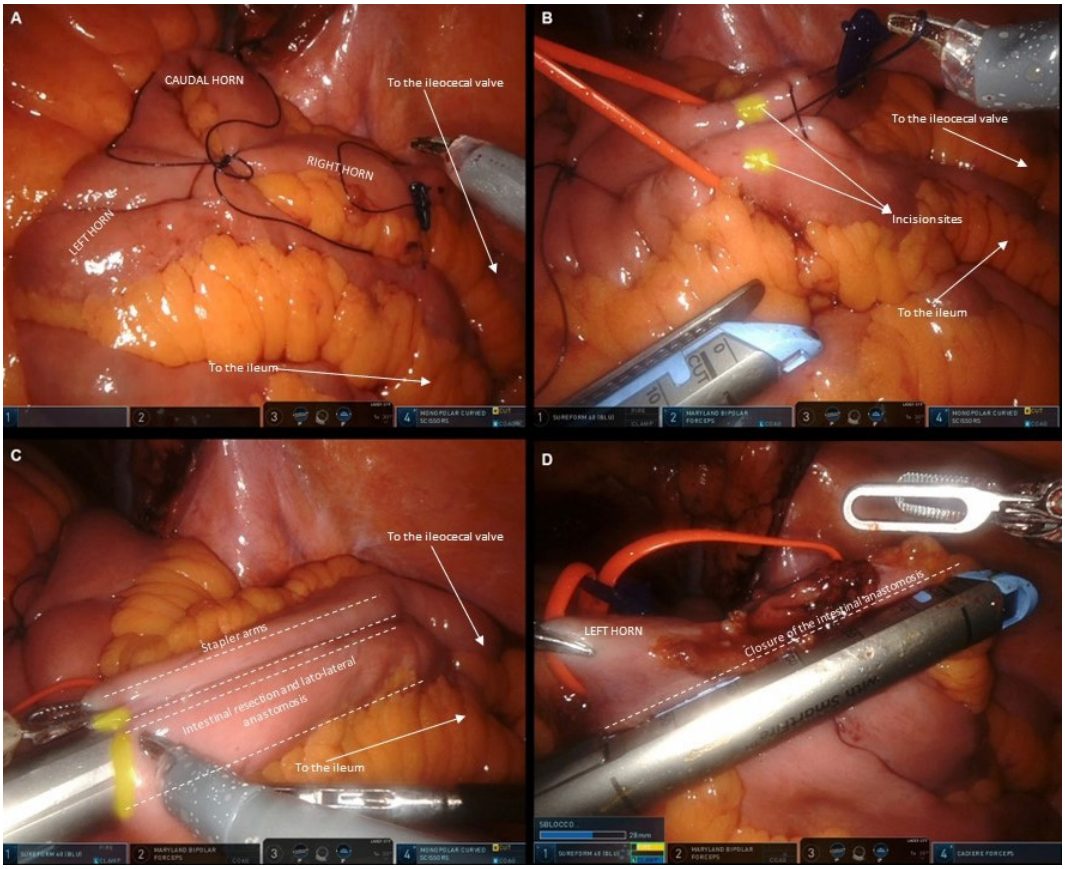

Figure 1. (**A**) Shaping the reservoir. (**B**–**D**) Intestinal resection.

4. Utilizing the opening in the intestinal tract resulting from the first anastomosis, another side-to-side anastomosis is performed in the lateral right horn, utilizing the 60 mm mechanical stapler in order to detubularize this intestinal tract (Figure 2A).
5. A 1.5 cm perpendicular incision of the intestinal tract is made at the level of the lateral left horn, in order to permit the introduction of the 60 mm mechanical stapler (SureForm®, Intuitive Surgical, Sunnyvale, CA, USA) and perform the detubularization of the lateral left horn, similarly as done before for the right horn (Figure 2B,C).
6. To avoid the incision of the caudal horn (in order to provide a narrow neck of the neobladder for the successive anastomosis with the native urethra), utilizing the detubularized lateral left horn, the 60 mm mechanical stapler (SureForm®, Intuitive Surgical, Sunnyvale, CA, USA) is introduced up to reach the caudal horn of the reservoir, to detubularize this tract. If an incomplete detubularization occurs, the process can be repeated in order to complete the detubularization (Figure 2D).
7. Ureters are incannulated with double J ureteral catheters, 7 mm × 260 mm, utilizing a guidewire if needed.
8. Incannulated ureters are anastomosed with the homolateral horns, using interrupted 3/0 Vicryl sutures (Figure 3A–C). This step can also be made after the neobladder-urethral anastomosis.
9. A small perpendicular incision of 1 cm is made at the apex of the caudal horn, to create the neck of the neobladder.
10. A Vicryl 3/0 suture is used to approach the posterior periurethral tissue, the Denonvillier fascia, and the posterior margin of the neobladder neck, similarly to Rocco's stitch used in radical prostatectomy. Finally, neobladder-urethral anastomosis is performed on a Foley 18F or 20F catheter with two continuous Vicryl 3/0 sutures (Figure 3D). The neobladder is then slowly filled with 100–150 mL of saline to confirm water tightness.

