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Surgery in Motion

Robot-assisted Supratrigonal Cystectomy and Augmentation Cystoplasty with Totally Intracorporeal Reconstruction in Neurourological Patients: Technique Description and Preliminary Results

Nuno Grilo [a,b,*], *Emmanuel Chartier-Kastler* [a], *Pietro Grande* [a], *François Crettenand* [b], *Jérôme Parra* [a], *Véronique Phé* [a]

[a] *Department of Urology, Médecine Sorbonne Université, Pitié-Salpêtrière Academic Hospital, Assistance Publique-Hôpitaux de Paris, Paris, France;* [b] *Department of Urology, University Hospital CHUV, Lausanne, Switzerland*

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Abstract

Background: Augmentation cystoplasty as a third-line therapy for neurogenic detrusor overactivity performed by an open approach has long been studied. Few laparoscopic and robot-assisted series have been reported.
Objective: To evaluate the feasibility, safety, and functional outcomes of completely intracorporeal robot-assisted supratrigonal cystectomy and augmentation cystoplasty (RASCAC) in patients with refractory neurogenic detrusor overactivity.
Design, setting, and participants: We identified all patients undergoing RASCAC, as treatment for refractory neurogenic detrusor overactivity, from August 2016 to April 2018.
Surgical procedure: RASCAC was performed in all cases using a standardized technique with the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) in a four-arm configuration.
Measurements: Perioperative data, and functional and urodynamic results at 1-yr follow-up were assessed. Statistical analysis was performed using Stata version 15.1.
Results and limitations: Ten patients were identified. No conversion to open surgery was needed. The median operative time was 250 (interquartile range 210–268) min, the median estimated blood loss was 75 (50–255) ml, and the median hospitalization time was 12 (10.5–13) d. The 30-d major complication rate was 10%. Two patients presented a late urinary fistula; in one of the cases, surgical revision was needed. In both cases, low compliance to intermittent self-catheterization was identified. At 1-yr follow-up, functional and urodynamic outcomes were excellent.
Conclusions: Robot-assisted augmentation cystoplasty has been shown to be safe and feasible, with a reasonable operative time and low complication rate in experienced hands. A higher number of patients and longer follow-up are, however, warranted to draw definitive conclusions.
Patient summary: In this report, we look at the outcomes of robot-assisted supratrigonal cystectomy and augmentation cystoplasty in neurourological patients. Perioperative, functional, and urodynamic results are promising. Further studies with a longer follow-up are needed to confirm these findings.

* Corresponding author. CHUV, Service dUrologie, Rue du Bugnon 46, 1011 Lausanne, Switzerland. Tel. +41 21 314 30 15; Fax: +41 21 314 29 92.
E-mail address: nuno.grilo@chuv.ch (N. Grilo).

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1. Introduction

The first line of treatment of neurogenic detrusor overactivity includes anticholinergic drugs [1] and then intradetrusor botulinum toxin A injections [2], combined with intermittent self-catheterization (ISC) [3]. In case of failure of previous conservative treatments and if ISC is still possible, augmentation cystoplasty can be considered in order to achieve continence by increasing the bladder capacity and improving bladder compliance, protect the upper urinary tract, and improve patients' quality of life and autonomy [4].

Supratrigonal cystectomy with augmentation cystoplasty consists in performing a partial cystectomy while preserving the bladder trigone, ureters, and urethra and then harvesting a segment of bowel, which is detubularized and sutured to the bladder trigone [5,6].

