Parastomal Hernia: A Growing Problem with New Solutions

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Abstract

Parastomal hernia is one of the most common complications following stoma creation and its prevalence is only expected to increase. It often leads to a decrease in the quality of life for patients due to discomfort, pain, frequent ostomy appliance leakage, or peristomal skin irritation and can result in significantly increased healthcare costs. Surgical technique for parastomal hernia repair has evolved significantly over the past two decades with the introduction of new types of mesh and laparoscopic procedures. The use of prophylactic mesh in high-risk patients at the time of stoma creation has gained attention in lieu of several promising studies that have emerged in the recent days. This review will attempt to demonstrate the burden that parastomal hernias present to patients, surgeons, and the healthcare system and also provide an overview of the current management and surgical techniques at both preventing and treating parastomal hernias.

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Introduction

The earliest reports of stomas arose from their spontaneous formation after trauma or via fistula formation from an incarcerated hernia. One of the earliest published

cases was that of George Deppe, a soldier who suffered an abdominal injury at the battle of Ramillies in 1706. His injury resulted in a large portion of his colon protruding out of his abdomen with discharge of feces from the colonic segment [1]. Another case reported by Cheselden in 1784 involved Margaret White, a patient with an obstructed umbilical hernia that sloughed and formed a colostomy at the navel [2]. Albeit with a diminished quality of life, both these patients survived for many years.

In 1710, Littré was the first person to suggest in the literature the deliberate creation of a colostomy to treat an infant with an imperforate anus. However, it was not until 1793 that the first successful colostomy was performed by Duret for a child with anal atresia [1]. Despite occasional success, colostomy operations during this time period carried a high risk of mortality, secondary to fecal contamination and peritonitis [2]. A new extraperitoneal lumbar approach without violation of the peritoneum was introduced by Amussat in 1841 [3]. However, this approach was complicated by an inability to determine the underlying pathology causing bowel obstruction, difficulty managing the stoma due to its location on the flank, and a high rate of stricture and stenosis [2]. Finally, the first abdominal colostomy with suturing of the seromuscular layer to the skin similar to practice today was performed by Allingham in 1887 [4].

Disclosures: None.

Table 1. A list and description of the four parastomal hernia classifications

Subtype	Description
<i>Parastomal hernia classifications</i>	
1 Interstitial	Enters into a muscular plane
2 Subcutaneous	Enters into the subcutaneous tissue
3 Intrastomal	Enters between the emerging intestinal wall and everted intestinal layer
4 Peristomal	Enters the space between layers of prolapsed bowel

Today, ostomy creation is a common procedure with an estimated 120,000 new stomas created each year and a prevalence of up to 800,000 patients in the United States living with a stoma [5]. It is further projected that 40 to 60% of patients with an ostomy will never undergo a reversal procedure [6]. Unfortunately, ostomy complications, including skin irritation and leakage, dehydration from high output stomas, bowel obstruction, prolapse, and parastomal hernia, are quite prevalent. Of these problems, parastomal hernia is the most common and significant issue that patients face [7–9].

Definition and Incidence

Broadly defined as an incisional hernia located at or immediately adjacent to a stoma, a parastomal hernia (PSH) develops in up to 78% of patients with a stoma and typically occurs within 2 years of ostomy creation but may develop as long as 20 or 30 years after surgery [7, 10–13]. Goligher even went so far as to claim that some degree of parastomal herniation is inevitable given enough follow-up time [14]. While there is little argument that PSH is a common complication, the literature contains a broad range of PSH rates as a result of varying definitions, method of diagnosis, length of follow-up, and type of stoma.

One reason for the significant heterogeneity in reported PSH rates is that there is currently no universal definition for PSH. Some studies define herniation as a palpable bulge at the ostomy site upon a Valsalva maneuver [15, 16] while many other reports offer no definition at all [7, 8, 17, 18]. The most common classification system describes four subtypes: type 1: interstitial hernia; type 2: subcutaneous hernia; type 3: intrastomal hernia; and type 4: peristomal hernia (stoma prolapse) (table 1). The interstitial type includes a hernia sac within the muscle and

Table 2. Rates of parastomal hernia in current literature for different types of stomas

Type of stoma	Rates of parastomal hernia in the literature
<i>Rate of parastomal hernia for different types of stomas</i>	
Loop ileostomy	0–6.2% [21]
Loop colostomy	0–30.8% [21]
End ileostomy	1.8–28.3% [21]
End colostomy	4–48.1% [21]
Urostomy	5–28% [10, 22–27]

aponeurotic layers, the subcutaneous type contains a subcutaneous hernia sac, the intrastomal type contains a hernia sac between the intestinal wall and the everted intestinal layer, and the peristomal type results in the prolapse of bowel through a circumferential hernia sac surrounding the stoma [19]. However, these four subtypes are difficult to ascertain on clinical exam and, therefore, have not been useful for clinical studies or in clinical decision-making.