2.4. Postoperative Assessment and Care

The nasogastric tube was removed the day after the surgery, contextually to the feeding and mobilization of the patient. The abdominal drain was removed the second day after the surgery and patients were discharged 10 days after the surgery. A retrograde cystography was performed before discharge and on day 20 after surgery, prior to the removal of the urethral catheter if no urine leakage occurred (Figure 4). Bladder volume was evaluated by ultrasonography three months after the surgery. Day and night-time continence were defined as no pad use.

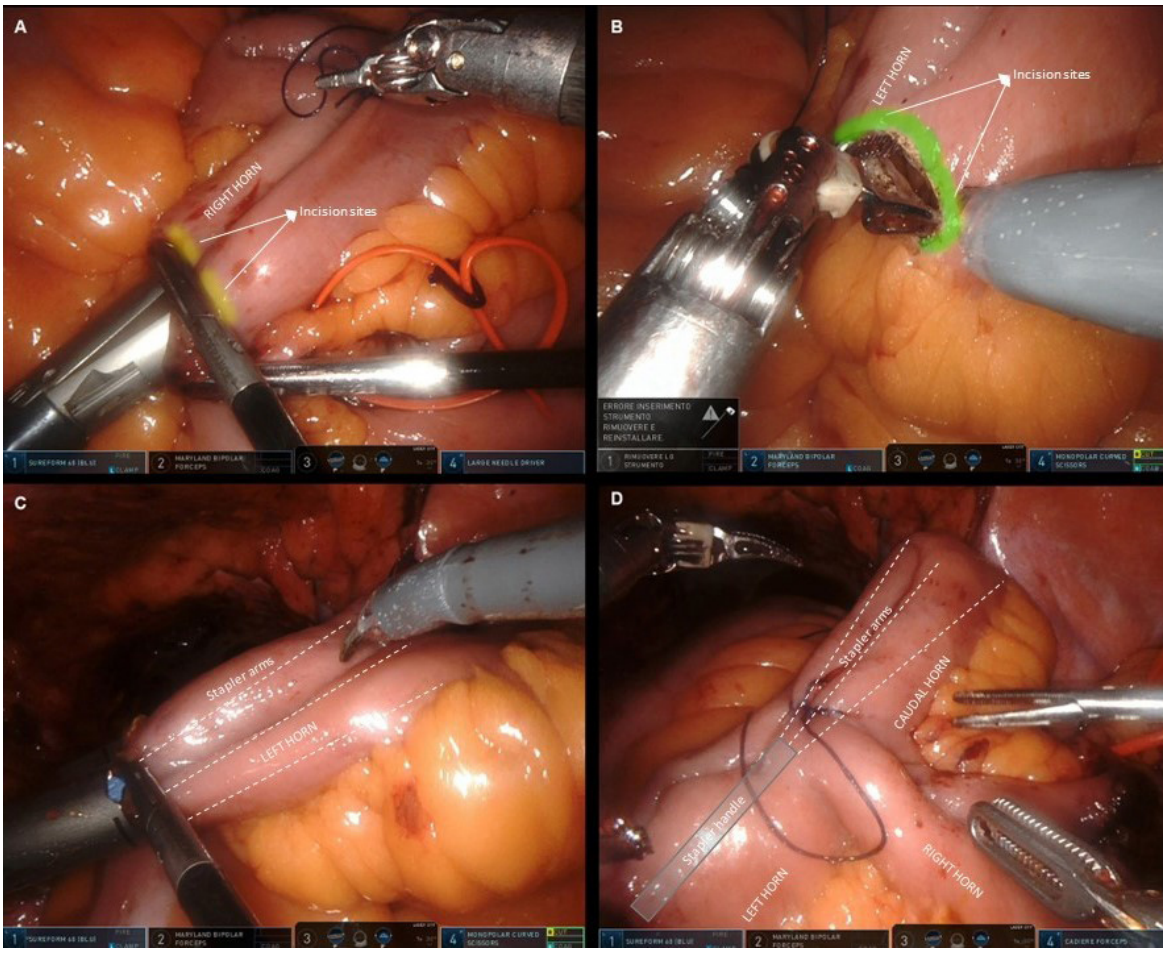

Figure 2. (**A**) Side-to-side anastomosis of the right horn. (**B**) Incision of the left horn. (**C**) Introduction of the stapler through the incision and anastomosis, producing a detubularized horn. (**D**) Through the same incision, the stapler is pushed toward the caudal horn to complete the detubularization of the intestinal tract utilized for the neobladder.

