Hernia (2016) 20:321–325
DOI 10.1007/s10029-015-1452-8

ORIGINAL ARTICLE

Onlay parastomal hernia repair with cross-linked porcine dermal collagen biologic mesh: long-term results

A. M. Warwick[1] · R. Velineni[1] · N. J. Smart[1] · I. R. Daniels[1]

Received: 29 April 2015 / Accepted: 3 December 2015 / Published online: 21 December 2015

Abstract
Purpose The optimal technique and mesh type for parastomal hernia repair have yet to be ascertained. Biologic meshes have been advocated in parastomal hernia repair due to purported resistance to infection in contaminated fields. The aim of this study was to evaluate the effectiveness of additionally cross-linked acellular porcine dermal collagen mesh (Permacol^{TM}) for onlay parastomal hernia repair.
Methods A retrospective review of case notes, and abdominal CT scans when available, was performed for consecutive patients who had a parastomal hernia repaired between January 2007 and May 2010. All hernias were repaired with onlay placement of the biologic mesh. Hernias were classified according to the Moreno-Matias classification where CT scans were available.
Results Over a 34-month period, 30 consecutive patients, median age 74 years, 17 female, underwent parastomal hernia repair using onlay biologic mesh. There were 23 paracolostomy and seven paraileostomy hernias. The hernia was primary in 26 patients. Pre-operative CT scans were available in 18 patients (Moreno-Matias Type 1 = 1, Type 2 = 4, Type 3 = 13). There was one perioperative death, and 29 patients were available for follow-up, and median duration of follow-up (either CT or clinical) was 36 months (range 3–79). Twenty-six patients developed recurrence of the parastomal hernia (89.6 %), and median time to recurrence was 10 months (range 3–72),with Moreno-Matias Type 1 = 0, Type 2 = 4, Type 3 = 14, unknown = 8. Fifteen out of 26 patients have had repairs of the recurrence using a variety of techniques. Of these, 10 patients have had further recurrence.
Conclusion Onlay repair of parastomal hernia with cross-linked porcine dermal collagen biologic mesh reinforcement has poor long-term outcomes with unacceptably high recurrence rates and should not be performed.

Keywords Parastomal · Hernia · Biologic · Mesh · Permacol · Recurrence

Introduction

The reported incidence of parastomal hernias ranges from 4 to 48 %, and it has been proposed that parastomal herniation is an inevitable consequence of stoma formation [1]. The disparity in the reported incidence is related to the length and intensity of follow-up. Parastomal herniation may significantly adversely affect quality of life and psychological well-being and has a huge impact on healthcare resources [2, 3]. The perception that most parastomal hernias are asymptomatic and can be managed non-operatively has recently been disputed [4]. A study of 202 ostomates with parastomal hernias and follow-up of more than 10 years found that only 24 % of patients with

The data in this paper have, in part, been presented at the following meetings: (1) Annual Scientific Congress, Royal Australasian College of Surgeons, Singapore, 5–9 May 2014. (2) European Hernia Society, Edinburgh, 28–30 May 2014.

Disclaimer: NJS and IRD have received honoraria from Covidien for lecturing on the use of biologic mesh in colorectal and hernia surgery.

✉ A. M. Warwick
mda99amw@yahoo.com

I. R. Daniels
i.daniels@nhs.net

[1] Exeter Surgical Health Services Research Unit, Royal Devon and Exeter Hospital, Barrack Road, Exeter, Devon EX2 5DW, UK

parastomal hernias were free from symptoms [5]. It has been demonstrated that 50 % of parastomal hernias will occur within the first 2 years after surgery [4].

When parastomal hernias are managed surgically, the outcomes have been poor, with high rates of recurrence [3]. Operative strategies that can be used to manage parastomal hernias are: direct fascial repair with sutures, relocation of the stoma and repair with a prosthetic mesh. Both sutured repairs and relocation of the stoma are associated with high rates of recurrence and are no longer recommended [3, 6]. Whilst we know that repairs using mesh reinforcement are better, the ideal technique of parastomal hernia repair is not known. Factors that are likely to affect recurrence are the choice of mesh and the position that the mesh is placed.