Nowadays, open surgery represents the prevalent, if not the sole, approach used to perform this intervention with limited experience in laparoscopic [7,8] or robot-assisted approach [9], and almost no previous reported experience of totally intracorporeal bladder reconstruction. Open augmentation cystoplasty has been reported to be a safe and effective procedure in neurourological populations in general, mostly in patients with a spinal cord injury. Currently, augmentation cystoplasty represents the third, if not the fourth, line of treatment in patients with overactive bladder [5,10] due to its invasiveness, irreversible character, and associated morbidity [11]. Despite this, it represents a valuable option with excellent functional results and level of satisfaction for spinal cord injury and other neurological patients [12,13]. In order to decrease the invasiveness and morbidity of this intervention, laparoscopic [8] and robot-assisted approaches [14] have been proposed, but few data exist on these types of experience. After the first description by Al-Othman et al [14], very few cases of robot-assisted supratrigonal cystectomy and augmentation cystoplasty (RASCAC) have been reported so far. However, robot-assisted radical cystectomy is an established procedure to treat bladder cancer, having shown similar results to open surgery [15]. The objective of this study was to report the feasibility and safety of a standardized technique of RASCAC with total intracorporeal reconstruction, and to report the perioperative and 1-yr functional outcomes obtained with this technique.

2. Patients and methods

2.1. Study population

Overall, 10 consecutive patients with refractory neurogenic detrusor overactivity were prospectively selected after providing written informed consent to undergo RASCAC in a French tertiary referral center from August 2016 to April 2018 (to ensure minimum 1-yr follow-up). All patients were followed by a multidisciplinary neurourology team comprising urologists, rehabilitation physicians, and dedicated nurses. The motivation and ability to perform ISC were evaluated thoroughly. The dataset included preoperative medical history of the patient, and intraoperative and follow-up data.

In this first phase of development of the technique, patients with no history of previous abdominal surgery were selected. Only patients able to perform ISC by the urethra were included. Patients who required a continent cutaneous urinary diversion were excluded and operated using an open approach. Any patient who needed additional procedures including bladder neck surgery was excluded from this initial experience. No other selection criteria were set.

All patients were admitted 48 h before surgery to receive two enemas and 2 l of an oral polyethylene glycol solution. All interventions were performed using a transperitoneal approach, in a center with extensive experience of open supratrigonal cystectomy and augmentation cystoplasty, and extensive experience of robotic surgery and robot-assisted radical cystectomy with total intracorporeal urinary diversion. Postoperative complications within 30 d were reported according to the Clavien-Dindo classification [16]. The primary endpoint was to assess the safety of RASCAC among neurological patients. The secondary endpoints were 1-yr functional outcomes and complication rate.

2.2. Surgical technique

The patient is placed in 30° Trendelenburg position, with the legs placed in lithotomy position as for robot-assisted radical cystectomy [17]. The first trocar is placed using the Hasson's technique about 5 cm above the umbilicus. The remaining trocars are placed under direct vision. Two 8-mm robotic trocars are placed on the right side and one on the left side. Two more trocars (one 12 mm and one 5 mm) are placed for the assistant surgeon (Fig. 1).

2.2.1. Step 1: access to the extraperitoneal space and dissection of the bladder dome

The intervention starts with a longitudinal incision between the umbilical ligaments to access the extraperitoneal space. Once the space is reached, the bladder is located and the bladder dome detached from the overlying peritoneum (Fig. 2).

2.2.2. Step 2: supratrigonal cystectomy

After complete detachment of the overlying peritoneum, the bladder dome is incised longitudinally and opened. At this point, the two ureteral orifices are located and a double J stent is inserted bilaterally in order to avoid any possible injury during the subsequent partial cystectomy (Fig. 3). If preferred, this could instead be performed by an endoscopic approach at the beginning of surgery. In our experience, inserting the double J stent during the supratrigonal cystectomy was easy to perform and allowed to spare time and additional endoscopic tools.

Finally, partial cystectomy is performed using monopolar scissors, leaving about 2 cm of detrusor around the bladder neck and trigone.

