20 Robotic Parastomal Hernia

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Introduction

Parastomal hernias represent a challenging complication following many common surgical procedures such as colon resections and radical cystectomies. Early literature included descriptive case series [1] and retrospective reviews [2] indicating a 10% incidence of parastomal hernia formation. The majority of these hernias were not believed to be clinically significant with only 10–20% undergoing repair. More recent literature reviews indicate a much more significant incidence of parastomal hernia formation (up to 50%) [3]. In addition, the incidence of associated complications including bowel obstruction, urinary obstruction, chronic pain, and intestinal ischemia were found to be higher than initially belived [4]. Furthermore, quality of life scoring showed parastomal hernia formation to be associated with decreased physical function, increased pain, and decreased perception of general health [5]. For these reasons, the potential role of risk factor optimization prior to index operation and the need for elective parastomal hernia repairs need to be considered.

Review of the risk factors for parastomal formation shows many similarities to incisional hernia data. Evaluation of 165 patients who underwent elective colectomy with end colostomy formation with 36-month follow-up showed parastomal hernia formation in 37.8% of cases. Furthermore, multivariate analysis showed body mass index (BMI) > 25, hypertension, female gender, and age > 60 to be independent risk factors for the development of parastomal hernia [6]. Similarly, Donahue et al. reviewed 433 consecutive patients undergoing open radical cystectomy with ileal conduit formation and found the incidence of parastomal hernia formation to be 48% at 2 years. In addition, multivariate analysis once again showed female gender and increasing BMI to be independent risk factors for hernia formation as well as poor nutrition as indicated by lower serum albumin levels [7].

A large cross-sectional survey of 2854 patients with varying stoma types (colostomy, ileostomy, and urostomy) was also completed via a detailed questionnaire to evaluate potential risk factors for the development of parastomal hernias. The results indicated that preoperative risk factors such as cirrhosis, increased abdominal girth, active smoking, and previous hernias were associated with increased risk [8].

Evaluation of the risk factors for parastomal hernia formation is imperative to allow for potential optimization prior to operation. Attempts at weight reduction, improved nutrition, and smoking cessation could potentially lead to better outcomes. While many stomas are required at the time of emergency surgical procedures, the ones that are created on a more elective or planned basis may allow for time to decrease risk and optimize outcomes.

Despite patient optimization and improving techniques, the incidence of parastomal hernia formation remains significant. As previously stated, the development of a parastomal hernia increases the risk of bowel and urinary obstruction as well as decreases abdominal wall functionality and overall health. For these reasons, operative repair is often indicated. A review of common parastomal hernia repair techniques via open, laparoscopic, and robotic approaches is provided below.

Open Parastomal Hernia Repair

Symptomatic parastomal hernias can greatly increase patient morbidity, and up to half of patients require operative repair. Systematic reviews have evaluated different open repair techniques and found that non-mesh primary fascial repair was associated with an approximately 50% incidence of recurrence. Mesh reinforcement was found to

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decrease recurrence rates to 7.9–14.8% [9]. An additional review completed by Hansson et al. mirrored these results showing primary suture repair to be associated with increased recurrence rates when compared to mesh repair (odds ratio 8.9, 95% CI 5.2–15.1, $p < 0.0001$). Overall, evaluation of the available literature indicates that mesh repair is associated with acceptable rates of infection (approximately 3%) while offering improved long-term repair durability [10].

Literature discussing open parastomal hernia repair with mesh is somewhat limited with early publications consisting of small case series or case reports [11, 12]. Later reviews evaluated the commonly utilized "keyhole" technique. The technique involves lysis of adhesions followed by primary fascial closure at the time of parastomal hernia repair. Next, the stoma is pulled through a slit cut in the center of the mesh which is either placed in an onlay or sublay position. Fifty-eight patients undergoing keyhole repair were reviewed by Steele et al. and found to have a 36% incidence of morbidity (recurrence, obstruction, prolapse, wound infection, fistula, and erosion) with recurrence rates of 26% at a mean follow-up of 50.6 months [13].

Another commonly deployed repair is the "Sugarbaker" technique. The Sugarbaker repair involves lysis of adhesions followed by intraperitoneal sublay mesh with broad coverage of the stoma. Stelzner et al. completed a retrospective review of 30 patients undergoing open parastomal hernia repair via the Sugarbaker technique with a mean follow-up of 3.5 years showing a 15% incidence of parastomal hernia recurrence [14].

