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ORIGINAL ARTICLE

Robotic parastomal hernia repair in Ileal-conduit patients: short-term results in a single-center cohort study

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Abstract

Purpose To describe and evaluate safety and feasibility of the robotic modified Sugarbaker technique with intraperitoneal underlay mesh (IPUM) for repairing parastomal hernias associated with ileal conduits (ICPSH).

Methods This retrospective, single-center cohort study analyzed data from 15 adult patients who underwent robotic ICPSH repair using the modified Sugarbaker IPUM technique between July 2021 and July 2023. The primary endpoints were hernia recurrence rates and 30-day morbidity. Secondary endpoints included length of stay, conversion to open surgery, 30-day readmission, and 30-day reoperation.

Results The mean patient age was 69.1 years, and 53.3% were female. Most patients (86.6%) had undergone radical cystectomy as the index surgery. The mean operative time was 249 min, with no conversions to open surgery. The 30-day complication rate was 26.7%, and the mean hospital stay was 3.6 days. No hernia recurrences, hydronephrosis, rise in creatinine or distended conduit on imaging suggesting poor drainage were observed during a mean follow-up of 15.2 months.

Conclusions The robotic modified Sugarbaker IPUM technique appears safe and feasible for PSH repair in IC patients, with promising short-term outcomes. Further studies with larger cohorts and longer follow-up are needed to confirm its long-term efficacy and establish its role in ICPSH management.

Keywords Robotic surgery · Minimally invasive surgery · Parastomal hernia · Ileal conduit · Sugarbaker

Introduction

Despite the growing popularity of orthotopic neobladder substitution, ileal conduit (IC) remains the most common urinary diversion performed following radical cystectomy [1–4]. One of the most common postoperative sequelae of IC construction is parastomal hernia (ICPSH) development. ICPSH has a reported occurrence rate of 17.1% [5]. In a recent systematic review, all patients undergoing an ileal conduit urinary diversion were evaluated for the occurrence of ICPSH based on symptoms, clinical exam, or based on radiographic findings. The proportion of patients diagnosed based on symptoms and exam ranged from 4.1% up to 27.6% across studies. Cross-sectional imaging has a higher sensitivity for small, asymptomatic ICPSH with a detection rate as high as 35.4% [5]. In two more recent series, the ICPSH rate was reported to be 30% [6] and 68.2% [7]. Symptoms of ICPSH can include abdominal discomfort or pain, intestinal obstruction, urinary obstruction, urinary leakage caused by poor appliance fit, and skin irritation [8]. Several factors, including advanced age, obesity, female gender, malnutrition, and previous laparotomy, have been linked to ICPSH [9–13]. Thus, ICPSH is a significant cause of morbidity and compromised quality of life in patients following IC construction.

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Multiple approaches to parastomal hernia (PSH) repair for both intestinal and urinary conduits have been previously described with varying success rates [14]. Primary hernia repair is associated with nearly 100% recurrence and should be avoided [15]. Relocation of the IC is a challenging option but is associated with a similar risk of PSH development as the index operation [16]. Numerous studies have demonstrated that PSH repair with a mesh offers the most durable repair option [17]. Similar to abdominal wall hernia repair, prosthetic meshes are used in PSH repair to reduce hernia recurrence rate. PSH repairs using mesh, either synthetic or biologic, placed as an on-lay, within the abdominal wall, or as an intra-peritoneal sublay have been described [18]. One of the intra-peritoneal sublay approaches with the lowest recurrence rate is the Sugarbaker repair [19], which includes reduction of the hernia content, lateralization of the ileal conduit to the trephine edge, and covering of both the trephine and the stoma bowel loop with an intraperitoneal mesh, sutured to the trephine defect edge. Later modifications of the procedure included closure of the defect with more extensive lateralization of the stoma bowel loop and at least 5 or more cm of mesh overlap around the trephine and lateralized stoma loop of bowel. Both laparoscopic and robotic approaches to this technique have been described [20, 21].