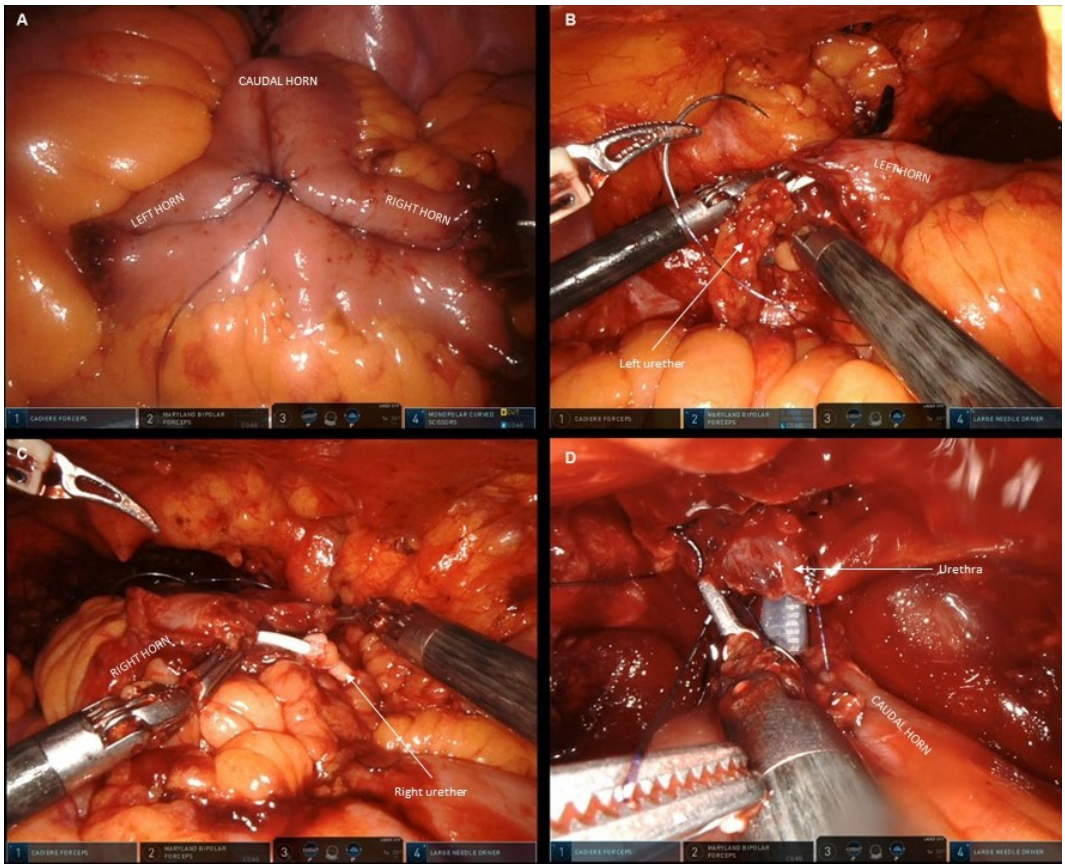

Figure 3. (**A**) Final shape of the neobladder prior to the ureteral and urethral anastomosis. (**B**) Anastomosis of the right ureter in the right horn. (**C**) Anastomosis of the left ureter in the left horn. (**D**) Anastomosis of the caudal horn to the urethra.