Furthermore, studies vary in their length of follow-up and assessment methods, which may consist of solely clinical exam findings or also include diagnostic imaging. Many studies have follow-up periods of less than one year resulting in lower PSH rates than those with longer lengths of follow-up. In comparing diagnostic methods, the use of CT-scan can sometimes detect smaller parastomal hernias that are not apparent on clinical exam. Clinical exam alone also has been shown to be quite inaccurate at diagnosing PSH [20]. Therefore, the distinction between the use of clinical exam and CT imaging for diagnosis leads to highly variable rates of PSH between studies.

With regard to stoma type, colostomies traditionally have been thought to confer a higher risk of PSH than ileostomies. However, there are conflicts in the literature. Overall, the rate of PSH for a loop colostomy and end colostomy ranges from 0 to 30.8% and 4.0 to 48.1%, respectively [21]. The rate for a loop ileostomy and end ileostomy ranges from 0 to 6.2% and 1.8 to 28.3%, respectively [21]. The likely explanation for the lower rates of PSH for loop ostomies is due to their reversal prior to the development of a PSH. This problem is not confined to gastrointestinal or general surgery because ostomy formation at the site of an ileal conduit is quite common. The rate of herniation at a urostomy site is similar to that of an end ileostomy with a range of 5 to 28% [10, 22–27] (table 2).

Risk Factors

Both patient and operative technical factors have been implicated in the subsequent risk of PSH. Individual patient characteristics that have been shown to be independent risk factors for PSH development include older age [7, 10, 28, 29], increased BMI [8, 30, 31], increased waist circumference [30], respiratory comorbidity [8], cancer [8], diabetes mellitus [8], and the presence of other abdominal wall hernias [7]. Other factors in the literature that have been suggested but not validated include malnutrition, smoking status, chronic coughing, chronic constipation, ascites, corticosteroid use, and postoperative wound sepsis [21]. Technical aspects related to ostomy creation that have been suggested as risk factors for PSH include bringing the stoma out through the resection site [9], an intraperitoneal route as opposed to an extraperitoneal one [7, 31–33], a laparoscopic approach [31], and increased aperture size [10, 29, 34].

Goligher and Sames first reported extraperitoneal stoma formation in 1958 [35, 36]. Since then, several studies have shown a decreased risk of PSH with the extraperitoneal approach, but no randomized clinical trial has yet been performed. Funahashi et al. reported a laparoscopic approach as an independent risk factor [31], but no randomized trials comparing a laparoscopic and open approach have been performed. Hotouras et al. suggest making the aperture size ≤ 25 mm in size based on an observational study comparing the aperture size and presence of PSH on CT scan in 43 patients undergoing permanent colostomy for malignancy [34]. However, there have been no clinical trials to date evaluating the ideal aperture size and subsequent risk of PSH. There is also no evidence that fixating the mesentery or stoma to the fascia is protective against PSH [21].

Additionally, surgical dogma has taught that stomas created through the rectus abdominis muscle are protective against PSH formation. This teaching is largely a result of a 130-patient study by Sjodahl et al. that demonstrated a significantly lower rate of PSH when the stoma was fashioned through a transrectus route as opposed to a lateral pararectus approach (3 vs. 22%) [37]. However, a recent Cochrane review in 2013 showed no statistically significant difference in the rate of PSH or stomal prolapse between the two techniques [38]. As no clinical trials comparing the varying surgical techniques for ostomy creation exist, the ideal approach remains controversial.