The recurrence rate after the repair of ICPSH has been reported to vary widely, ranging from 0 to 30% [12, 22, 23]. These variations are attributed to factors such as the chosen approach (open, laparoscopic, or robotic), the repair technique employed (such as Sugarbaker, Keyhole, and Sandwich techniques), and the duration of the follow-up period [24–30]. Most of the published studies focus on end ileostomy or end colostomy, with lacking data regarding the robotic ICPSH repair. This series, conducted in a single center, by a single surgeon seeks to better inform the literature by reporting the outcomes achieved through the utilization of the robotic modified Sugarbaker with intraperitoneal underlay mesh (IPUM) in r-ICPSH (robotic ileal conduit parastomal hernia) repair.

Methods

This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement guidelines for reporting observational studies [31]. After Institutional Review Board approval (ID: 23-005902), data on all consecutive adult patients who underwent robotic parastomal hernia repair of ileal conduits between July 15, 2021, and July 7, 2023, were retrospectively identified from a prospectively maintained database of robotic-assisted procedures. Gathered data included: patients' characteristics such as age, sex, body mass index (BMI), ostomy type, and European hernia society classification grade based on CT scan, as well as intraoperative variables such as operating time, type of mesh used, estimated blood loss (EBL), rate of conversion to open surgery, and additional hernia repair. Finally, postoperative data including 30-day complications, length of stay (LOS), 30-day readmission, 30-day reoperation, follow-up duration, hernia recurrence, and short or long term hydronephrosis requiring intervention or rise in creatinine (defined as an increase in plasma creatinine of > 50% or > 26.5 μmol/L compared to last preoperative value within 24 h of surgery [32]) was collected.

The primary endpoints were hernia recurrence rates and 30-day morbidity; secondary endpoints were LOS, rate of conversion to open surgery, 30-day readmissions, and 30-day reoperation.

All the procedures were completed using the robotic Da Vinci® Xi Surgical System (Intuitive Surgical, Sunnyvale, California, USA).

Surgical technique [33]

Following the induction of anesthesia, the patient is positioned in a supine position with split leg extension. A Foley catheter is inserted into the ileal conduit. We do not routinely ask to place ureteral stents. However, in patients who have had multiple abdominal surgeries other than the conduit construction operation stents were placed by interventional radiology. Pneumoperitoneum is established after placement of a 5 mm Optiview trocar in the left upper quadrant. Three robotic 8 mm trocars e placed on either the right or left flank, opposite the ileal conduit (Fig. 1). An AirSeal™ trocar (ConMed, Utica, NY, USA) is positioned in the upper quadrant to ensure continuous CO2 insufflation, smoke evacuation, and acts as an assistant port for instrumentation and access for the mesh.

After adhesiolysis and identification of the ileal conduit and ureters (Fig. 2), the hernia content is reduced. If the contents of the PSH sac cannot be reduced robotically, the robot is undocked, and an incision into the hernia sac is made 3–4 cm lateral to the marked edge of patient's stoma appliance: we call this hybrid modification. This incision is made in the cranial-caudad direction and is 5–7 cm in length although it can be enlarged as needed. Once the hernia sac is entered, the content of the hernia sac is reduced under direct vision. In cases where the stoma limb of bowel needs to be re-oriented, the stoma is disconnected at the skin level and the bowel limb is reoriented appropriately and the stoma is re-matured in the same location. Once the hernia has been reduced, the operation proceeds in a robotic fashion and the PSH defect is closed using a continuous 0 permanent barbed suture. It is also at this time that any midline