An additional consideration during parastomal hernia repair is the potential for resiting of the stoma to either the ipsilateral or contralateral side of the abdominal wall. An early retrospective review compared parastomal hernia repair via primary fascial closure and stoma relocation in 94 patients. The incidence of recurrence was 76% in the primary fascial closure cohort compared to 33% in the stoma relocation cohort ($p < 0.01$) [15]. An additional small review completed of 50 patients by Riansuwan et al. compared stoma relocation and fascial repair during recurrent parastomal hernia repair. The findings were similar with decreased rates of recurrence in the stoma relocation group (38% versus 74%, $p = 0.02$) [16]. Overall, the literature available evaluating stoma relocation is limited; however, the results indicate potential improvement in outcomes when compared to primary fascial closure alone.

Review of the literature available for open parastomal hernia repair shows significant recurrence rates with an incidence surpassing 50% in some studies. Primary fascial closure with mesh placement has been associated with a decrease in recurrence and is indicated in most cases. With the development of improved laparoscopic imaging and techniques, the role of laparoscopic parastomal hernia repair and the associated potential decreased wound complications needs to be considered.

Laparoscopic Parastomal Hernia Repair

Improvements in laparoscopic techniques have led to their widespread utilization for both ventral and incisional hernias, including parastomal hernias. Early case reports described the feasibility of the technique with intraperitoneal mesh placement [17]. More recently, a systemic review was completed on the American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) data comparing all patients that underwent open or laparoscopic hernia repair from 2005 to 2011. A total of 2167 cases were reviewed; only 10.4% of cases were completed laparoscopically. After adjusting for confounding variables, laparoscopic repair was associated with shorter operative times (137.5 vs. 153.4 min; $p < 0.05$), shorter length of hospital stay by 3.32 days ($p < 0.001$), and lower risks of overall morbidity (OR = 0.42, $p < 0.01$) and surgical site infections (OR 0.35, $p < 0.01$) [18]. Unfortunately, a paucity of published longer term recurrence data comparing open and laparoscopic repair exists at the time of this chapter.

Later retrospective case reviews evaluated laparoscopic keyhole repairs in 29 patients (Fig. 20.1). Findings confirmed the feasibility of the technique; however, the incidence of parastomal hernia recurrence was noted to be 46.4% with mean follow-up of 28 months [19]. An additional review of 55 patients undergoing laparoscopic keyhole repair completed by Hansson et al. showed similar recurrence rates of 37% at 36 months after repair. Observations included the unacceptably high recurrence rate associated with the technique and need to consider alternate approaches [20].

A multicenter cohort study was completed evaluating 61 consecutive patients undergoing laparoscopic parastomal hernia repair with the modified Sugarbaker technique using

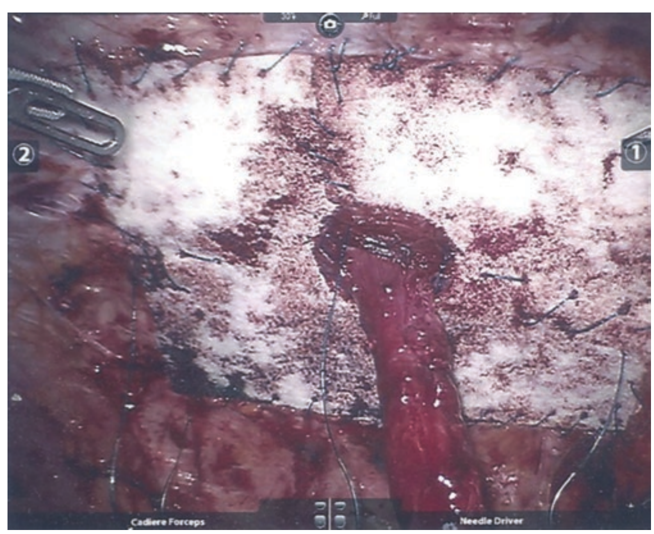

Fig. 20.1 Keyhole repair of parastomal hernia. Appearance of stoma site after minimally invasive (robotic-assisted laparoscopic) keyhole repair of parastomal hernia using bioabsorbable mesh

prosthetic mesh. The incidence of recurrence at 26 months was found to be 6.6% with an overall morbidity of 19% (ileus, wound infection, trocar site bleeding, and pneumonia) [21]. These findings suggest improve outcomes using the Sugarbaker as opposed to the keyhole technique. DeAsis et al. recently completed a meta-analysis of 15 manuscripts consisting of 469 patients comparing laparoscopic keyhole and Sugarbaker repairs. Recurrence rates were found to be decreased with the Sugarbaker technique (10.2%, 95% CI, 3.9–19.0) as compared to the keyhole repair (27.9%, 95% CI, 12.3–46.9). Postoperative complications included surgical site infection (3.8%, 95% CI, 2.3–5.7), infected mesh (1.7%, 95% CI, 0.7–3.1), and obstruction (1.7%, 95% CI, 0.7–3.0) [22].