2.2.3. Step 3: bowel preparation

A 40 cm bowel is harvested in order to create the enterocystoplasty. No bowel wash is performed intraoperatively. A first incision of the bowel, using monopolar scissors, is performed 30 cm proximal to the ileocecal valve on its antimesenteric border. The bowel is connected to the posterior margin of the remaining bladder using a 3-0 Vicryl stitch. A second one is performed 20 cm proximal to the first incision, and the bowel is connected to the bladder in the same fashion as before (Fig. 4). This allows a better exposure for subsequent reconfiguration. At this point, the intestinal segment is divided 10 cm distally from the first incision and 10 cm proximally to the second one using an Echelon EndoGIA stapler (Johnson & Johnson, NJ, USA). The continuity of the small bowel is then restored through a laterolateral anastomosis performed with the same stapler.

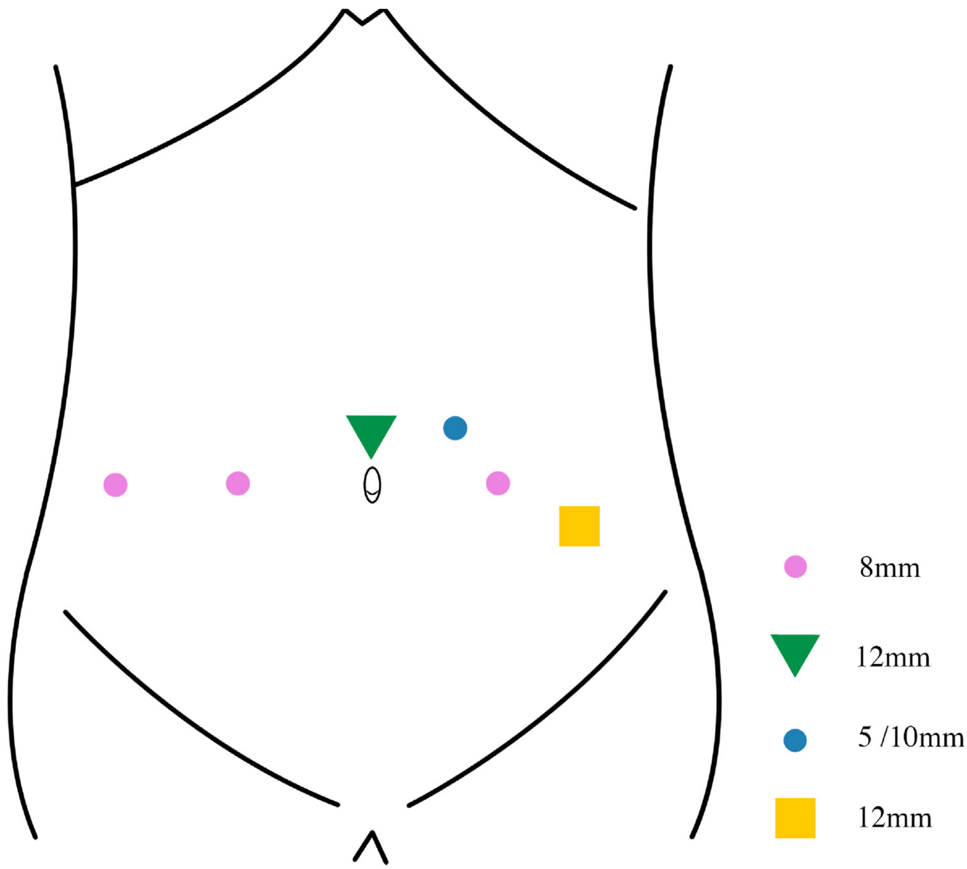

Fig. 1 – Trocar placement.

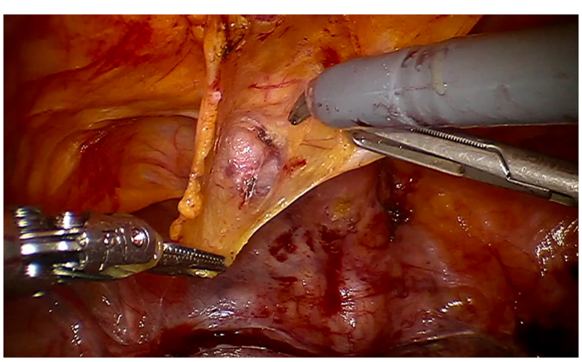

Fig. 2 – Peritoneum incision and vesicoperitoneal dissection.