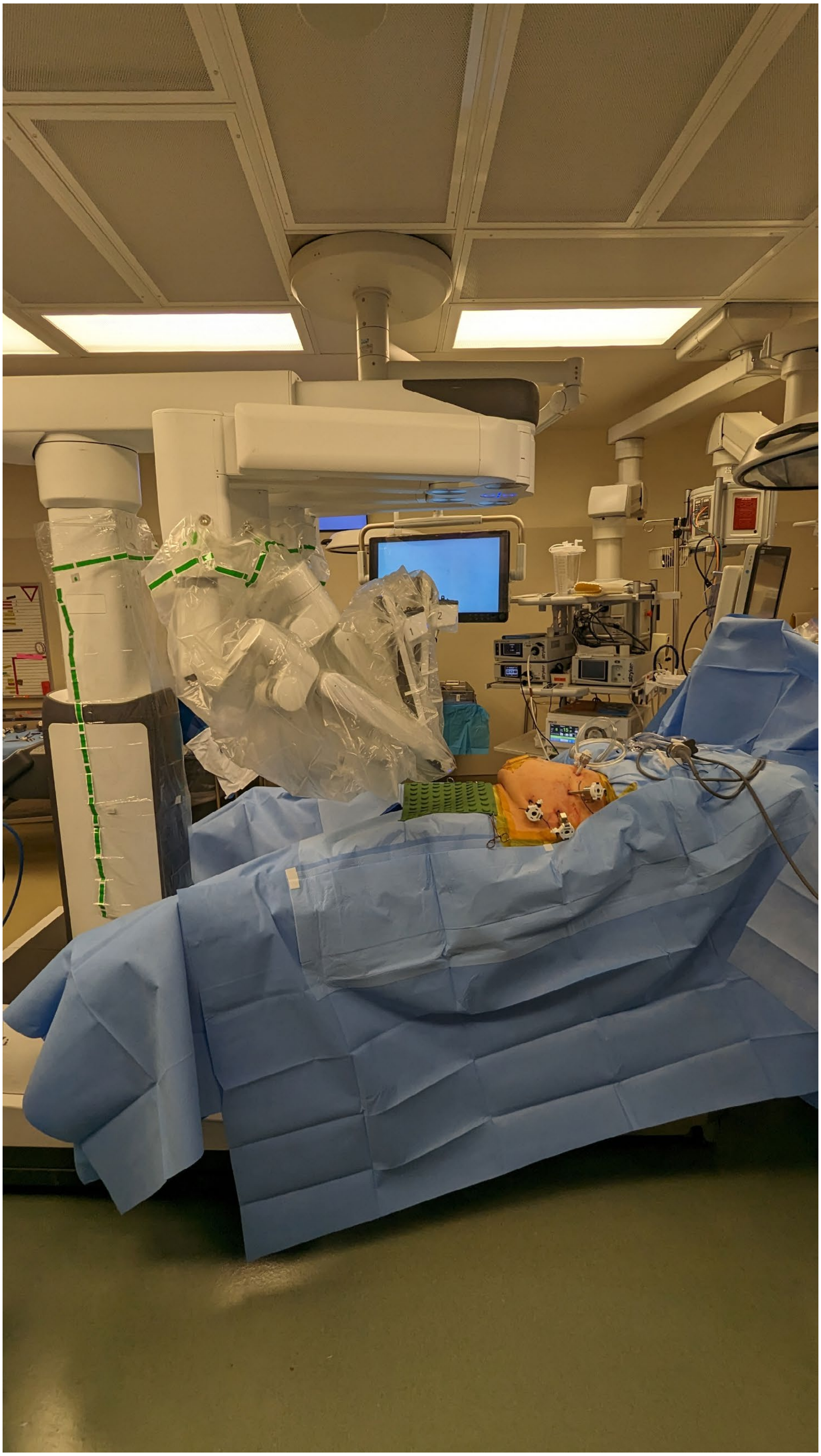

Fig. 1 Operative room set-up and trocar disposition

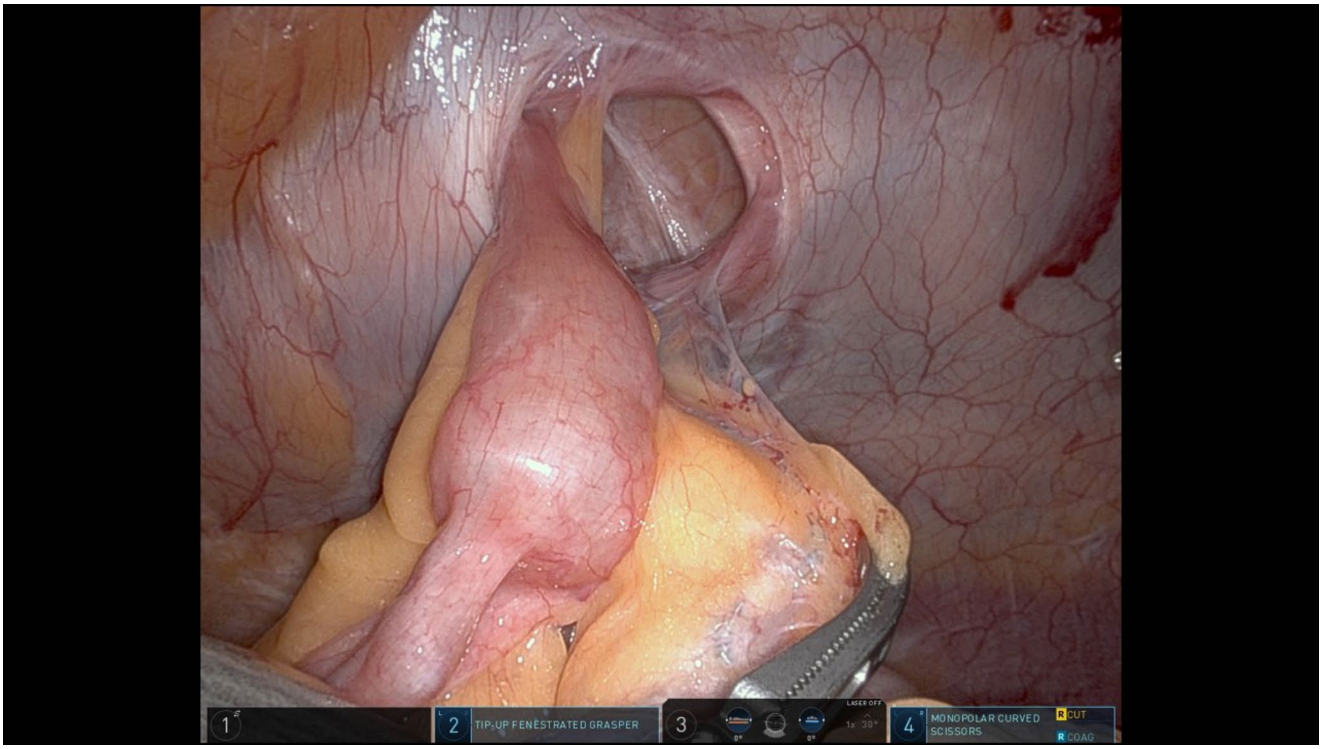

Fig. 2 Abdominal exploration and evidence of an ileal conduit with