Onlay mesh has been one of the most commonly employed techniques for parastomal hernia repair and variable recurrence rates, between 0 and 62.5 %, are reported [3]. There has been less published on the long-term recurrence rates using sublay placement of mesh, but placing the mesh between the layers of the abdominal wall may prevent mesh "lift-off" and improve recurrence rates. Intraperitoneal techniques have been used, but there is ongoing concern about mesh related complications [3].

The ideal mesh is unknown. Biologic meshes have been advocated in parastomal hernia repair due to purported resistance to infection in contaminated fields [7, 8]. However, in general, the infective complications with synthetic mesh used in parastomal hernia repair have been low [9]. There is uncertainty about the durability of biologic mesh, and no "head-to-head" studies have compared recurrence rates using different mesh types and the same repair technique [6, 10, 11].

The reason for the uncertainty over the optimal operative technique and type of mesh is that published follow-up is often short, and of poor quality [8]. There has also been difficulty in comparison between studies. The Moreno-Matias classification is a radiological classification used to improve our ability to accurately characterise parastomal hernia and allow easier comparison of different studies and their results [12].

Our group has previously reported short-term outcomes on the effectiveness of hexamethylene diisocyanate (HMDI) additionally cross-linked acellular porcine dermal collagen (Permacol™, Covidien, Fareham, Hampshire, UK) mesh in onlay parastomal hernia repair [13]. It was found that recurrence was related to the position of the stoma relative to the rectus sheath, with higher recurrence rates in those who had the stoma placed lateral to, rather than within, the rectus sheath. Our aim was to evaluate this technique with longer follow-up and objective cross-sectional imaging.

Methods

Study design

A retrospective review was performed of the case notes and CT scans of consecutive patients who had an onlay repair of parastomal hernia between July 2007 and May 2010. Data collected included age, sex, stoma type, stoma position in relation to the rectus sheath (ascertained either by pre-operative abdominal computed tomography (CT) scan and/or intraoperative findings), number of previous repairs, and recurrence rates, both clinical and radiological.

Parastomal hernia recurrence was defined both clinically, during outpatient visits, and radiologically if cross-sectional imaging had been performed. Pre-operative and post-operative CT scans were assessed, and the parastomal hernia was graded according to the Moreno-Matias classification (Table 1). Two authors (AMW/NJS) independently assessed the parastomal hernia Moreno-Matias grade. Differences were resolved by discussion.

Inclusion/exclusion criteria

Patients over the age of 18 underwent an elective onlay repair of an isolated parastomal hernia using HMDI cross-linked acellular porcine dermal collagen (Permacol™). Any patient who had a different type of mesh placed, or the mesh was placed in a different anatomical position was excluded.

Surgical technique

The surgical technique used has been described previously [13]. To recapitulate, all parastomal hernias were repaired via a lateral approach through an inferolateral curvilinear

Table 1 Summary of Moreno-Matias classification [12]

Type	Content of hernia sac
0	Peritoneum follows the wall of the bowel forming the stoma, with no formation of a sac
1a	Bowel forming the colostomy with a sac <5 cm
1b	Bowel forming the colostomy with a sac >5 cm
2	Sac containing omentum
3	Intestinal loop other than the bowel forming the stoma

incision, approximately 5 cm from the mucocutaneous junction of the stoma. The hernia sac was dissected free, the contents were reduced into the abdomen, and the defect was closed with interrupted 1 polypropylene sutures. The closure was reinforced with a 10 × 10 cm piece of diisocyanate cross-linked acellular porcine dermal collagen mesh (Permacol^{TM}, Covidien, Gosport, Hampshire, UK) with a keyhole defect cut to accommodate the stoma. The mesh was secured in an onlay technique to the underlying external oblique aponeurosis with interrupted 2/0 polypropylene sutures. A 10-F suction drain was routinely placed between the biologic mesh and the abdominal wall. The subcutaneous fat was approximated with 2/0 polyglactin sutures, the skin was closed with subcuticular absorbable monofilament sutures and cyanoacrylate wound glue was used as a waterproof dressing. No stomas were relocated. A prophylactic single dose of cefuroxime and metronidazole antibiotics was given on induction.