Presentation and Diagnosis

A diagnosis of PSH is made either through clinical examination or imaging. Unfortunately, not only is development of a PSH after ostomy creation quite common, but roughly three-quarters of patients suffer from clinical symptoms related to their hernia [12]. For these patients that are symptomatic, they most often will present with complaints of peristomal bulging when coughing, pain, or discomfort around the stoma, and difficulty keeping the stoma appliance in place with subsequent leakage. Peristomal bulging is a result of increased intra-abdominal pressure resulting in abdominal contents protruding through the fascial defect. Pain and discomfort is generally caused by stretching of the abdominal wall and adjacent skin. Difficulty with maintaining a seal between the ostomy appliance and the stoma is secondary to periodic peristomal bulging [39]. As a result, leakage around the stoma appliance may be frequent, resulting in significant peristomal dermatitis and difficulty concealing the ostomy under clothing. Skin irritation is more prevalent with ileostomies and urostomies due to their respective effluent [40]. Inquiring about levels of peristomal pain or discomfort, frequency of leakage and appliance change, and degree of skin irritation can be helpful in determining the severity of symptoms.

On physical examination, similar to other incisional hernias, a bulging adjacent to the stoma may be apparent upon Valsalva maneuver in the standing position. Additionally, a fascial defect adjacent to the stoma may be palpable. However, clinical diagnosis has been found to be challenging with poor inter-observer reliability [20]. It can be difficult to distinguish between an abdominal bulge and a true PSH on clinical exam alone. Although there is no gold standard for diagnosis, a CT scan of the abdomen has been the traditional imaging modality to confirm the diagnosis or obtain better characterization of the PSH. A numerical classification system for PSH based upon CT findings exists, which includes type I (hernia sac containing stoma loop), type II (hernia sac containing omentum), and type III (hernia sac containing a loop other than the stoma) parastomal hernias [16]. However, some hernias may be missed on a CT scan due to the inability of the patient to lie supine. Abdominal ultrasonography can make a dynamic diagnosis of PSH without the necessity of the patient lying supine and can distinguish PSH from simple abdominal bulging. However, this technique has not been well-described in the literature [41].

Intrastomal ultrasonography has gained recent interest as a potentially superior imaging modality as it is dynam-

ic and avoids the use of radiation. Preliminary studies testing feasibility and accuracy have been promising with demonstration of a relatively low learning curve and good inter-observer reliability [42, 43]. Using a rectal setting on the ultrasound probe with a frequency of 9 MHz, the fascia, rectus muscle, bowel, and implanted mesh when present can be identified. Bowel appears as five different hypoechogenic and hyperechogenic layers, similar to the rectal wall layers seen on endorectal ultrasound, and PSH can be diagnosed by visualizing an opening in the adjacent fascia and/or penetration of intestine and peritoneum into the subcutaneous fat. A learning curve of approximately 30 patients has been suggested [43]. However, more studies are needed to make it the imaging modality of choice.

Quality of Life and Financial Impact

Unfortunately, patients who are symptomatic from a PSH often suffer from poor quality of life [39, 44]. In one study evaluating the effects of peristomal bulging and subsequent quality of life, patients reported significant impairment in quality of life regarding symptom load, worry, and general sense of well-being. In comparison to patients without bulging, patients with parastomal bulging had significantly higher rates of needing to know where the nearest toilet was, concern that the pouch would loosen, worry that their family would feel awkward around them, and fatigue symptoms such as feeling tired or needing to rest during the day [39].

Patients may become increasingly self-conscious and develop a fear of going out into public due to the appearance of a bulge under their clothing or because of frequent appliance leakage [45]. Leakage leads to unpleasant odor, soiling of clothes, and often skin complications, which are both difficult to manage and financially expensive [46]. In a study by Meisner et al., increasing the frequency of appliance leakage and severity of peristomal contact dermatitis were directly related to stoma cost. Patients with frequent leakage accrued a nearly three-fold increase in treatment and ostomy supply cost compared to those without leakage, while severe skin irritation led to a nearly six-fold increase in cost compared to only mild skin irritation [47].

While the average wear time of an ostomy appliance in the United States is 4.55 days for colostomies and 5.01 days for ileostomies according to one survey [48], patients with PSH often need to change their appliance much more frequently. Frequent changing of appliances, more expensive custom-fit appliances, and other accessories required to form a better seal can greatly increase a

patient's monthly cost expenditure for stoma care [9]. It is estimated that the cost of an individual ostomy pouch and bag is ~\$24 for a patient receiving home care [49]. Therefore, frequent leakage can increase healthcare expenditure on the order of several hundreds of dollars per month. Furthermore, as many insurance companies do not reimburse the cost of ostomy supplies, much of the cost may be out-of-pocket for the patient adding financial burden to an existing emotional distress. It is also not uncommon for patients to go on disability due to activity restrictions secondary to their hernia, leading to a substantial loss of work productivity.