a parastomal hernia defect, with correct orientation of the stoma limb

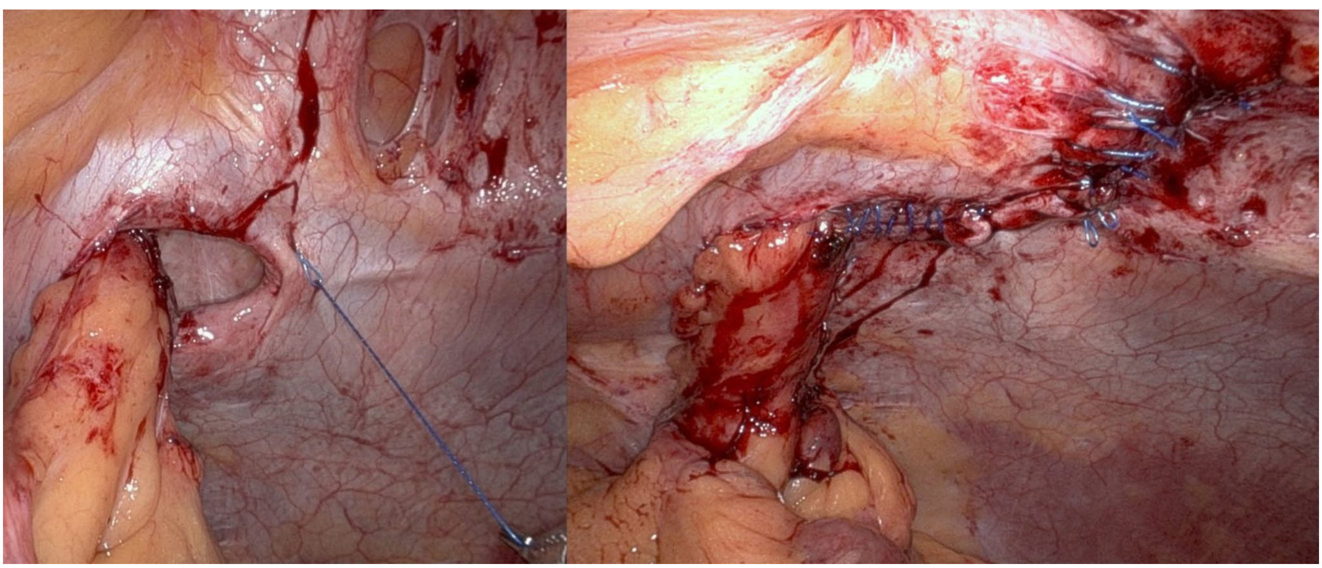

Fig. 3 Direct closure of the parastomal defect and of a concomitant midline hernia defect