Results

Over a 34-month period between July 2007 and May 2010, 30 consecutive patients (17 female) underwent parastomal hernia repair using onlay biologic mesh. The median age was 74 years (range 55–88 years) (Table 2). Twenty-three patients (76.7 %) had paracolostomy, and seven (23.3 %) had paraileostomy hernias. Twenty-six of the hernias were primary (86.7 %), and one was a primary parastomal hernia in a patient who had had a prophylactic mesh placed at the initial surgery. Three were recurrent hernias that had previously been repaired. Pre-operative CT scans were available in 17 patients, and the majority demonstrated the hernia involving multiple loops of bowel (Moreno-Matias Grade 1; $n = 1$, Grade 2; $n = 4$, Grade 3; $n = 12$).

There was one perioperative death, on the sixth post-operative day, due to renal failure in a dialysis-dependent patient giving 29 patients available for analysis. The median duration of follow-up was 36 months (range 3–79). The majority, 26 out of 29 patients (89.6 %), developed recurrence of parastomal hernia. The median time to recurrence was 10 months (range 3–72).

Of the 26 recurrences, the majority (19) were confirmed and characterised with CT, but seven were made using a clinical diagnosis only. Of those that had a recurrence the majority involved multiple loops of bowel (Moreno-Matias Grade 1a; $n = 1$, Grade 2; $n = 3$, Grade 3; $n = 15$).

Table 2 Patient characteristics

Number of patients	30
Male/female ratio	13:17
Median age (range) in years	74 (55–88)
Colostomy/ileostomy ratio	23:7
Primary/recurrent hernias	27:3

Table 3 Overall outcomes and relationship to stoma site

	Through rectus muscle	Lateral to rectus muscle	p value
Number of recurrences	9/11	15/15	$p =$ ns
Median time to recurrence in months (range)	15 (2–72)	8 (4–67)	$p =$ ns
Ileostomy recurrence	3/4	3/3	$p =$ ns
Colostomy recurrence	7/8	12/12	$p =$ ns

Comparison of recurrence in patients with paraileostomy and paracolostomy hernias revealed no difference. There were six out of seven recurrences in patients with an ileostomy, and 20 out of 22 in patients with a colostomy. ($p = 1$ Fischer exact test).

A comparison was performed of whether the position of the stoma is relative to the rectus muscle affected recurrence. (Table 3) The stoma passed through the rectus muscle in 11 patients; in 15 patients the stoma was lateral to rectus. There were no data available in three patients. Of the three patients who did not have a recurrence, two had a stoma within the rectus muscle. In the remaining patient, it was not noted on the operation note whether the stoma passed through the rectus muscle, and they did not have a CT scan. All stomas that passed lateral to the rectus muscle recurred, and eight of the 10 stomas placed within rectus recurred. ($p = 0.15$).

Repair of the recurrence using a variety of techniques was performed in 15 out of 26 patients (57.7 %). Sutured repairs were performed in 10, because at the time this was part of our practice. Of these 10 patients, nine recurred again after a median of 14 months (range 4–62 months). Two stomata were re-sited, and neither had recurred after 5 years; one had the stoma re-sited, and a prophylactic biologic onlay mesh was placed at the new site, and the hernia recurred after 17 months; one had an onlay with prolene, with no recurrence after 5 years, and one had a retrorectus repair with HMDI cross-linked acellular porcine dermal collagen as part of an abdominal wall reconstruction. This patient had no recurrence after 2 years of follow-up.

Discussion

Parastomal hernia remains a challenging problem, and the optimal method of repair is not known. Reported rates of recurrence after parastomal hernia repair are variable, and published studies have used a combination of clinical and/or radiological methods for diagnosis, and there is no standardization [6].

