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ORIGINAL ARTICLE

Radiological incidence of donor-site incisional hernia and parastomal hernia after vertical rectus abdominus myocutaneous flap-based reconstruction following colorectal surgery

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Abstract

Aim: A vertical rectus abdominis myocutaneous (VRAM) flap is commonly used to reconstruct perineal defects for low rectal and anal cancer. The incidence of midline incisional hernias after VRAM reconstruction varies from 3.6% when detected clinically to 50% when detected radiologically. The aim of this study is to accurately determine the radiological incidence of donor-site incisional and parastomal hernia following VRAM reconstruction.

Method: This was a retrospective cohort study of patients undergoing colorectal surgery requiring VRAM reconstruction over 10 years. Data were collected on patient demographics, indication for surgery and surgical procedure, including details of any hernia repair. Images from surveillance CTs were reviewed for the presence and size of midline incisional and/or parastomal hernias. Parastomal hernias were classified based on the European Hernia Society (EHS) classification.

Results: One hundred and seventy three patients were included in the analysis. The median age was 67 years (range 29–88 years) and the median length of follow-up was 49 months (interquartile range 24.3–71.0 months). The cumulative incidence of donor-site incisional hernia after VRAM at 1, 2 and 5 years was 15.1%, 25.4% and 29.1%, respectively. The cumulative incidence for PSH at 1, 2 and 5 years was 33.1%, 46.6% and 53.3%, respectively (95% CI 45.4%–60.5%).

Conclusion: Most patients who develop donor-site incisional hernia and parastomal herniation following VRAM tend to do so within the first 2 years. Although the use of CT imaging improves the diagnosis of donor-site incisional and parastomal hernias, the clinical significance of this is unknown.

KEYWORDS
colorectal cancer, incisional hernia, parastomal hernia, radiology, Vertical Abdominus Myocutaneous flap

INTRODUCTION

The management of perineal defects following surgery for pelvic malignancy continues to be debated, especially when the patient has undergone neoadjuvant radiotherapy [1, 2]. An approach is required to filling the 'dead space' and promoting effective wound healing to a previously irradiated area [2].

Typically, myocutaneous flap reconstruction is utilized when primary closure is not viable. Due to the good quantity of muscle with substantial underlying vasculature, the vertical rectus abdominis myocutaneous (VRAM) flap is deemed a suitable option for such cases. However, VRAM flaps are not without their complications with regards to donor site morbidity.

A systematic review conducted by Radwan et al. [2], analysing 64 studies involving 1673 patients who underwent VRAM flap reconstruction after pelvic oncological surgery, found that 315 patients (18.8%) experienced complications at the donor site, including abdominal wound dehiscence (5.6%), infection (4.4%) and incisional hernia (IH; 3.6%). Compared with other midline laparotomy studies, the incidence of IH appears low [3-5]. Most of the studies only included clinical diagnosis of hernias [2]. Relying solely on clinical diagnosis may obscure the true incidence of IH and parastomal hernia (PSH), and assessing the radiological incidence of hernias following VRAM reconstruction may provide a more accurate representation. A randomized controlled trial by Mortensen et al. [6] detected IH in the CT images (performed with elevated legs) of 50% of patients in the conventional closure group compared with 33% of patients in the mesh group at 1 year follow-up, suggesting that the true incidence of IH and PSH is higher than originally thought [6].

The primary aim of this study is to determine the radiological incidence of midline donor-site IH following VRAM flap reconstruction for pelvic oncological surgery for colorectal and anal malignancies at 1 year postoperatively. Secondary aims include radiological incidence of midline donor-site IH at 2 and 5 years post-operatively, the radiological incidence of PSH during 1–5 year follow-up, the difference in incidence between PSH in ostomies formed via the contralateral rectus muscle and the oblique muscles in those undergoing total pelvic exenteration (TPE; and thus bilateral ostomies) and to assess the variation of the hernia defect size over the follow-up period.

METHOD

This retrospective observational cohort study is reported according to the STROBE guidance [7]. All patients undergoing VRAM flap reconstruction for defects resulting from excision of colorectal and anal malignancies between July 2009 and February 2019 were included. Patients were either referred from primary care within our local health board (Swansea Bay University Health Board) or from external multidisciplinary teams (MDT) in Wales to the Swansea Colorectal MDT, a tertiary referral unit for advanced colorectal malignancies.