hernia defects are closed with running permanent 0 barbed sutures (Fig. 3). Lowering the intra-abdominal pressure to 8–10 mmHg often facilitates the closure. Subsequently, the conduit is lateralized to the abdominal wall peritoneum for a length of 10 cm. The mesenteric edge at the interface with the bowel serosa is carefully secured to the peritoneum on both sides of the stoma bowel limb with two running non-absorbable 2 – 0 barbed sutures. This lateralization with the mesentery facing medially allows a large panel of composite mesh to be secured to the abdominal wall minimizing the stoma limb of bowel serosa contacting mesh that does not have a protective barrier (Fig. 4**).** Every effort is made to minimize mesh contact with the serosal surface of the bowel, including revising or reorienting the conduit so that the mesentery faces towards the mesh underlay. These running sutures cannot be too tight as it potentially can

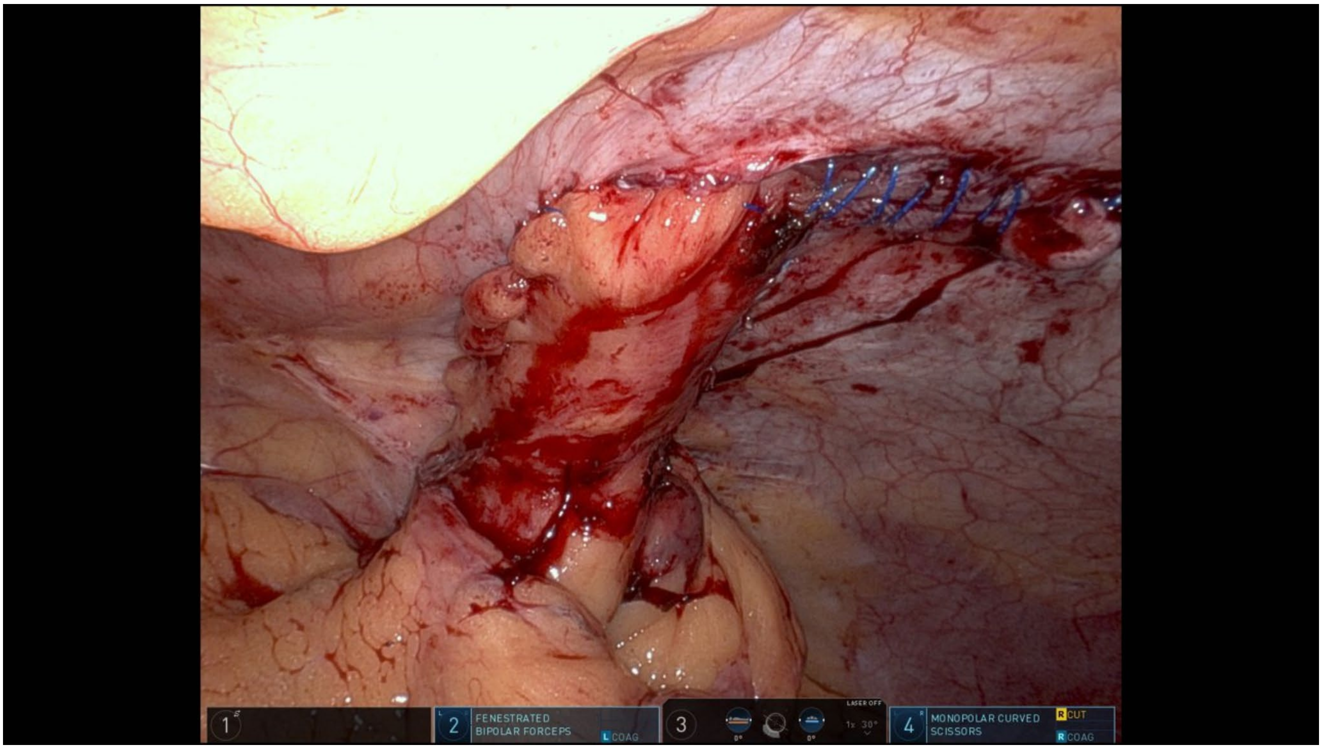

Fig. 4 Lateralized stoma limb, with a running non-absorbable 2 – 0 barbed suture on each side, with the mesentery facing the abdominal cavity