Medical Management

As surgical treatment historically has had relatively high recurrence rates, the best strategy is limiting the risk of PSH during ostomy creation by removing the surgical specimen through a site separate from the stoma and minimizing the trephine size. If feasible, ostomy reversal within a timely fashion will also reduce risk. Unfortunately, as previously stated, an estimated 40% to 60% of stomas are never reversed [6]. Luckily, while most patients do have symptoms related to their PSH, only 30% of patients have symptoms severe enough to undergo operative repair [40].

Treatment for patients who have relatively mild symptoms should include conservative management with well-made stomal support. The use of skin protective sealants, a flexible appliance, and a stoma or abdominal support belt can often improve appliance security [45]. The use of regular wound ostomy care nursing has been shown to be an effective strategy to help manage peristomal dermatitis and improve quality of life. In a study by Erwin-Toth et al., the use of regular wound ostomy care nursing visits significantly increased the patient's quality of life and reduced the rate of ostomy appliance leakage [50]. Unfortunately, only 13% of patients in that same study had regular consultation with a wound ostomy care nurse prior to enrollment in the study, indicating a need for better patient access to care and increased resource utilization.

Surgical Treatment

While most patients can be managed conservatively, surgical management is required when there is obstruction, incarceration, or strangulation of the hernia and is typically offered on an elective basis to patients with recurrent pain, poor cosmesis, and a consistent inability to

maintain the seal of the appliance around the stoma. In a study of patients with PSH by Ripoche et al., 15% of patients suffered at least one episode of obstruction, 35% reported frequent episodes of pain, and 27% had repeated episodes of leakage [12].

Various surgical techniques have been described in the literature over the past few decades. The main techniques have included suture repair of the fascial defect, translocation of the stoma, and mesh repair. Several different approaches also have been described which include laparotomy, lateral approach, and laparoscopic methods. Each of these modalities have had varying rates of success. Regardless of repair technique, emergent repair appears to be an independent risk factor for PSH recurrence and reoperation making elective repair ideal [51].

Simple Fascial Repair

Suture repair was one of the techniques of choice in the past but has been largely abandoned today. After a parastomal incision and reduction of the hernia sac, repair involves narrowing the parastomal fascial opening by suturing the musculoaponeurotic tissues of the fascia with either absorbable or nonabsorbable suture [21]. While technically simple with low early complication rates, local repair without mesh has had high recurrence rates ranging from 10 to 76% [52]. Suture repair for a recurrent PSH has even worse results with recurrence rates as high as 100% [52, 53]. This technique should be reserved only for patients with small defects in whom there is a strong desire to avoid prosthetic mesh or more extensive surgery.

Stoma Translocation

While stoma relocation also was a technique of choice in the past and appears to have lower recurrence rates than simple fascial repair, this too is best avoided due to a high rate of hernia at both the previous and new stoma sites as well as risk of operative complications. In the only study directly comparing local tissue repair with stoma relocation, Rubin et al. demonstrated that first-time PSH repair with stoma relocation was superior to simple fascial repair with recurrence rates of 33% and 76%, respectively [52]. However, the relocation of the stoma may also require a laparotomy along with all of its associated risks, and additional studies have shown a substantial risk of hernia at both the previous stoma site and the new ostomy site. The rate of hernia is as high as 52% at the previous site [52] and

ranges anywhere from 0% to 76% at the new site depending on the study [13, 21, 52, 54, 55]. If a stoma is relocated, it should be created on the opposite side of the midline due to higher rates of PSH for same-side relocation [13].

Mesh Repair

Mesh repair was first introduced by Rosin and Bonardi in 1977 [56] and has over time become the preferred technique for surgical management of PSH due to lower recurrence rates. Synthetic meshes, such as polypropylene, were the predominant mesh types used in the past. However, due to concerns for fistula formation from mesh erosion into proximal bowel [57], the development of dense intra-abdominal adhesions to the mesh making future surgery difficult [58], and the risk of mesh infection in contaminated fields with subsequent need to explant the foreign body material, polypropylene has fallen out of favor with replacement by PTFE (polytetrafluoroethylene) or biologic meshes.