What does this paper add to the literature?

There is a paucity of literature on the true incidence of incisional and parastomal herniation after vertical rectus abdominis myocutaneous reconstruction of perineal defects following pelvic oncological surgery. This paper reports the radiological incidence of incisional and parastomal herniation, providing a more accurate representation of the true incidence.

Procedure

Excision surgeries were performed by experienced pelvic surgeons. The decision to proceed with flap reconstruction was made intraoperatively between the pelvic and reconstructive surgeons after assessing the residual defect following tumour excision. Extended VRAM flaps (30 cm × 8 cm) were raised using a fascia-sparing technique described by Butler and Rodriguez-Bigas [8]. The medial side of the flap is raised at the beginning of the procedure, preserving all perforating vessels and 2 cm or more of the anterior rectus sheath medially. The rectus muscle is then reflected laterally to expose the posterior rectus sheath, which is incised in the paramedian position. On completion of pelvic surgery, the rectus muscle is divided at the costal margin and the remainder of the flap is raised preserving as much of the anterior rectus sheath as possible laterally. Preserving the anterior sheath facilitates a more robust primary closure which is done in two layers (anterior and posterior sheath) with a polypropylene suture [1, 8, 9]. It was recorded intraoperatively whether the ostomy was formed through the rectus muscle on the contralateral side to the donor site in abdominoperineal excision (APER) operations or through the contralateral oblique muscles in cases of TPE with bilateral ostomies.

Data collection

Patient medical records and radiological imaging were reviewed retrospectively. Data were collected on patient demographics, surgical diagnosis, operative details from time of surgery as well as information from follow-up consultations.

Colorectal and anal cancer patients were chosen as all patients undergo a standardized follow-up programme using CT scanning at 1 and 2 years, with an additional CT at 5 years for colorectal cancer patients. Patients are referred to their local health boards for follow-up imaging. The time from operation to each CT scan was documented. Scans within 2 months either side of the 1, 2 and 5 year end-points were included to define the incidence rate at those time points. Scans which fell outside the specified time periods were also analysed to demonstrate the average time to hernia occurrence.

Scans were reviewed for the identified patients until July 2020. Scans for patients living within the local health board region were analysed

on the local imaging reporting system. Patient scans from other health boards in Wales were either analysed using the image viewing system available on the Welsh Clinical Portal system or requested from the health board and transferred to the local Synapse system for analysis.

An IH was defined as an abdominal wall gap with or without protrusion of intraperitoneal contents through a defect in the abdominal wall at the site of previous incision [10,11]. A PSH was defined as the protrusion of abdominal contents through the abdominal wall defect created by forming a stoma [12] and classified according to the European Hernia Society (EHS) classification for PSH [13] (Table 1). Hernia defects were measured with the maximum diameters of the defect in the abdominal wall at the musculofascial layer of the rectus sheath in both sagittal and axial views using the ruler function embedded within the local reporting programme system [14]. All scans were reported by a radiologist, or if reported by a registrar were validated by a consultant radiologist. Due to difficulties trying to ascertain the true incidence of surgical site infections (SSIs), either diagnosis of SSI by a clinician or a positive wound swab was deemed to be adequate for a diagnosis of SSI.

Data analysis

Statistical analysis was carried out with R (version 4.1.0). Patient demographics, length of follow-up and total number of scans were summarized with descriptive statistics (median, interquartile range) and results presented in percentages where appropriate. Chi-square testing was carried out for categorical variables and a p-value of <0.05 was deemed as statistically significant. Hernia-free survival curves for IH and PSH and the cumulative incidence at 1, 2 and 5 years were calculated using the Kaplan–Meier method and presented with 95% CIs. The cumulative incidence function (CIF) at 1, 2 and 5 years for IH and PSH was also calculated to account for death as a competing risk. The operation date was used as the start of the follow-up period and patients were followed up until the end of the follow-up period or death. Where hernia repair was undertaken or if a patient was lost to follow-up the data were then censored.