Fig. 1 Recurrence after onlay mesh repair

In our series nearly 90 % of patients had recurrence of the parastomal hernia after a repair reinforced with onlay biologic mesh. Reported recurrence rates after onlay repair using biological mesh have not been as high as ours [3, 6, 8, 13]. However, short follow-up intervals, variable follow-up techniques and heterogeneous patient groups may vastly underestimate the true rate of recurrence after parastomal hernia repair. Even within our own initial series, published with a median follow-up of 16 months, the rate of recurrence was found to be much lower (57.7 %). We previously found that recurrence was related to the position of the stoma in the rectus sheath [13]. In fact with longer follow-up, it has become clear that stoma position within the rectus muscle may delay the onset of getting a recurrence, but it does not prevent it, with 80 % of patients still having a recurrence.

We know that the technique of the repair is important in influencing recurrence rates [14]. There is increasing evidence that retrorectus repair has a lower recurrence rate than onlay repair in patients having complex abdominal wall reconstruction [15, 16]. It is likely that long-term recurrence rates after parastomal hernia repair will also see similar differences after onlay and sublay repair, but randomised comparisons of technique are lacking. It is unclear to what degree the mesh choice influences the rate of recurrence [3]. Largely owing to their cost, many surgeons feel that a biological mesh is only indicated in cases of contamination where a synthetic mesh cannot be used. Some biologics may take longer to integrate completely and hence may lift off the sheath easier compared with certain synthetics, which adhere to the fascia more rapidly due to tissue ingrowth [17]. Whether the use of a biological mesh is associated with a higher recurrence rate than a synthetic mesh is a controversial topic, but a recent systematic review found no difference in recurrence rates. [18].

The recurrence predominantly occurred in one of two ways in our patients. The first was the mesh lifting off the anterior rectus sheath/external oblique aponeurosis (depending upon location) and the small bowel getting incarcerated between the mesh and rectus sheath. This tended to occur early. The second mechanism, seen later, was after the mesh had remodelled (>12 months) with the recurrence occurring through the central keyhole (Fig. 1). The shape of the Permacol was detectable, but it had been remodelled throughout by host tissue. The use of a keyhole technique may be an important factor in our rate of recurrence. It has been demonstrated that a hole in the centre of a mesh tends to enlarge over time giving the possibility of a recurrence through the keyhole defect. [14] Whilst aperture widening is true for mesh contraction in synthetic mesh, it has not been established for biologic mesh [19, 20].

The future may be in prevention of parastomal hernia with prophylactic mesh at the time of the index procedure, particularly for patients having formation of a permanent stoma [21, 22]. However, a recent randomised controlled trial using biologic mesh found that prosthetic reinforcement of stomas was safe, but it did not significantly reduce the incidence of parastomal hernia formation at 24 months [20]. We await longer-term follow-up, but even if prophylactic reinforcement of the stoma does decrease the

incidence of parastomal hernia, it is unlikely to completely eradicate the problem, and it will remain important to find the ideal technique and mesh for parastomal hernia repair.

Conclusion

Onlay repair of parastomal hernia with biologic mesh reinforcement results in unacceptably high recurrence rates and should not be performed.

Compliance with ethical standards

Conflict of interest AMW declares no conflict of interest. RV declares no conflict of interest. NJS declares conflict of interest not directly related to the submitted work. IRD declares conflict of interest not directly related to the submitted work.