PTFE is a soft, inert material that does not appear to adhere to bowel. However, it has a tendency to shrink, leading to higher rates of recurrence [59]. Biologic grafts are absorbable meshes that recently have gained interest due to their resistance to mesh infection in a potentially contaminated field. In addition, a recent systematic review has shown that biologic grafts have similar recurrence rates to synthetic meshes [60]. However, biologic meshes are much more expensive than synthetic ones and may lead to higher rates of seroma formation [61]. Recent literature has also challenged the long-held belief that synthetic mesh is unsafe in contaminated fields by demonstrating favorable rates of infection, mesh removal, and recurrence after utilizing newer lightweight polypropylene mesh for ventral hernia repair in a contaminated field [62]. Recent studies have demonstrated overall mesh infection rates as low as 3% following parastomal hernia repair [63]. Specific factors associated with mesh infection include smoking, obesity, older age, emergent repair, and longer operative time [64]. Despite advances in mesh type, overall wound complications are nonetheless still common and occur in up to 25% of PSH repairs [60, 63].

Based on recent systematic reviews of the literature, reported recurrence rates for mesh repair have been less than 20% for both synthetic and biologic meshes [60, 63]. Surgical technique involves mesh placement to either reinforce suture repair or bridge the fascial gap. Subtypes of the mesh repair are based upon the anatomic location of the mesh and include onlay, retromuscular, inlay, and in-

traperitoneal approaches. The onlay method involves subcutaneous placement of the mesh with fixation to the anterior rectus sheath and aponeurosis of the external oblique muscle. The retromuscular technique is placement of the mesh between the rectus muscle and posterior oblique muscle. The inlay method largely has been abandoned due to high recurrence rates but indicates that the mesh is placed within the fascial defect and sutured to the fascial edges. With the intraperitoneal approach, the mesh is placed intra-abdominally and fixated onto the peritoneum. Laparoscopic repair involves the intraperitoneal technique, and open repair may incorporate any of the subtypes of mesh repair. For the intraperitoneal techniques, surgeons typically utilize one of two major methods, the keyhole technique or the 'Sugarbaker' procedure.

Both the keyhole and Sugarbaker techniques can be utilized for open and laparoscopic repairs. For open repair, an incision should be made far enough away from the stoma that the stoma appliance will not cover the incision. During a laparoscopic repair, standard techniques are employed in accessing the abdomen. For a typical left-sided colostomy, trocars are typically placed on the right side of the abdomen and include a 10 mm port along the anterior axillary line halfway between the costal margin and the superior iliac crest, a second 10 mm port subcostally, and a 5 mm port just above the superior iliac crest [65]. Regardless of the technique, once inside the abdomen, adhesiolysis is carefully performed, and the hernia sac is identified and reduced into the abdominal cavity. In the keyhole method, a 2–3 cm 'keyhole' is fashioned in the mesh through which the stoma passes, and the rest of the mesh covers the entirety of the hernia orifice. Care should be taken while making the slit in the mesh as a hole that is too small will increase the risk of obstructing the enterostomy, while a hole that is too large will lead to a higher risk of hernia recurrence.

The 'Sugarbaker' technique was first described by Paul H. Sugarbaker in 1985 [8]. Of the six patients with recurrent PSH and one patient with primary PSH in Sugarbaker's original case series, none of them had a recurrent hernia within a 4 years follow-up period. For this technique, a ring of prosthetic mesh is cut to snugly fill the fascial defect. Individual sutures or staples are fashioned approximately one centimeter apart from one another around the fascial ring to secure the mesh in place. The bowel loop exiting from the stoma site is secured to the anterior and lateral abdominal wall. The lateral portion of the mesh is left open for this loop of bowel to pass over the lateral edge of the mesh for a distance of at least 5 cm and then enter into the abdominal cavity.

More recently, the laparoscopic sandwich technique was introduced by Berger et al. with excellent results [66, 67]. The sandwich repair is a combination of the keyhole and Sugarbaker techniques utilizing two pieces of mesh. First, a piece of mesh is incised in a keyhole fashion, placed around the stoma, and fixed to the abdominal wall with staples. Next, an additional larger piece of mesh covers the stoma site, and the stoma loop is lateralized between the slit mesh and larger mesh for at least 5 cm. In their observational study of 47 patients, a recurrence rate of only 2.1% was noted [67].