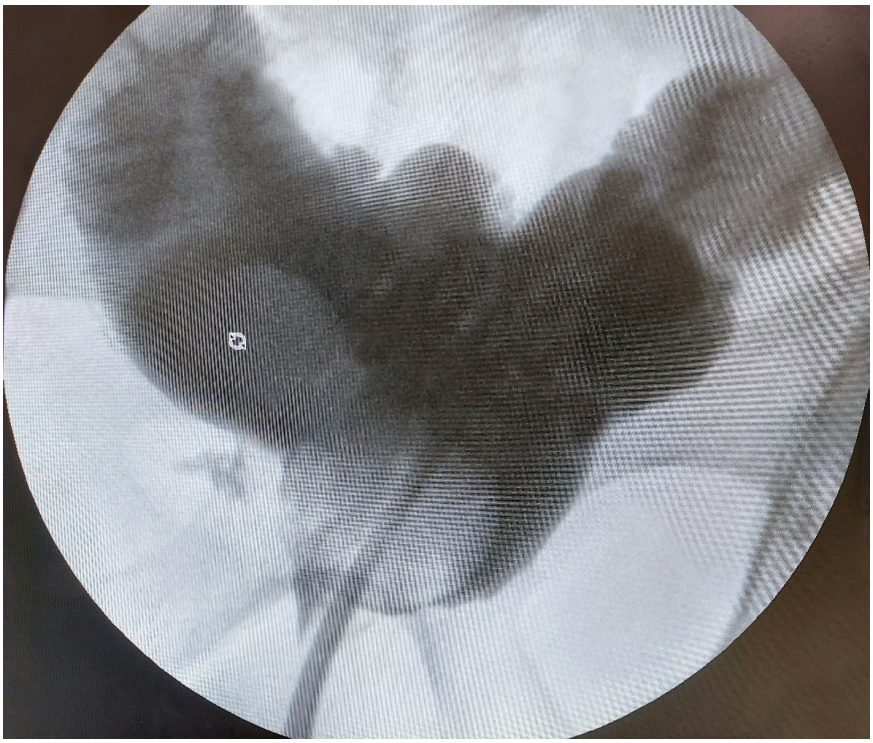

Figure 4. Postoperative cystogram performed before discharge.

3. Results

In this preliminary study, the VON was performed in two male patients affected by MIBC with a mean age of 58.5 ± 3.53 years, between September and November 2021. Both patients were suitable for the neobladder reconstruction, according to the inclusion criteria previously reported. The involved patients had no other significant comorbidities and neither underwent previous abdominal surgery. The mean overall operative time was 435 ± 35.35 min while the mean operative time for neobladder reconstruction was 59 ± 4.24 min. No intraoperative or postoperative complications were reported. The hospital stay was similarly uneventful and patients were discharged 10 days after the surgery. Successively, 20 days after surgery, a cystography was performed, showing no urinary leakage. The urinary catheter was therefore removed. Neobladder volume, measured at ultrasound scan after 3 months, reported a mean volume of 265 ± 21.20 mL.

4. Discussion

As reported by the European Association of Urology (EAU) guidelines, RC with urinary diversion is the standard treatment recommended for non-metastatic MIBC while is an advised option for high-risk NMIBC [8]. Despite the variety of urinary diversions, orthotopic neobladder represents the preferred option by patients undergoing RC due to a better-preserved quality of life compared to other types of urinary continent and non-continent diversions, and due to the presence of an intracorporeal urine reservoir which avoids the need for a stoma and is more socially accepted by the patient [36]. Nevertheless, bladder reconstruction after RC represents one of the most challenging and technically demanding procedures in the urologic field, independent of the chosen technique. In this regard, most surgeons still perform the reconstruction of the urinary diversion in an extracorporeal manner, especially for neobladder reconstruction, due to the prolonged operative times and steep learning curve of an intracorporeal procedure [32]. Despite the challenge and the difficulty of a totally intracorporeal bladder reconstruction, the increasing experience in robotic pelvic surgery, the simplified suturing inherent to wristed instruments, the superior ergonomics, and the high-definition visualization, in addition to the possibility to limit the manipulation of the bowel (potentially avoiding the complications related to this issue), have greatly contributed to maintaining the totally intracorporeal bladder reconstruction as an appealing procedure [37]. Based on the literature, the ideal reservoir should have adequate capacity, low-pressure storage, absence of reflux, and high compliance to help continence while permitting voluntary emptying at convenient intervals, without residual urine. To obtain all these characteristics, the spherical reservoir has been evaluated as the best choice, due to the possibility to contain higher volumes at lower intraluminal pressures while contextually limiting the surface area and the potential issues related to the electrolyte exchange [19]. Nevertheless, a spherical reservoir with a large initial volume would not be associated with better continence rates and could instead be more prone to developing progressive enlargement, leading to atony and emptying failure [38]. The choice of orthotopic urinary neobladder shape and technique (among the many existents) is, however, based on surgeon preferences, experience and technical ease of performance, aiming to obtain the optimal reservoir. As previously reported, the creation of urinary diversion after robotic RC is considered the most challenging step of the entire surgical procedure. As result, in the majority of centers, the extracorporeal urinary diversion is the preferred choice due to the perceived difficulties with the intracorporeal bowel reconfiguration as well as the concerns regarding the time efficiency [39]. The objective pursued with our technique, i.e., the VON, was to obtain a reservoir which had all the previous characteristics while being easy and quickly reproducible for surgeons without an apical experience in intracorporeal bladder reconstruction. Compared to other techniques, our technique is easier and simpler and optimizes the final volume obtained with the same ileal loop length used, due to a complete detubularization [40]. Another interesting point of our technique is the absence of an antiperistaltic intestinal tract, as both ureters are anastomized in two completely detubularized horns [41]. A further