RESULTS

Demographics

One hundred and seventy six patients were identified from hospital records. Three patients were excluded as radiological data were unobtainable. One hundred and seventy three patients were included in the final analysis, of these 50.9% were female ($n = 88$) and 49.1% were male ($n = 85$). The median age of this cohort was 67 years (range 29–88 years) and the median length of follow up was 49 months (interquartile range 24.3–71.0 months). A total; of 80.4% patients were American Society of Anesthesiologists grade I–II. The most common indication for surgery was rectal cancer (76.4%). The majority of patients underwent an APER with (31.8%) or without (29.9%) an additional procedure. Defects were most frequently reconstructed with a right VRAM (86.2%). Patient demographics are illustrated in Table 2.

The mortality rate at 30 days was 0.6% ($n = 1$). This progressively increased to 7.5% at 1 year and 28.7% at 5 years. The 10 year all-cause mortality in our cohort was 40.2%. Seven patients (4.0%) had full-thickness abdominal wound dehiscence which necessitated a return to theatre. The SSI rate was 18.5% ($n = 32$).

A total of 909 CT scans were analysed. The median number of scans for each patient was four (range 1–24).

Donor site incisional hernia

Only 6.3% of donor site IHs were detected clinically during the follow-up period. The cumulative incidence of donor site IH at 1, 2 and 5 years was 15.1% (95% CI 6.5%–27.9%), 25.4% (95% CI 14.3%–36.6%) and 29.1% (95% CI 18.9%–40.2%), respectively. The hernia-free survival curve for donor site IH is illustrated in Figure 1. The CIF estimates at 1, 2 and 5 years for donor site IH were 7.5%, 15.2% and 27.5%, respectively.

At initial surgery 10.3% of patients had prophylactic mesh insertion. Compared with patients without mesh insertion, the occurrence of IH was not significant ($\chi^2 = 0.332$, $p = 0.565$). The diagnosis of a SSI was not significant either in the occurrence of donor site IH ($\chi^2 = 0.028$, $p = 0.95$).

Only three patients had operative intervention for their IH during the study period. Two patients had a single intervention, one with a retromuscular placement of a biological mesh (Permacol™) and one with a hybrid hernia repair device (Zenapro™) placed retromuscularly with unilateral posterior component separation. One patient had initial primary suture repair and subsequently required reintervention 7 months later due to the development of a small bowel fistula. This was managed surgically with posterior component separation with retromuscular placement of Strattice™.

Parastomal hernia

The incidence of PSH detected clinically was 19.7%. All PSHs were through rectus abdominis and there were no PSHs reported through

TABLE 1 European Hernia Society classification of parastomal hernias

Type	Definition
I	Parastomal hernia ≤5 cm without concomitant incisional hernia
II	Parastomal hernia ≤5 cm with concomitant incisional hernia
III	Parastomal hernia >5 cm without concomitant incisional hernia
IV	Parastomal hernia >5 cm with concomitant incisional hernia

TABLE 2 Patient demographics

	Number of patients (*N* = 173)	Percentage (%)
Sex		
Male	85	49.1
Female	88	50.9
Welsh multiple deprivation index quartile		
I	46	26.6
II	47	27.0
III	38	21.8
IV	42	24.1
Indications		
Anal cancer (total)	**31**	**17.9**
Anal SCC	*27*	*15.6*
Anal adenocarcinoma	*4*	*2.3*
Rectal cancer (total)	**132**	**76.3**
Recurrent disease	**8**	**4.6**
Recurrent rectal	*7*	*4.0*
Recurrent sigmoid	*1*	*0.6*
Invasive colonic cancer	**2**	**1.2**
Neoadjuvant therapy		
Chemotherapy		
Yes	98	56.6
No	36	20.8
No data	39	22.6
Radiotherapy		
Yes	140	80.9
No	33	19.1
ASA grade		
I	19	11.0
II	120	69.4
III	34	19.6
Preoperative stoma		
Yes	68	39.3
No	105	60.7
Primary operative procedure		
APER	**51**	**29.5**
With additional procedure[a]	*55*	*31.8*
Excision of pouch	**1**	**0.6**
Panproctocolectomy[a]	**2**	**1.2**
Posterior pelvic clearance	**14**	**8.1**
With additional procedure[a]	*5*	*2.9*
TPE	**39**	**22.5**
With additional procedure[a]	*6*	*3.5*
Reconstruction – VRAM		
Right	151	86.2
and bilateral IGAP flap advancement	1	0.6
and bilateral posterior thigh V–Y advancement flap	1	0.6
Left	20	11.5

Bold value indicates total for all anal cancer, italics value indicates numbers according to sub-types of anal cancer.