In a recent systematic review and meta-analysis by Hansson et al. in 2012, the authors compared recurrence and complication rates for suture repair, onlay mesh placement, retromuscular mesh placement, open intraperitoneal mesh placement with either the keyhole or Sugarbaker technique, and laparoscopic mesh placement with either the keyhole, Sugarbaker, or sandwich technique [63]. Only studies with a mean follow-up time of at least 12 months were included in the meta-analysis. In their comparison between techniques, suture repair had a significantly higher recurrence rate than mesh repair. Open and laparoscopic mesh repair had no significant difference in recurrence rates. Within the subset of laparoscopic procedures, the Sugarbaker technique had a significantly lower recurrence rate than the keyhole method. There was no difference in mesh infection or postoperative morbidity between any of the mesh repair subgroups. Studies performed after this meta-analysis have had similar findings [68–70] (table 3). Advantages of the laparoscopic approach include the detection and treatment of other abdominal wall hernias, shorter hospital stay, decreased risk of surgical site infection, and lower risk of overall morbidity [69, 71].

Unfortunately, it is difficult to make any definitive conclusions about which techniques are superior due to small sample sizes, short follow-up periods, and lack of randomization in most of the studies to date. While mesh repair does appear to have lower recurrence rates than suture repair and stoma translocation, which type of mesh is superior remains a topic of debate. Larger randomized controlled trials comparing the different techniques and mesh materials would be the ideal approach to formally critiquing these different methods of PSH repair.

Prevention with Prophylactic Mesh

With such a high incidence of PSH and recent success with mesh repair, much attention has been given to prophylactic mesh placement at the time of primary stoma

Table 3. Range of recurrence rates for the different parastomal hernia repair techniques from studies published between January 1990 and January 2014

Technique	Number of subjects in each study	Number of recurrences in each study	Recurrence rate (%)
Recurrence rates for different surgical techniques of parastomal hernia repair			
<i>Suture repair</i>			
Cheung et al. [54]	13	6	46.1
Pastor et al. [72]	13	7	53.8
Rieger et al. [73]	13	7	53.8
Riansuwan et al. [53]	27	20	74.1
Rubin et al. [52]	36	29	80.6
Total	102	69	67.6
<i>Onlay mesh</i>			
Venditti et al. [74]	8	0	0
Ho and Fawcett [75]	15	1	6.7
de Ruiter and Bijnen [76]	46	7	15.2
Luning and Spillenaar-Bilgen [77]	16	3	18.7
Kald et al. [78]	5	1	20
Steele et al. [79]	58	15	25.9
Total	148	27	18.2
<i>Retromuscular mesh</i>			
Longman et al. [80]	10	0	0
Guzman-Valdivia et al. [81]	25	2	8
Kasperk et al. [82]	7	2	28.6
Total	42	4	9.5
<i>Open intraperitoneal mesh – Keyhole technique</i>			
Byers et al. [83]	9	0	0
Fei [84]	11	1	9.1
van Sprundel and Gerritsen van der Hoop [85]	16	2	12.5
Morris-Stiff and Hughes [58]	7	2	28.6
Total	43	5	11.6
<i>Open intraperitoneal mesh – Sugarbaker technique</i>			
Stelzner et al. [86]	20	3	15
Total	20	3	15
<i>Laparoscopic mesh – Keyhole technique</i>			
Wara and Andersen [87]	72	2	2.8
Craft et al. [88]	5	1	20
LeBlanc et al. [89]	5	1	20
Hansson et al. [59]	55	20	36.4
Safadi [90]	9	4	44.4
Mizrahi et al. [70]	28	13	46.4
Asif et al. [68]	19	11	57.9
Pastor et al. [72]	3	2	66.7
Muysoms [91]	11	8	72.7
Total	207	62	30
<i>Laparoscopic mesh – Sugarbaker technique</i>			
Craft et al. [88]	16	0	0
Asif et al. [68]	14	0	0

Table 3. (continued)

Technique	Number of subjects in each study	Number of recurrences in each study	Recurrence rate (%)
LeBlanc et al. [89]	7	0	0
Berger and Bientzle [66]	66	8	2.1
Mancini et al. [92]	25	1	4
Hansson et al. [69]	61	4	6.1
Muysoms [91]	13	2	15.4
Pastor et al. [72]	7	2	28.6
Total	209	17	8.1
<i>Laparoscopic mesh – Sandwich technique</i>			
Berger and Bientzle [67]	47	1	2.1
Total	47	1	2.1

Only studies with a mean follow-up of ≥ 12 months are included.