References

1. Goligher J (1984) Surgery of the anus, colon and rectum. Balliere Tindall, London
2. Nugent KP, Daniels P, Stewart B, Patankar R, Johnson CD (1999) Quality of life in stoma patients. Dis Colon Rectum 42(12):1569–1574
3. Hotouras A, Murphy J, Thaha M, Chan CL (2013) The persistent challenge of parastomal herniation: a review of the literature and future developments. Colorectal Dis 15(5):e202–e214
4. Ellis CN (2014) Indication for the surgical management of parastomal hernias. Dis Colon Rectum 57(6):801–803
5. Ripoche J, Basurko C, Fabbro-Perray P, Prudhomme M (2011) Para-stomal hernia: a study of the French federation of ostomy patients. J Visc Surg 148:e435–e441
6. Hansson BM, Slater NJ, van der Velden AS, Groenewoud HM, Buyne OR, de Hingh IH, Bleichrodt RP (2012) Surgical techniques for parastomal hernia repair: a systematic review of the literature. Ann Surg 255(4):685–695
7. Ellis CN (2010) Short-term outcomes with the use of bioprosthetics for the management of parastomal hernias. Dis Colon Rectum 53(3):279–283
8. Slater NJ, Hansson BM, Buyne OR, Hendriks T, Bleichrodt RP (2011) Repair of parastomal hernias with biologic grafts: a systematic review. J Gastrointest Surg 15(7):1252–1258
9. Shabbir J, Chaudhary BN, Dawson R (2012) A systematic review on the use of prophylactic mesh during primary stoma formation to prevent parastomal hernia formation. Colorectal Dis 14(8):931–936
10. Petter-Puchner AH, Dietz UA (2013) Biological implants in abdominal wall repair. Br J Surg 100(8):987–988
11. Smart NJ, Bryan N, Hunt JA, Daniels IR (2014) Porcine dermis implants in soft-tissue reconstruction: current status. Biologics 8:83–90
12. Moreno-Matias J, Serra-Aracil X, Darnell-Martin A, Bombardo-Junca J, Mora-Lopez L, Alcantara-Moral M et al (2009) The prevalence of parastomal hernia after formation of an end colostomy. A new clinico-radiological classification. Colorectal Dis 11(2):173–177
13. Smart NJ, Velineni R, Khan D, Daniels IR (2011) Parastomal hernia repair outcomes in relation to stoma site with diisocyanate cross-linked acellular porcine dermal collagen mesh. Hernia 15(4):433–437
14. Hansson BM (2013) Parastomal hernia: treatment and prevention 2013; where do we go from here? Colorectal Dis 15(12):1467–1470
15. Nieuwenhuizen J, Eker HH, Timmermans L, Hop WC, Kleinrensink GJ, Jeekel J et al (2013) A double blind randomized controlled trial comparing primary suture closure with mesh augmented closure to reduce incisional hernia incidence. BMC Surg 13:48
16. Helgstrand F, Rosenberg J, Kehlet H, Jorgensen LN, Bisgaard T (2013) Nationwide prospective study of outcomes after elective incisional hernia repair. J Am Coll Surg 216(2):217–228
17. Smart NJ, Bryan N, Hunt JA (2012) A scientific evidence for the efficacy of biologic implants for soft tissue reconstruction. Colorectal Dis 14(Suppl 3):1–6
18. Darehzereshki A, Goldfarb M, Zehetner J, Moazzez A, Lipham JC, Mason RJ, Katkhouda N (2014) Biologic versus nonbiologic mesh in ventral hernia repair: a systematic review and meta-analysis. World J Surg 38(1):40–50
19. Nikberg M, Sverrisson I, Tsimogiannis K, Chabok A, Smedh K (2015) Prophylactic stoma mesh did not prevent parastomal hernias. Int J Colorectal Dis 30(9):1217–1222
20. Fleshman JW, Beck DE, Hyman N, Wexner SD, Bauer J, George V, PRISM Study Group (2014) A prospective, multicenter, randomized, controlled study of non-cross-linked porcine acellular dermal matrix fascial sublay for parastomal reinforcement in patients undergoing surgery for permanent abdominal wall ostomies. Dis Colon Rectum 57(5):623–631
21. Hauters P, Cardin JL, Lepere M, Valverde A, Cossa JP, Auvray S (2012) Prevention of parastomal hernia by intraperitoneal onlay mesh reinforcement at the time of stoma formation. Hernia 16(6):655–660
22. Lee L, Saleem A, Landry T, Latimer E, Chaudhury P, Feldman LS (2014) Cost effectiveness of mesh prophylaxis to prevent parastomal hernia in patients undergoing permanent colostomy for rectal cancer. J Am Coll Surg 218(1):82–91