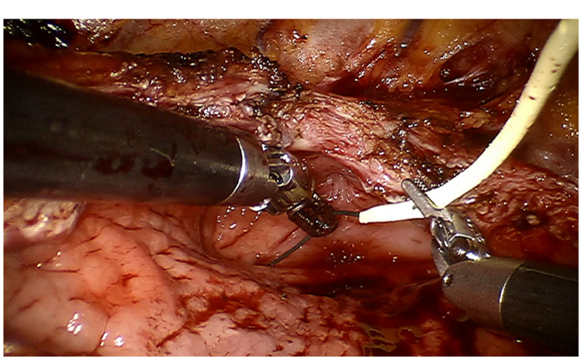

Fig. 3 – Double J ureteral stent insertion with a guide wire.

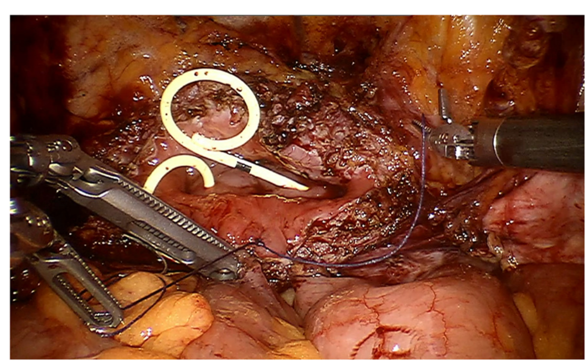

Fig. 4 – Connection of the bowel, not yet detubularized, to the posterior margin of the partially resected bladder. Two stiches are performed next to each other: one 10 cm proximal to the distal extremity of the ileal loop and another 20 cm proximal to the previous one.

2.2.4. Step 4: bowel detubularization and configuration of the enterocystoplasty

The bowel is configured in order to form a "W" shape (Fig. 5). Beginning with the two distal portions of the isolated bowel segment, detubularization is performed by an incision of the antimesenteric border with the exception of a 2 cm chimney on the top of the "W" (Fig. 6A). The suction device is used to guide the direction of the incision. One 3/0 V-lock suture is used to connect the distal segments of the "W" (Fig. 6B). Incision of the adjacent portion of the bowel is then performed, and this one is sutured

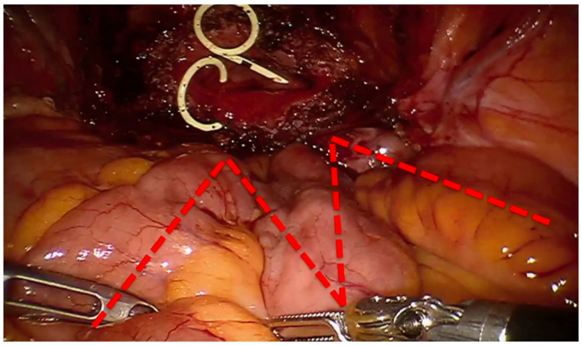

Fig. 5 – Ileal loop configuration in a "W" shape.

to the previous one in the same fashion. Lastly, the proximal portion of the bowel segment is opened with the exception of a 2 cm chimney, and the last suture is performed, achieving a W-shaped enterocystoplasty (Fig. 6C and 6D). We have since modified our surgical technique slightly and stopped keeping this 2 cm chimney.

2.2.5. Step 5: ileobladder anastomosis

An ileobladder anastomosis is performed by two running sutures on each side beginning from the posterior stiches applied previously (Fig. 7A and B). Before completing these sutures, and once there is no more risk of injuring the ureters, double J stents are removed. The intervention terminates with the closure of the peritoneum while relocating the enterocystoplasty extraperitoneally (Fig. 8).