compress the limb against the abdominal wall resulting in an obstruction, and possible subsequent hydronephrosis. The repair then involves a modified Sugarbaker technique, where a large panel of mesh is placed as an intra-peritoneal underlay repair. The mesh is secured to the anterior abdominal wall using absorbable laparoscopic tacks in combination with continuous permanent 0 V-lock sutures around the circumference of the mesh. (Fig. 5). We aim to achieve an optimal mesh overlap of 7–8 cm from either the stoma trephine or the edge of the defect closure line. This criterion guides our selection of mesh size. When a midline hernia defect is addressed concurrently, a single sheet of mesh is used for the PSH and midline hernia repair. The choice of mesh typically hinges on institutional supply and ultimately falls to the discretion of the operating surgeon. However, the Parietene™ DS Composite Mesh, characterized by its macroporous barrier-coated design, including a barrier side, and developed by Medtronic in Minneapolis, MN, USA, emerges as the most commonly utilized option.

The barrier side is marked with a permanent surgical marker before the insertion of the mesh to ensure that the barrier side is secured to the abdominal wall facing the abdominal contents. At the conclusion of the surgery, it is mandatory to confirm that the patient has excellent flow of urine through the conduit without new distension of the intra-abdominal conduit.

Patient follow-up

Patient follow-up is important for at least 2 years after surgery, as hernia recurrences mostly occur within that time frame [34, 35]. Patients were seen in person or virtually every 3, 6 and 12 months in the first year, and annually thereafter. These assessments can also be performed using Telemedicine, according to the patient's preferences. Either CT urogram or loopgram were performed to assess uretero-ileal strictures prior to stent removal or if a creatinine rise was noted. In case of suspected recurrent hernia on clinical examination or based on patient symptoms, a CT scan is obtained. Additionally, in case of oncological history, patients underwent follow-up according to the relevant guidelines, including CT scans that were used to assess ventral hernia recurrences and hydronephrosis. Patient education about signs of hernia recurrence and its complications is also very important. Patients were advised to immediately contact our office if they had any signs or symptoms of hernia recurrence or changes in ostomy output or appliance dysfunction.

Statistical analysis

In this study, only descriptive statistics were utilized. Categorical variables are presented as numbers and percentages, whereas continuous variables are expressed as means

Fig. 5 Complete modified Sugarbaker repair, with running permanent 0 barbed sutures on the border of the mesh, combined with absorbable laparoscopic tacks. The mesh covers both the parastomal and the midline defect

Table 1 Patient demographics and preoperative characteristics

Characteristic	Patients ($n = 15$)
Gender, n %	
Female	8 (53.3)
Male	7 (46.7)
Age (years), mean ± SD	69.1 ± 10.2
Body mass index (kg/m^2), mean ± SD	31.6 ± 6.2
ASA, n %	
2	5 (33.3)
3	10 (66.7)
Number of previous repairs, n %	
0	11 (73.3)
1	3 (20.0)
2	1 (6.7)
Defect size, cm, mean ± SD	3.78 (1.4)
EHS classification, n %	
I	5 (33.3)
II	5 (33.3)
III	4 (26.7)
IV	1 (6.7)
Indication for surgery:	
Bladder carcinoma	12 (80)
Neurogenic bladder	2 (13.3)
Interstitial cystitis	1 (6.7%)

and standard deviations or median and interquartile range as appropriate. To assess the statistical significance of the difference in preoperative and postoperative creatinine levels, we utilized the Wilcoxon Rank-sum test.

Results

Fifteen patients were included, with the majority being females (8, 53.3%). Mean age at the time of surgery was 69.1 ± 10.2 years, mean BMI was 31.6 ± 6.2 kg/m^2. The underlying etiologies for cystectomy (reported in Table 1) included bladder carcinoma (12, 80%), neurogenic bladder (2, 13.3%), and interstitial cystitis (1, 6.7%). The most common index surgery reported was radical cystectomy (13, 86.6%), the others can be found in Table 2. The majority of patients in the study were categorized as ASA 3 (10, 66.7%), with the remaining classified as ASA 2 (5, 33.3%). A small number of patients had undergone previous hernia repair surgery, with most having undergone one prior procedure (3, 20%), and only one patient having had two previous attempted repairs (1, 6.7%).