Abbreviations: APER, abdominoperineal excision; ASA, American Society of Anesthesiologists; IGAP, inferior gluteal artery perforator; SCC, squamous cell carcinoma; VRAM, vertical rectus abdominis myocutaneous.

[a]Additional procedures – examples include sacrectomy, coccygectomy, vaginectomy, prostatectomy and pelvic lymphadenectomy.

the obliques. All stomas formed through the obliques were urostomies ($n = 44$). The cumulative incidence for PSH at 1, 2 and 5 years was 33.1% (95% CI 23.6%–42.9%), 46.6% (95% CI 38.2%–54.5%) and 53.3% (95% CI 45.4%–60.5%), respectively. The PSH-free survival curve is illustrated in Figure 2. The CIF estimates at 1, 2 and 5 years for PSH were 1.8%, 5.7% and 22.1%, respectively. The EHS classification of PSH in our patient cohort changed with time. While most patients remain in classes I and II, there was an increase in the proportion of patients in classes III and IV as time progresses. (Table 3, Figure 3).

In total, 10 patients underwent PSH repair. Seven patients had a single procedure, the majority of whom ($n = 5$) had a local primary suture repair. The other two patients had biological mesh repair, one placed in the retrorectus plane. There was insufficient information on the plane of mesh placement in the second patient.

The remaining three patients required subsequent procedures following their first procedure. Operative information was unavailable for one patient. In the two patients for whom information was available, one had a primary suture repair and had an intraperitoneal keyhole repair using a biological mesh for their second procedure. The second patient had a retrorectus biological mesh repair primarily and in the second procedure had an intraperitoneal Sugarbaker repair with biological mesh.

DISCUSSION

Despite being a recognized complication, there are few studies which accurately assess the presence of hernias following VRAM. These studies, mainly case series, are limited by the retrospective nature, inadequate follow-up and lack of radiological diagnosis. To date, there are only two studies which report on the radiological incidence of hernias following VRAM [6,15].

The findings from the present study suggest that most patients who do develop IH or PSH tend to do so in the first 2 years, and these figures plateau thereafter. The radiological incidence of IH