2.3. Postoperative care and follow-up

A Blake drain is left in the pelvis at the end of the procedure and removed on the 2nd postoperative day (POD) if draining < 60 ml/d. A 22-French urethral catheter is left until the 12th POD, when the patient is instructed to restart ISC every 3 h. Nasogastric tube is usually removed after bowel movement relapse. A multidisciplinary team performs a first clinical assessment, 3 mo after surgery, followed by a 3-d voiding diary, complete urodynamic study, kidney ultrasound, assessment of renal function, and cystoscopy at 12 mo.

2.4. Statistical analysis

Categorical data were summarized as raw frequencies and group percentages. Differences in categorical data distributions between pre- and postoperative groups were assessed using the chi-square test. Continuous data were summarized as median and interquartile range (IQR). Differences in means between two groups were assessed using paired Student *t* test. A *p* value of < 0.05 was considered statistically significant. All statistical analyses were performed using Stata version 15.1 (StataCorp, College Station, TX, USA).

3. Results

The median (IQR) age of the patients was 44 (28–58) yr, and the median (IQR) body mass index was 23.5 (21.6–27.7) kg/m^2. The main indication for RASCAC was that in all the cases, refractory neurogenic detrusor overactivity was no longer responding to onabotulinumtoxin A. At the time of surgery, all patients were under onabotulinumtoxin A treatment, and six had concomitant antimuscarinic therapy. Only three patients were continent before the intervention. Further patient characteristics are reported in Table 1.

Perioperative outcomes are presented in Table 2. No conversion to open surgery was ever necessary. The median (IQR) operative time was 250 (210–268) min. Estimate blood loss was 75 (50–205) ml, and the median length of stay was 13 (10–14) d. The median (IQR) time to restart ISC was 12 (10.5–13) d.

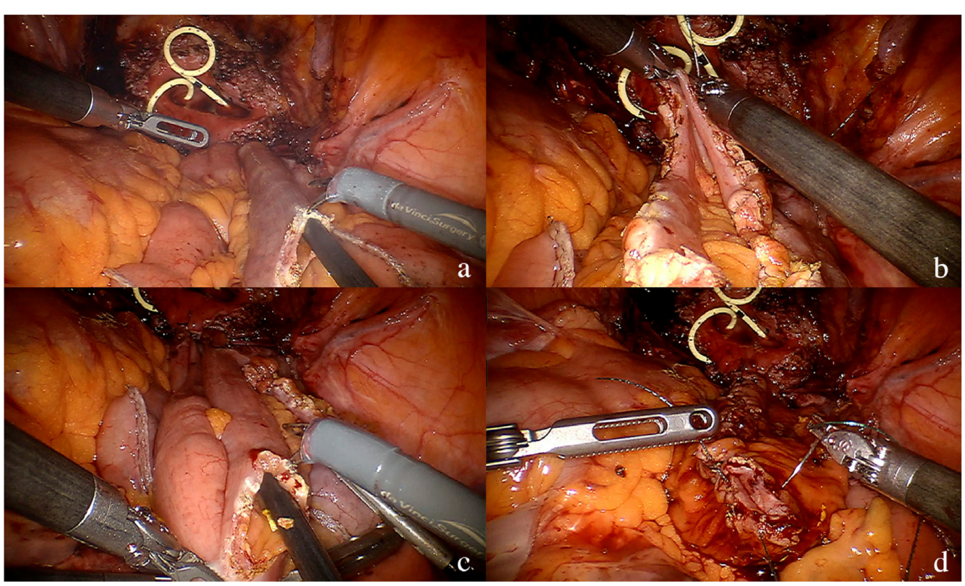

Fig. 6 – (A) Detubularization of the distal arm of the "W": An incision of the antimesenteric border of the bowel is guided by the suction device, sparing a chimney of 2 cm at the upper part of the "W". (B) After detubularization of both distal segments of the "W", a 3/0 V-lock suture is used to connect them. (C) Incision of the adjacent segment of the bowel is then performed, and this one is sutured to the previous one in the same fashion as before. (D) Proximal portion of the bowel segment is opened with the exception of a 2 cm chimney and the last suture is performed, achieving a "W"-shaped detubularized ileal loop.