The utilization of laparoscopic techniques for parastomal hernia could potentially offer decreased length of stay as well as surgical site infections with equivalent recurrence rates when compared to open repairs. Furthermore, the laparoscopic Sugarbaker technique seems to offer improved outcomes when compared to keyhole repair. As the overall incidence of laparoscopic repair remains low (10.4%), novel robotic platforms could offer avenues toward decreasing the technical learning curve and encouraging more widespread utilization of minimally invasive techniques.

Areas of Debate in Parastomal Hernia Repair

Prophylactic Mesh Placement

Secondary to the elevated incidence of parastomal hernia occurrence, some surgeons have employed the use of prophylactic mesh placement at the time of an index operation. Gogenur et al. completed an early prospective study evaluating the placement of a synthetic onlay mesh at the time of index colorectal procedures. This early trial enrolled only 24 patients and showed potential as the incidence of parastomal hernia at 12 months was only 8% [23]. Since that time, several randomized trials have been completed with mixed results. Recently, Pianka et al. completed a systematic literature search and meta-analysis of controlled trials comparing prophylactic mesh placement with standard controls. A total of 755 patients were included with results from the included randomized controlled trials showing a significant reduction in the incidence of parastomal hernia with prophylactic mesh placement (OR 0.24; 95% CI 0.1 to 0.58, $p = 0.034$). Furthermore, no significant differences were noted in postoperative complication rates indicating the safety of prophylactic mesh placement [24]. While additional trials are needed, preliminary data supports the utilization of prophylactic mesh placement at the time of index operation to decrease the incidence of parastomal hernia.

Utilization of Prosthetic Versus Biologic Mesh

Secondary to concern for potential mesh related complications such as infection, biologic or absorbable mesh is often used in parastomal hernia repair and/or for prophylactic placement in clean contaminated or contaminated cases. A recent systematic review of randomized trials consisting of 129 patients utilizing prophylactic composite or biologic mesh showed a reduction in parastomal hernia formation (RR 0.23, 95% CI 0.06 to 0.81; $p = 0.02$) and a decrease in the hernias requiring surgical repair (RR 0.13, 95% CI 0.02 to 1.02; $p = 0.05$) indicating the potential efficacy of these materials [25]. The increased cost associated with biologic materials has led to additional investigation comparing mesh types. A recent meta-analysis including 569 patients from 9 randomized trials showed similar results with prophylactic mesh leading to a decreased incidence of parastomal hernia as well as the need for hernia repair. Interestingly, a subgroup analysis comparing synthetic and biologic mesh types showed that the lower incidence of parastomal hernia formation was not appreciated in the biologic mesh group without any difference in morbidity from utilization of prosthetic material [26]. While review of the data indicates that prophylactic prosthetic mesh placement provides improved results with equal morbidity, additional trials are required to more clearly identify optimal mesh material.

Robotic Parastomal Hernia Repair

Robotic platforms offer increased degrees of freedom and the potential for a decreased learning curve during minimally invasive cases. While not mainstream, the utilization of such platforms has gained popularity over the previous years. Early literature consisted of small case series describing the technical feasibility of robotic-assisted laparoscopic ventral and incisional hernia repair [27]. More recently, larger retrospective reviews have been completed showing and confirming the safety of the procedure [28]; however, to date there is a paucity of long-term outcome data utilizing a robotic platform for ventral or incisional hernia repair. In addition, at the time of this review, there are zero publications specifically discussing the potential role of robotics for parastomal hernia repair. Therefore, this chapter will additionally review the preoperative planning, setup, and technical aspects of completing a robotic-assisted parastomal hernia repair.

Preoperative Planning

Parastomal hernias can often be associated with complex defects in the abdominal wall and, in many times, be present in the setting of concomitant midline incisional hernias.