Parastomal hernias were classified using the European Hernia Society (EHS) classification based upon preoperative CT scan, with the majority falling into class I (5, 33.3%) and II (5, 33.3%), followed by class III (4, 26.7%) and IV (1, 6.7%) [27]. The mean defect size of the hernias was 3.78 cm ± 1.40 cm. All the PSH were repaired using the modified Sugarbaker technique with IPOM as described above. Only one (6.7%) patient underwent a planned concurrent ureteral re-implant. Table 3 provides a comprehensive list of the meshes used in the series; the most common

Table 2 Intraoperative and postoperative outcomes

Characteristic	Patients ($n = 15$)
Operative time (minutes), mean ± SD	249 ± 63
Conversion to open, n %	0 (0)
Hybrid modality, n %	3 (20)
Estimated blood loss (ml), mean ± SD	62.7 ± 111
Intraoperative fluids (ml), mean ± SD	2346 ± 646
Additional hernia repair, n %	6 (42.9)
Length of stay (days), mean ± SD	3.6 ± 1.9
30-day morbidity, n %	4 (26.7)
Ileus, n %	3 (20)
Abdominal collection, n %	1 (6.7)
Creatinine rise or hydronephrosis, n %	0 (0)
Preoperative creatinine level (mg/dl), median (IQR)	1.19 (0.4)
Postoperative creatinine level (mg/dl), median (IQR)	1.15 (0.3)
30-day readmission, n %	3 (20)
30-day reoperation, n %	1 (6.7)
30-day recurrence, n %	0 (0)
Follow-up (months), mean ± SD	15.2 ± 7.6
Recurrence during the follow-up, n %	0 (0)

Table 3 Mesh used during surgery

Mesh	Patients ($n = 15$)
Parietene, n %	
20 × 15	6 (40)
25 × 20	4 (26.7)
Symbotex, n %	
15 × 10	2 (13.3)
20 × 12	2 (13.3)
20 × 15	1 (6.7)

meshes used were Parietene 20 × 15 cm (6, 40%) and Parietene 25 × 20 cm (4, 26.7%). The different meshes were used based upon institutional contracts at the time of the repair. Mean operative time was 249 ± 63 min, the hybrid approach was required in 3 cases (20%) and no conversion to open surgery was required. Mean EBL was 25 ml (20.5–81.4). Six patients underwent an additional hernia repair (42.9%), which in all cases was represented by a midline hernia that was closed and covered with the same mesh used for the PSH. A mean hospital stay of 3.6 ± 1.9 days was observed. The complete list of postoperative complications is reported in Table 2. Within 30-days following the robotic ICPSH repair, four patients (26.7%) encountered postoperative complications. There were three readmissions (20%): one due to an abdominal collection that was managed with ultrasound-guided drainage and antibiotics, and two cases of ileus treated with nasogastric tube placement. The series reported only one reoperation: a negative exploratory laparoscopy conducted due to concerns about possible peritonitis.

During the follow-up period of 15.2 ± 7.6 months, 12 patients underwent a follow-up abdominal CT scan, CT urogram, or renal ultrasound as indicated, while the remaining patients were clinically evaluated. For the whole cohort no hernia recurrence was recorded, and there was no evidence of hydronephrosis, rise in creatinine, uretero-ileal strictures, or distended conduit on imaging, indicating satisfactory drainage. This positive outcome was further supported by the analysis of preoperative and postoperative creatinine levels. The preoperative median was 1.19 mg/dl, while the postoperative median was 1.15 mg/dl. Utilizing a Wilcoxon rank-sum test, we observed no significant difference between these two values ($p = 0.4$).

Discussion

The robotic modified Sugarbaker IPUM in patients with an ileal conduit appears to be a safe procedure with acceptable short-term outcomes in terms of 30-day complication, recurrence, length of stay, need for conversion to open surgery, and 30-day reoperations.