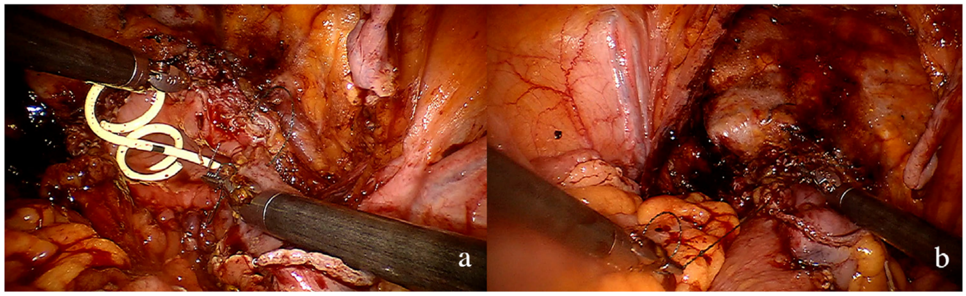

Fig. 7 – Ileobladder anastomosis: beginning at the previously applied stiches between the ileal loop and the posterior border of the partially resected bladder, anastomosis of the “W”-shaped ileal loop with the bladder is performed by two running sutures.

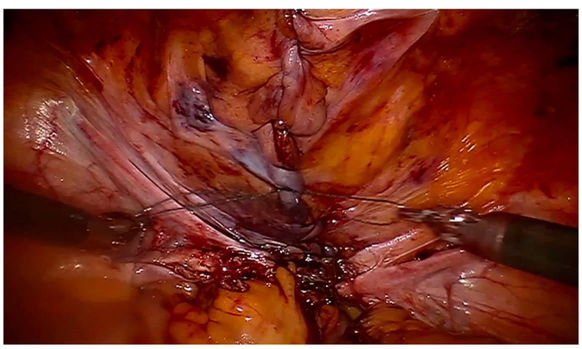

Fig. 8 – Ileocystoplasty is relocated in the extraperitoneal space and the peritoneum is closed.

Table 1 – Patients’ baseline characteristics

Variable	Total = 10
Age (yr), median (IQR)	44 (28–58)
BMI (kg/m^2), median (IQR)	23.5 (21.6–27.7)
ASA score, *n* (%)	
1	5 (50)
2	4 (40)
3	1 (10)
Gender, *n* (%)	
Male	7 (70)
Female	3 (30)
Duration of neurological disease (yr), median (IQR)	14 (11–17)
Neurological disease, *n* (%)	
Spinal cord injury (tetraplegy)	1 (10)
Spinal cord injury (paraplegy)	5 (50)
Myelitis	1 (10)
Strumpell-Lorrain disease	1 (10)
Neurosarcoidosis	1(10)
Devic's disease	1 (10)
Previous antimuscarinic therapy, *n* (%)	8 (80)
Previous onabotulinumtoxin A intradetrusor injections, *n* (%)	10 (100)
Number of onabotulinumtoxin A intradetrusor injections, median (IQR)	8 (5.75–11.5)
Creatinine clearance (ml/min/ 1.73 m^2), median (IQR)	119 (96.5–131)

ASA = American Society of Anesthesiologists; BMI = body mass index; IQR = interquartile range.

Table 2 – Perioperative outcomes

Variable	
Operation duration (min), median (IQR)	250 (210–268)
Hospitalization (d), median (IQR)	13 (11.5–14.8)
Estimated blood loss (ml), median (IQR)	75 (50–255)
Days to restart self-catheterization, median (IQR)	12 (10–13)
30-d postoperative complications, *n* (%)	
Clavien II (details)	3 (30)
Clavien IIIa (details)	1 (10)
Overall complication rate	4 (40)
Bowel function recovery (d), median (IQR)	5 (4–8)

IQR = interquartile range.