Therefore, it is recommended to proceed with preoperative imaging to include a CT scan of the abdomen and pelvis in order to assess the abdominal wall musculature and size of the hernia defects.

As previously discussed, prior to any elective procedure attempts at risk factor optimization should be completed to decrease the risk of morbidity. Ensuring adequate nutrition, tobacco cessation, diabetic management, and weight management are cornerstones to this process. Elective parastomal hernia repair should not be considered in patients who are actively using nicotine products. It is our practice to require 4 weeks cessation and check for urine nicotine metabolites prior to proceeding with operation.

Obesity is also an important risk factor for recurrence with data showing increased incidence of recurrence when BMI surpasses 30 kg/m^2 [29]. Recent consensus statements and research has also highlighted the potential benefit of weight loss surgery prior to elective hernia repair with an initial BMI > 40 kg/m^2 [30, 31].

Finally, prior to the operation, we recommend attempts at multimodal pain management utilizing regional anesthesia and narcotic sparing pain regimens to include pretreatment with medications such as gabapentin, pregabalin, and celexicob. Improved perioperative pain control can lead to improved mobilization and recovery times. In addition, secondary to the potential for prolonged case duration, intraoperative decompression of the bladder with a Foley catheter is recommended in most cases.

Setup

The location of port placement is very important to avoid any external interference during the case. As most stoma sites are through the rectus muscle at approximately the level of the umbilicus, placing the trocars in the side contralateral to the stoma is key. Typically, we place the ports as previously described for ventral hernia repair (Fig. 20.2). A 12-mm camera port is placed with two 8-mm working ports on either side. It is important to allow 8–10 cm between ports to avoid external interference.

The patient is placed in supine position after induction, and the arm contralateral to the stoma site is tucked, leaving the arm on the side of the stoma out to ease the docking process. After draping, the abdomen can be entered per surgeon preference (optical entry, Veress needle, direct cutdown). The ports are placed in the previously stated configuration. While we do not routinely use an assist port (opting to complete suture exchange via the camera port), the operating surgeon can opt to place a 5–12-mm assist port for suctioning, retraction, and placement of suture and mesh during the case. At this point the patient is rotated slightly toward the side of the stoma.

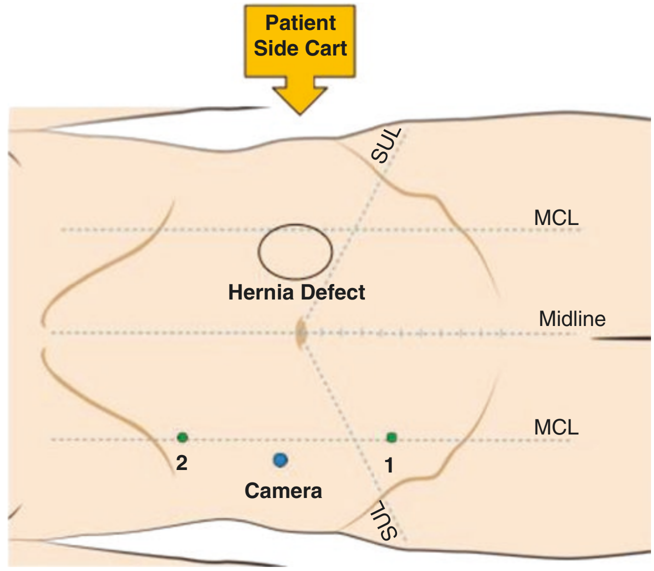

Fig. 20.2 Port placement The location of port placement is very important to avoid any external interference during the case. As most stoma sites are through the rectus muscle at approximately the level of the umbilicus, placing the trocars in the side contralateral to the stoma is key. Typically, we place the ports as previously described for ventral hernia repair (Fig. 20.2). A 12-mm camera port is placed with two 8-mm working ports on either side. It is important to allow 8–10 cm between ports to avoid external interference. for robotic parastomal hernia repair. A perpendicular dock is typically used for the patient side cart (SI). With the Xi system, there is more flexibility for positioning of the patient side cart. Typically two working ports (5 or 8 mm, depending on robotic system and instruments utilized) and an 8- or 12-mm camera port are placed on the side opposite to the hernia defect. For smaller patients, breaking the bed can allow for more room between ports. Additionally, a bump can be placed on the side of the ports to allow for more lateral placement if necessary. In general, an assist port is not necessary, as needles and mesh can be placed through the camera or instrument ports

The robot is then docked via a direct side dock bringing the platform over the side of the patient containing the stoma. The arms are then docked, and a 30° camera is used in the "up" position. In most cases a combination of needle drivers, monopolar shears, and a grasping device (bowel graspers, Cadiere Forceps, or ProGrasp™ forceps) is used. To avoid elevated costs, we typically find three instruments which are sufficient for each case (monopolar shears, grasping device, and a single needle driver).