The current literature on robotic surgical techniques for managing ICPSH exhibits significant variability and lack of a standardized procedure. Xu and colleagues reported their experience with the use of the Da Vinci Single Port robotic system in four cases of ICPSH repair with a keyhole technique [36], while Dewulf et al. published a series including fifteen patients who, in ten cases, underwent robotic ICPSH repair with different techniques [37]. In Xu's series, four patients were included, with a median age of 74.4 years and a median BMI of 28.6 Kg/m². The median operative time was 3.9 h, and the median EBL was 50 ml. The median LOS was 1 day. Complications were reported only if they were grade 2 or higher on the Clavien-Dindo classification scale. Only one postoperative complication, accounting for 25%, was recorded in the study, closely resembling our own findings. At a median follow-up of 18.3 months, no recurrences were observed. In Dewulf's series, mesh placement methods varied with a retromuscular position in 5 cases and an intraperitoneal position in the remaining 5 cases. Robotic cases had a mean operative time of 221 min, and a 30-day morbidity rate of 30% was reported. The 30-day readmission and reoperation rates were 10%. During a mean follow-up period of 366 days, a recurrence rate of 10% was recorded. The outcomes from these studies suggest that the robotic platform can safely be applied to address be a safe approach for treating ICPSH. However, a significant challenge encountered in these studies is the lack of a standardized technique. This makes it difficult to draw meaningful comparisons between our series and the two previously mentioned.

To evaluate the robotic Sugarbaker technique for ICPSH as described above, we opted to compare our outcomes with both open and laparoscopic Sugarbaker hernia repairs documented in the literature. A retrospective multicenter cohort study [38], which included 10 patients who underwent both laparoscopic and open modified Sugarbaker IPOM in ICPSH (8 and 2 cases respectively) reported a recurrence rate of 10% during a follow-up of 21 ± 7 months. Comparing our results with this study we can clearly appreciate how even if our robotic series had a longer operative time (249 ± 63 min in our series vs. 141 ± 46 min), the hospital stay was shorter (3.6 ± 1.9 days in our series, compared to 6.3 ± 3.7 days), with similar postoperative outcomes, but with a lower recurrence rate which may be lower due to the shorter follow-up. In a French multi-center study focusing on the surgical management of ICPSH, a total of 51 patients were included and underwent treatment using various approaches such as Keyhole, Sugarbaker, or direct repair with suture, the majority (88%) with an open approach [22]. During a median follow-up period of 15.3 months, the recurrence rate in the Sugarbaker group, which happened to be the lowest among all the groups studied, was 10%. Therefore, we believe that the robotic platform, utilizing a modified Sugarbaker technique, in ICPSH could lead to an even better outcome in terms of recurrence.

Various studies, ranging from retrospective cohort analyses to randomized trials, have investigated the role of prophylactic mesh in preventing ICPSH, yet the existing body of evidence remains insufficient to confirm its effectiveness, highlighting the challenges in finding a definitive solution to prevent the occurrence of ICPSH [39–42]. Given the absence of a foolproof method for preventing this complication, establishing a standardized technique for managing ICPSH is crucial. In this context, our robotic approach could play a significant role in achieving this goal. One of the most crucial endpoints to consider when evaluating a hernia repair technique is the recurrence rate. In our case, we have not had a recurrence to date, a result that stands out significantly, particularly when compared to previous studies in the literature. Further follow up of this cohort will be needed to ensure these results remain as promising over time.

The authors acknowledge several limitations in this study. First, its retrospective nature. Secondly, the relatively small number of patients and the short duration of the follow-up period limit the study's ability to assess long-term outcomes. Further, not all patients had dedicated cross-sectional imaging in follow up if they were symptom free without concerning clinical exam findings. It is possible that we could be missing small, asymptomatic recurrences. Lastly, the high complexity of the procedure raises concerns about its reproducibility in various medical centers across the country. Given the intricate nature of such surgeries, the authors express the opinion that these procedures should ideally be performed in specialized tertiary referral centers.

Conclusion

The robotic modified Sugarbaker technique for ICPSH appears to be not only feasible but also safe, as evidenced by its low short-term recurrence and complication rates. The promising outcomes observed in this study suggest the potential that this approach could become the standard of care in ICPSH management. However, it is crucial to note that further studies are necessary to assess its long-term effectiveness comprehensively.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10029-024-03153-2.

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