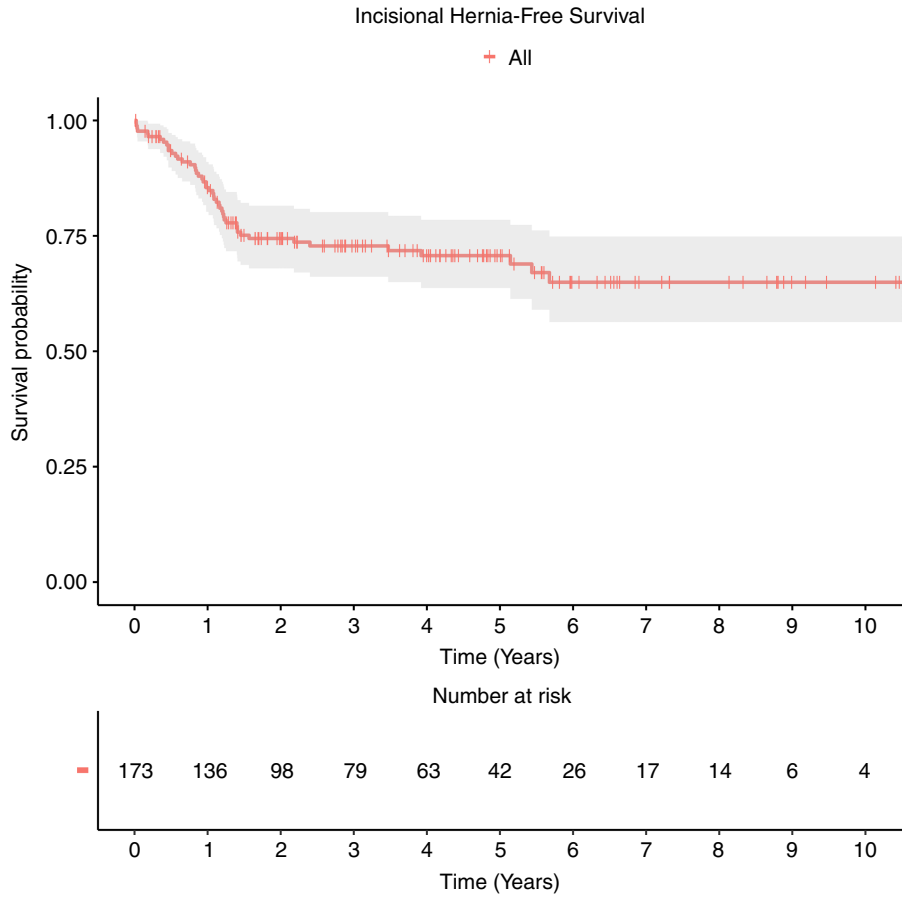

FIGURE 1 Hernia-free survival curve for donor-site incisional hernias

of 15.1% in our cohort at 1 year is consistent with results seen in a similar cohort study of VRAMs by Kim et al. [15]. This is lower than the cited figure of 50% at 1 year by Mortensen et al. [6], where CT imaging was performed with raised legs to simulate the Valsalva manoeuvre to demonstrate herniation. This is not routine in most clinical settings, particularly when the indication for imaging is cancer surveillance. Prophylactic mesh insertion did not make a significant difference in terms of occurrence of IH in our cohort, echoing the findings in a randomized controlled trial by Mortensen et al. [6], although it is appreciated that the numbers in both cohorts were small. The findings of a large retrospective cohort study (n = 192) by Schellerer [16] reported promising results with IH rates of only 6% with donor site reinforcement with Vypro® mesh compared with primary closure. Although not statistically significant, this suggests that prophylactic mesh insertion may have a role in hernia prevention in this patient group [16].

The incidence at 1 year is comparable to other studies following midline non-VRAM laparotomy, with commonly cited figures of 11%–20% [3–5]. Within the STITCH trial, the incidence of IH at 1 year diagnosed via clinical examination and/or radiological assessment was 16.8% [3]. The similar rates in this study and the STITCH trial suggests that there are inherent patient factors which predispose to hernia formation regardless of the surgical techniques used, as it is hypothetical to expect higher rates of IH following VRAM given the removal of the rectus muscle and some anterior sheath unilaterally.

The radiological incidence of PSH at 1 year (33.1%) and in the full follow-up period (53.3%) is consistent with the published literature (32%–44% at 1 year and up to 58% at 7 years) [17]. While the true incidence of PSH following formation of an ileal conduit is unknown, it has been reported to be up to 28% (n = 3170) in a review by Narang et al. [18]. It is therefore unusual that in the 44 patients in our cohort who had urostomies formed, none were detected. This suggests that in the case of bilateral ostomies from TPE, should hernias develop, these tend to occur preferentially at the colostomy/ ileostomy site via the rectus rather than at the urostomy site via the oblique muscles. A retrospective cohort study by Huang et al. [19] compared the incidence of PSH in extraperitoneal colostomy and colostomies formed through the abdominal internal and external oblique muscle gap after laparoscopic APER. They reported no occurrences of PSH in the oblique group radiologically or clinically after 24 months [19]. It is possible that the oblique muscles provide a protective factor in PSH formation, possibly due to the alternative fibre directions of the muscles, or due to the difference in the contents of the stoma (urine versus faeces) and therefore peristaltic forces applied to the trephine.

A large discrepancy exists between radiological and clinical diagnosis for both donor-site IH (29.1% vs. 6.3%) and PSH (53.3% vs. 19.7%). A