Procedure

Once docked, we begin the dissection using a grasping instrument in the left-sided arm and the monopolar shears in the right-sided arm. The insufflation is kept at 15 mmHg, and extensive lysis of adhesions occurs to free any tissue from the anterior abdominal wall remote from the hernia. Gentle external traction is then used in an attempt to reduce the parastomal hernia contents. Next, a combination of sharp dissection with the shears and traction is used to completely free and reduce the hernia contents.

At this point the preperitoneal space is entered on the side of the fascial defect ipsilateral to the camera, and the preperitoneal plane is developed toward the hernia. This plane is extended into the hernia defect circumferentially to mobilize and attempt to completely reduce and excise the hernia sac. If the hernia sac is unable to be completely reduced, the sac is cut or released from the fascia circumferentially. After the adhesions are released, hernia contents are reduced and hernia sac excised or released; the intraabdominal pressure is reduced to 10–12 mmHg.

A ruler is then placed into the abdomen, and the width of the hernia defect is measured in order to select an appropriate-sized mesh. At this point we recommend attempted primary fascial closure secondary to a developing body of literature showing decreased adverse outcomes [32] when utilizing the technique. While any suture material can be used, we recommend a running closure utilizing an absorbable 0 barbed suture (Fig. 20.3). Of note, it is important to ensure an adequate opening for the existing stoma to avoid potential issue with obstruction or interference of blood flow.

As previously discussed, the existing data indicates the safety of synthetic mesh utilization for parastomal hernia repair [26]. Therefore, we recommend completing the hernia repair via the Sugarbaker technique with a medium weight macroporous mesh. Mesh size is calculated using the previously measured fascial defect, accounting for 5 cm of underlay in all directions. The mesh is inserted via the camera port after the center has been marked. The fascial closure suture is then used as a chandelier stitch to pull the mesh against the anterior abdominal wall. At this point the mesh is fixed to the posterior fascia of the anterior abdominal wall with a series of running

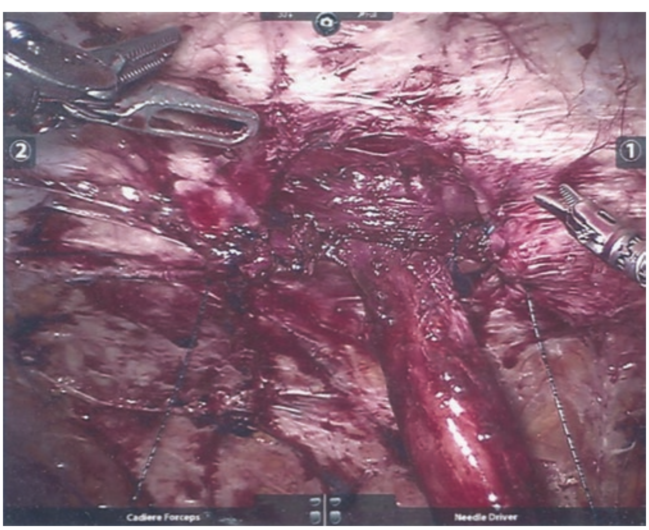

Fig. 20.3 Primary fascial closure. Intraoperative appearance of stoma site after primary fascial closure with barbed suture during robotic-assisted laparoscopic repair of a parastomal hernia