Table 4. Studies that have evaluated parastomal hernia rates following prophylactic mesh placement at time of stoma creation

Study	Mesh location	Mesh type	Number of subjects in each study	Number of parastomal hernias in each study	Parastomal hernia rate (%)
<i>Outcomes of prophylactic mesh placement at time of stoma creation</i>					
Bayer et al. [93]	Onlay	Marlex [®]	43	0	0
Hauters et al. [98]	Onlay	Parietex [®] composite	20	1	5
Gogenur et al. [94]	Retromuscular	Stomamesh [™]	24	2	8.3
Hammond et al. [102]	Retromuscular	Permacol	10	0	0
Janes et al. [103]	Retromuscular	Ultrapro lightweight	15	2	13.3
Janes et al. [104]	Retromuscular	Ultrapro lightweight	61	8	13
Marimuthu et al. [96]	Retromuscular	Surgipro [™]	18	0	0
Serra-Aracil et al. [99]	Retromuscular	Ultrapro lightweight	27	6	22.2
Vijayasekar et al. [100]	Retromuscular	Polypropylene	42	4	9.5
Berger [105]	Intraperitoneal	Dynamesh IPST [®]	22	0	0
Lopez-Cano et al. [101]	Intraperitoneal	Proceed [®] composite	18	9	50
Total	–	–	300	32	10.7

formation, especially for permanent colostomy after an abdominoperineal resection (APR). This idea was first implemented by Bayer et al. in 1979 in which they reinforced the stoma site with Marlex mesh in 43 patients [93]. None of these patients developed a PSH during the four-year follow-up period. Several subsequent observational studies found this practice to be safe and effective without an increased risk of infection or stoma complications [94–96].

A recent meta-analysis in 2012 that included three randomized controlled trials demonstrated a substantial

difference in the incidence of PSH between controls and patients with prophylactic mesh [97]. The incidence was 12.5% for those with mesh and 53% for controls with no difference in mesh-related morbidity. Studies have varied as to whether the prophylactic mesh was placed in an onlay, retromuscular, or intraperitoneal position. There does not appear to be any strong evidence to support any one method over another at this time (table 4) [94, 96, 98–105]. A recent cost-effectiveness analysis also demonstrated cost savings and improvement in effectiveness for patients with Stage I to III rectal cancer undergoing

APR with prophylactic mesh placement [106]. While most studies to date have had small sample sizes at single institutions, larger multi-center, randomized, controlled trials are currently underway, which may provide stronger evidence to support prophylactic mesh placement at the time of permanent ostomy creation [107, 108]. Future studies should also focus on the risk and benefits of prophylactic mesh placement while taking into account specific patient or operative factors, such as obesity or an emergent operation, which increases the risk of not only a parastomal hernia but also wound infection and subsequently mesh infection. This information would help identify which patients would most benefit from prophylactic mesh placement and could contribute to the development of future guidelines. Since current studies have only included cases under elective circumstances, comparative effectiveness of prophylactic mesh placement during emergent operation cannot be determined at this time and requires future investigation.

Conclusions and Future Directions

With improvement in rectal cancer survival, a rising incidence of obesity as a risk factor for PSH, and current estimates that the number of ostomies will grow at an annual rate of 3% in the United States [5], the prevalence of PSH will likely only increase. Morbidity from PSH, including discomfort or pain, frequent ostomy appliance

leakage, and peristomal skin irritation, is common and significantly decreases quality of life while substantially increasing financial costs. For patients with minimal symptoms, the use of regular wound ostomy care nursing services has been shown to improve the quality of life of patients living with stomas.

Mesh repair is now the gold standard for the treatment of symptomatic parastomal hernias. Simple fascial repair and stoma translocation were the procedures of choice in the past but should be avoided due to high recurrence rates. Both open and laparoscopic mesh repair appear to be effective with the exception of the laparoscopic key-hole technique which has had comparatively higher recurrence rates. Laparoscopic repair has the added benefit of the ability to detect and treat other abdominal hernias, a shorter hospital stay, and lower overall morbidity rates. There is still no clear consensus on the most effective location of mesh placement or mesh type. Both synthetic and biologic meshes have shown promising results; however, biologic mesh remains much more costly and should, therefore, be limited to use in contaminated fields.

In terms of prevention, timely stoma reversal when feasible will help eliminate the risk before a PSH develops. Prophylactic mesh placement appears to be a cost-effective strategy in limiting the risk of PSH in patients with permanent colostomy. If the results of ongoing multi-center, randomized, controlled trials continue to favor prophylactic mesh, it may soon become accepted as a standard of care.

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