Four patients experienced complications at 30-d follow-up. Two patients presented a symptomatic lower urinary tract infection after removing the Foley catheter (Clavien II). One of these patients also had acute postoperative bleeding in the trocar site, requiring selective arterial embolization (Clavien IIIa). Paralytic ileus was observed in other two patients (Clavien II).

Subsequently, two patients presented a urinary fistula of the enterocystoplasty. In both cases, patients had low adherence to ISC: they forgot or stated being too busy to perform ISC, and presented with acute urinary retention. One occurred at 6 wk and was complicated by urosepsis requiring intensive care support. Definite management did not require additional surgery. The other patient developed a urinary fistula at 9 mo, needing surgical revision. Additionally, within a median follow-up time of 30 mo, three patients presented bladder stones, managed by cystolitholapaxy in an outpatient setting.

Regarding functional outcomes, all patients reported full continence at the last follow-up, while performing ISC as an exclusive voiding method. At 1-yr urodynamic evaluation, the mean maximum cystomanometric capacity increased significantly from 260 ml (95% confidence interval [CI] 135–380) to 515 ml (95% CI 415–615; $p < 0.01$). The mean maximum detrusor pressure decreased significantly from 51 cmH_2O (95% CI 33–70) to 19 cmH_2O (95% CI 14–25; $p < 0.01$). No hydronephrosis or de novo renal insufficiency was found. Other relevant urodynamic findings are summarized in Table 3.

Table 3 – Functional outcomes after robot-assisted supratrigonal cystectomy and augmentation cystoplasty with total intracorporeal reconstruction in neurourological patients

Variable	Preoperative	Postoperative	*p* value
Maximum cystometric capacity (ml), mean (95% CI)	260 (135–380)	515 (415–615)	0.003
Pdetmax (cmH_2O), mean (95% CI)	51 (33–70)	19 (14–24)	0.001
Detrusor overactivity, *n* (%)	7 (87.5)	2 (25)	0.012
Incontinence, *n* (%)	6 (75)	0	0.002
Poor bladder compliance, *n* (%)	5 (71)	0	0.003

CI = confidence interval; Pdetmax = maximum detrusor pressure.

4. Discussion

Our initial experience has shown that RASCAC is feasible and can be performed within a reasonable operative time, compared with even the previous combined approach (robotic and mini-laparotomy) [9]. Interestingly, the median operative time was very similar to our open series: 250 (210–268) versus 260 (230–300) min [18]. Considering that we are reporting the beginning of our learning curve on RASCAC, a further reduction in operative time is expected in the future.

Total intracorporeal ileocystoplasty by a laparoscopic approach was first described as early as 2002 [19]. However feasible, such an intervention is time consuming and technically challenging, mainly due to intensive suturing and intracorporeal tying. The advent of robot-assisted surgery led to specific benefits over the laparoscopic approach. Enhanced dexterity with EndoWrist technology allowing three-dimensional (3D) instrument mobility, magnified 3D image, removal of hand shaking, and motion scaling improved intracorporeal dissection and suturing greatly [20]. Thereby, the first total intracorporeal robotic ileocystoplasty was described back in 2008 by Gundeti et al [21]. They reported the case of a 10-yr-old patient with neurogenic bladder due to myelomeningocele. A clam-like augmentation ileocystoplasty and a Mitrofanoff diversion were performed successfully. To date, only three series of robot-assisted ileocystoplasty were published in adult patients [9,22,23]. From these, only two reported on total intracorporeal surgical technique.