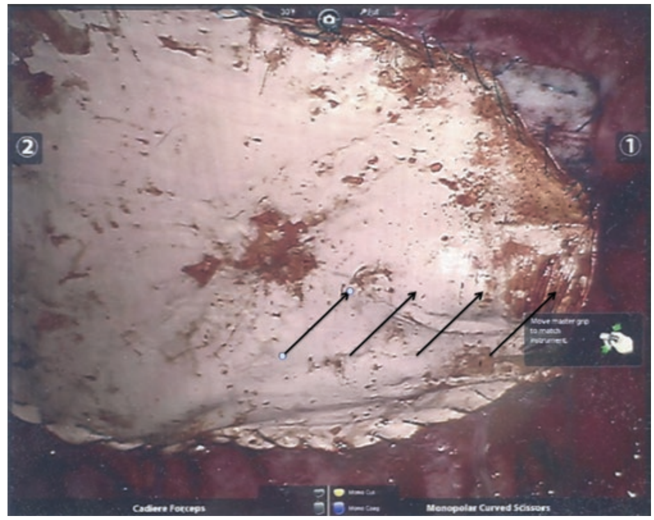

Fig. 20.4 Sugarbaker parastomal hernia repair. Intraoperative appearance after completion of parastomal hernia repair using the Sugarbaker technique. For this case, Dualmesh (W.L. Gore & Associates, Flagstaff, AZ) was utilized. Arrows indicate position of stoma

absorbable 0 barbed sutures. We recommend setting two separate sutures in place initially to anchor the mesh (one on the side contralateral to the camera and one adjacent to the tract of the stoma). After the mesh is anchored, fixation to the anterior abdominal wall is completed. Of note, avoid deep penetration when sewing to the posterior fascia. This can involve the overlying muscle and lead to bleeding with increased postoperative pain (Fig. 20.4). Once the mesh is fixed in place, conversion back to laparoscopic equipment occurs. The needles and ruler are removed, and the fascia of the12-mm camera port site was closed per surgeon preference. We then place an abdominal binder at the end of the case for patient comfort.

Postoperative Care

After robotic parastomal hernia repair, patients are closely monitored in the postanesthesia care unit to ensure adequate pain control. Operations for smaller defects often allow patients to be discharged the same day with special instruction to ensure proper ambulation once home. For larger repairs or the need for improved pain control, the patients are placed in overnight observation. It is important to avoid large quantities of narcotics via the utilization of intravenous acetaminophen, gabapentin, and pregabalin in association with preoperative regional anesthesia.

Conclusions

Parastomal hernias are a common complication of operations requiring fecal or urinary diversion with an incidence approaching 50%. Patients with parastomal hernias can experience issues with obstruction, pain, and decreased functional mobility often necessitating operative repair. The review of the available literature suggests that the laparoscopic modified Sugarbaker repair offers improved recurrence rates with decreased wound complications associated with open approaches. However, only approximately 10% of hernias are repaired via minimally invasive techniques. Robotic platforms offer increased degrees of freedom and could potentially decrease the learning curve for laparoscopic repair.