advantage of our technique is also related to the ipsilateral anastomosis of ureters, which are anastomized in two different positions (as for the Padua Ileal Bladder or the Y-shaped neobladder), as well as the lack of ureteral crossing or excessive manipulation to reach their definitive position. In this manner, the anatomical location is preserved and the neobladder is symmetrically allocated in the small pelvis, in a true orthotopic position, reducing the manipulation of the neobladder and the ureters to the minimum. Considering that the time-consuming procedure in robotic and laparoscopic surgery is suturing, the use of mechanical staplers in our technique greatly facilitates the procedure and significantly reduces the operative time. Compared to other techniques (such as the Y-shaped and the W-shaped Hautmann, the Studer pouch, or the Padua Ileal Bladder), our approach offers the advantage of being completely done with the use of staplers, avoiding the manual sewn of the intestinal tract, reducing intestinal manipulation as well as the operative time while providing a more standardized procedure [22,42]. In this way, the procedure presents only two critical time-consuming points which are the correct measuring of the intestinal tract to be resected (which would result otherwise in asymmetrical horns) and the correct insertion of intestinal loops into the arms of the mechanical staplers in order to achieve a complete detubularization. In this regard, those points could be further improved in order to reduce the operative time required to construct the described neobladder. Despite some authors having documented the detrimental effects of staples in the urinary tract, recent studies have reported how the rate of stone formation was comparable to that reported in the literature for hand-sewn ileal reservoirs [43,44]. In addition, the possibility to use biodegradable and absorbable staplers in the future could eliminate this eventuality [45]. We believe that our results will encourage the use of staplers more frequently for the intracorporeal robotic neobladder approach and, as previously reported, improve the standardization of the procedure. As reported in the literature, despite trends toward the centralization of robotic radical cystectomy and orthotopic neobladder reconstruction at high-volume centers, in order to improve the experience with this procedure, population-based studies have shown a decreasing utilization of orthotopic urinary diversion among patients undergoing radical cystectomy with up to 85.5% of patients who underwent an incontinent diversion [46,47]. Considering the advantages associated with orthotopic neobladder and the decreasing and concerning the trend of similar procedures being performed, it should be imperative to increase the number of urinary continent diversions, overcoming the limitations related to the intracorporeal reconstruction and the steep learning curve of the surgical technique [48]. The idea underlying the VON, both in its open and robotic intracorporeal approach, was to simplify the surgical technique and lower the learning curve, permitting us, therefore, to increase the number of procedures performed. A simpler and standardized technique could indeed extend the number of procedures to different centers facilitating, in addition, the diffusion of orthotopic neobladder reconstruction in non-high-volume centers. We are conscious that a larger sample size, as well as a longer follow-up, are required to properly evaluate this technique, albeit the satisfactory results obtained with our open technique could represent a first step in this direction [34]. More robust data could be obtained from a larger series with a longer follow-up, also permitting us to consider oncologic and functional outcomes. Finally, although the non-spherical configuration of our technique could be considered a restriction since the spherical configuration is considered the ideal shape for maintaining a good storage volume, it should also be emphasized that despite our neobladder being packaged with 36 cm of ileum—a measure among the shortest used for neobladder packaging techniques—the volume obtained is excellent, between 250 and 290 cc (which is not dissimilar from the volume obtained in the FloRIN), and could reach 400–500 cc due to the expansion of the reservoir in time [23,49]. Further studies are required to assess the functional outcomes of the VON, requiring a thorough urodynamic examination as well as a proper evaluation of day and night-time continence.

5. Conclusions

In recent years, the wide use of orthotopic neobladders has led to the development of several types of bladder reconstruction techniques, aimed to create the "ideal" neobladder while contextually reducing the rate of major complications. The new Vesuvian Orthotopic Neobladder technique is an appealing and feasible alternative to other longer and more complex orthotopic bladder procedures, offering the main advantages of speeding up the procedure and providing a standardized and simpler methodology of bladder reconstruction, using, furthermore, a shorter bowel length without sacrifice storage capacity. The ten surgical steps reported in this article can be considered a good starting point for additional surgical technique upgrades. More robust data, concerning the number of procedures and length of follow-up, are, however, needed to evaluate the oncological and functional outcomes.

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