This technique arises from our extensive experience on open augmentation cystoplasty [24], in order to standardize a minimally invasive approach. We believe that the standardization of this technique renders it reproducible, but previous surgical experience in both open augmentation cystoplasty and robotic surgery is necessary in order for this to be true. Since it was a novel technique, the surgery was performed, for the five first cases, by a dedicated team of surgeons, including a urologist highly experienced in robotic surgery (J.P.) and a surgeon who has vast experience in open supratrigonal cystectomy and augmentation cystoplasty, and is also experienced in robotic surgery (V. P.). Thereafter, the procedure could be performed by only one of the two surgeons assisted by a resident.

In our department, 630 robotic procedures are done per year, including 40 totally intracorporeal radical cystectomies for oncological diseases. Furthermore, during the period of this study, 40 augmentation cystoplasties were also performed by an open approach. In the authors' opinion, a team with good experience in both robotics and open augmentation cystoplasty should be able to overcome all technical problems of this surgical technique after a minimum of 10 procedures.

Nevertheless, even with extensive experience, augmentation cystoplasty is not devoid of complications [11,25]. In our series, we report trocar site bleeding, a well-known complication of minimal invasive surgery. The occurrence of urinary fistula due to bladder perforation is a rare complication that can happen even 2 yr after the intervention, with the most usual site being, understandingly, the junction between the bowel and the bladder wall due to ischemia [26,27]. In two of our patients, bladder perforations were located exactly on this site and were related to noncompliance to regular ISC in both cases. These results are consistent with those reported by Flum et al [23], with a similar rate of late bladder perforation. These complications highlight the absolute necessity of careful patient selection prior to surgery. Patient motivation should be evaluated thoroughly, and every patient should clearly be informed about the risk of severe complications in case of noncompliance to ISC.

Despite the reported complications, at the last follow-up, functional outcomes were excellent. All patients presented full urinary continence, and none of them presented renal function deterioration. One-year urodynamic results have shown, as expected, a significant improvement in bladder capacity and compliance, as well as a decrease in detrusor overactivity and maximum detrusor pressure. Functional results are comparable with those achieved with supratrigonal cystectomy with augmentation cystoplasty performed by an open approach [18].

This initial series demonstrates that, through standardization of the technique, results similar to open surgery are achieved. Customization of our preoperative care map is now needed in order to adapt to this less invasive approach that will surely allow a faster functional recovery, as observed by comparing open and totally intracorporeal robot-assisted radical cystectomy [28].

Despite promising results, safety, and feasibility of RASCAC, neurological patients have some specificity that should be addressed prior to surgery. For example, syringomyelia should be excluded with magnetic resonance imaging of the spine before any surgery with increased abdominal pressure, since this could lead to extension of the neurological lesion [29,30]. Furthermore, the presence of anatomic deformations such as severe scoliosis and past surgeries should be taken into account when deciding on the best surgical approach [31]. Careful patient selection and appropriate preoperative investigation are crucial for successful robotic surgery among these patients. This study has several limitations, including the small size of our cohort, the lack of comparative arm treated with an open approach, and the short follow-up.

5. Conclusions

Robot-assisted augmentation cystoplasty has been shown to be safe and feasible, with a reasonable operative time and low complication rate in experienced hands. A higher number of patients and longer follow-up are, however, warranted to draw definitive conclusions.

Author contributions: Nuno Grilo had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Grilo, Chartier-Kastler, Phé.
Acquisition of data: Grilo, Grande, Parra.
Analysis and interpretation of data: Grilo, Chartier-Kastler, Phé.
Drafting of the manuscript: Grilo, Crettenand, Grande.
Critical revision of the manuscript for important intellectual content: Chartier-Kastler, Phé.
Statistical analysis: Crettenand.
Obtaining funding: None.
Administrative, technical, or material support: None.
Supervision: Phé, Chartier-Kastler.
Other: None.

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Appendix A. Supplementary data

The Surgery in Motion video accompanying this article can be found in the online version at https://doi.org/10.1016/j.eururo.2020.08.005 and via www.europeanurology.com.

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