References

1. Leslie D. The parastomal hernia. Surg Clin North Am. 1984;64(2):507–15.
2. Pearl RK. Parastomal hernias. World J Surg. 1989;13(5):569–72.
3. Hotouras A, Murphy J, Thaha M, Chan CL. The persistent challenge of parastomal herniation: a review of the literature and future developments. Color Dis. 2013;15(5):e202–14.
4. Liu NW, Hackney JT, Gellhaus PT, Monn MF, et al. Incidence and risk factors of parastomal hernia in patients undergoing radical cystectomy and ileal conduit diversion. J Urol. 2014;191(5):1313–8.
5. Van Dijk SM, Timmermans L, Deerenberg EB, Lamme B, et al. Parastomal hernia: impact on quality of life? World J Surg. 2015;39(10):2595–601.
6. Sohn YJ, Moon SM, Shin US, Jee SH. Incidence and risk factors of parastomal hernia. J Korean Soc Coloproctol. 2012;28(5):241–6.
7. Donahue TF, Bochner BH, Sfakianos JP, Kent M. Risk factors for the development of parastomal hernia after radical cystectomy. J Urol. 2014;191(6):1708–13.
8. Temple B, Farley T, Popik K, Ewanyshyn C, et al. Prevalance of parastomal hernia and factors associated with its development. J Wound Ostomy Continence Nurs. 2016;43(5):489–93.
9. Al Shakarachi J, Williams JG. Systemic review of open techniques for parastomal hernia repair. Tech Coloproctol. 2014;18(5):427–32.
10. Hansson BM, Slater NJ, van der Velden AS, Groenewoud HM, et al. Surgical techniques for parastomal hernia repair: a systemic review of literature. Ann Surg. 2012;255(4):685–95.
11. Franks ME, Hrebinko RL Jr. Technique of parastomal hernia repair using synthetic mesh. Urology. 2001;57(3):551–3.
12. Kasperk R, Klinge U, Schumpelick V. The repair of large parastomal hernias using a midline approach and a prosthetic mesh in the sublay position. Am J Surg. 2000;179(3):186–8.
13. Steele SR, Lee P, Martin MJ, Mullenix PS, et al. Is parastomal hernia repair with polypropylene mesh safe? Am J Surg. 2003;185(5):436–40.
14. Stelzner S, Hellmich G, Ludwig K. Repair of paracolostomy hernias with a prosthetic mesh in the intraperitoneal onlay position: modified Sugarbaker technique. Dis Colon Rectum. 2004;47(2):185–91.
15. Rubin MS, Schoetz DJ Jr, Matthews JB. Parastomal hernia. Is stoma relocation superior to fascial repair? Arch Surg. 1994;129(4):413–8.
16. Riansuwan W, Hull TL, Millan MM, Hammel JP. Surgery of recurrent parastomal hernia: direct repair of relocation? Color Dis. 2010;12(7):681–6.
17. Pekmezci S, Memisoqlu K, Karahasanoglu T, Alemdaroglu K. Laparoscopic giant parastomal hernia repair with prosthetic mesh. Tech Coloproctol. 2002;6(3):187–90.
18. Halabi WJ, Jafari MD, Carmichael JC, Nguyen VQ, et al. Laparoscopic versus open repair of parastomal hernias: an ACS-NSQIP anaylsis of short term data. Surg Endosc. 2013;27(11):4067–72.
19. Mizrahi H, Bhattacharya P, Parker MC. Laparoscopic slit mesh repair of parastomal hernia using a designated mesh: long-term results. Surg Endosc. 2012;26(1):267–70.
20. Hasnsson BM, Bleichrodt RP, de Hingh IH. Laparoscopic parastomal hernia repair using a keyhole technique results in a high recurrence rate. Surg Endosc. 2009;23(7):1456–9.
21. Hansson BM, Morales-Conde S, Mussack T, Valdes J, et al. The laparoscopic modified Sugarbaker technique is safe and has a low recurrence rate: a multicenter cohort trial. Surg Endosc. 2013;27(2):494–500.
22. DeAsis FJ, Lapin B, Gitelis ME, Ujiki MB. Current state of laparoscopic parastomal hernia repair: a meta-analysis. World J Gastroenterol. 2015;21(28):8670–7.
23. Gogenur I, Mortensen J, Harvald T, Rosenberg J, et al. Prevention of parastomal hernia by placement of a polypropylene mesh at primary operation. Dis Colon Rectum. 2006;49(8):1131–5.
24. Pianka F, Probst P, Keller AV, Saure D, et al. Prophylactic mesh placement for the PREvention of paraSTOmal hernias: the PRESTO systemic review and meta-analysis. PLoS One. 2017;12(2):e0171548.
25. Wijeyekoon SP, Gurusamy K, El-Gendy K, Chan CL. Prevention of parastomal hernia with biologic/composite mesh: a systemic review and meta-analysis of randomized controlled trials. J Am Coll Surg. 2010;211(5):637–45.
26. Patel SV, Zhang L, Chadi SA, Wexner SD. Prophylactic mesh to prevent parastomal hernia: a meta-analysis of randomized controlled studies. Tech Coloproctol. 2017;21(1):5–13.
27. Allison N, Tieu K, Snyder B, Pigazzi A, et al. Technical feasibility of robot-assisted ventral hernia repair. World J Surg. 2012;36(2):447–52.
28. Gonzalez A, Escobar E, Romero R, Walker G, et al. Robotic-assisted ventral hernia repair: a multicenter evaluation of clinical outcomes. Surg Endosc. 2017;31(3):1342–9.
29. Nardi M Jr, Millo P, Brachet Contul R, et al. Laparoscopic ventral hernia repair with composite mesh: analysis of risk factors for recurrence in 185 patients with 5 years follow-up. Int J Surg. 2017;40:38–44.
30. Liang MK, Holihan JL, Itani K, et al. Ventral hernia management: expert consensus guided by systematic review. Ann Surg. 2017;265(1):80–9.
31. Pernar LI, Pernar CH, Dieffenbach BV, Brooks DC, Smink DS, Tavakkoli A. What is the BMI threshold for open ventral hernia repair? Surg Endosc. 2017;31(3):1311–7.
32. Tandon A, Pathak S, Lyons NJ, Nunes QM, et al. Meta-analysis of closure of the fascial defect during laparoscopic incisional and ventral hernia repair. Br J Surg. 2016;103(12):1598–607.