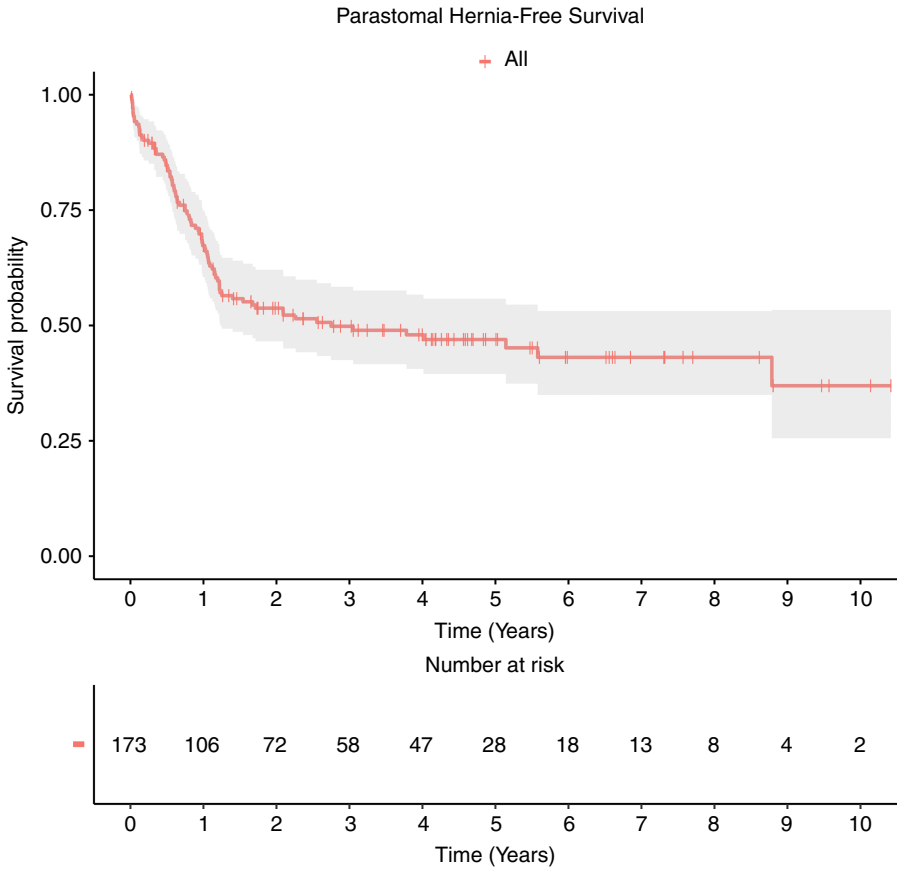

FIGURE 2 Hernia-free survival curve for parastomal hernias

Year (*N* = number of patients with PSH on CT scan)	EHS 1 (%)	EHS 2 (%)	EHS 3 (%)	EHS 4 (%)
Year 1 (*N* = 60)	36 (60)	12 (20)	12 (20)	0
Year 2 (*N* = 53)	24 (45.3)	12 (22.6)	11 (20.8)	6 (11.3)
Year 5 (*N* = 27)	10 (37.0)	9 (33.3)	6 (22.2)	2 (7.4)
Year 10 (*N* = 2)	1 (50)	1 (50)	0	0

TABLE 3 European Hernia Society (EHS) classification over time

systematic review by Kroese et al. [20] found that there was an increase in the rate of prevalence of IH with CT imaging compared with other diagnostic modalities (including clinical examination); they concluded that CT imaging provides the most accurate diagnosis [20]. Recent guidelines for reporting interventions in IH have therefore recommended CT imaging for detection within such trials [21]. In the case of PSH, the sensitivity of clinical examination ranges between 66% and 94%. While specificities up to 100% have been reported, negative predictive values of 63%–96% have been cited [18]. While CT imaging is recommended where clinical diagnosis of PSH is uncertain (or to aid surgical planning), the diagnosis can be missed up to 7% of the time. Interobserver reliability remains a challenge in the clinical diagnosis of these hernias [18,20].

Despite the high incidence of detected hernias, the number of patients undergoing surgical intervention in our cohort is small. Only three patients underwent a repair of their IH and 10 had a repair of their PSH. The reasons for this could be patient comorbidities and the risk of surgery outweighing the benefits, lack of symptoms warranting intervention or a lack of surgical experience/confidence in repairing complex hernias in the earlier part of the study period.

In general, up to 75% of patients diagnosed with PSH and a third with IH are symptomatic. These conditions have a significant impact on quality of life (QoL) and not infrequently lead to emergency presentations [22–24]. A cross-sectional study by van Dijk et al. [25] found that 56.8% of patients developed PSH following APER or Hartmann's. QoL was assessed with Short Form 36 (SF-36) and European Quality of Life 5 Dimension (EuroQol-5D) instruments and the Body Image Questionnaire (BIQ) and patients reported decrease in physical functioning and general health scores as well as increased pain. They also reported an increase in shame about the scar and a concurrent IH decreased patient scoring of the scar in the BIQ [25]. Similarly, Ramhorst et al. [26] assessed QoL outcomes with the SF-36 and FACT-C questionnaires in 519 patients who had VRAM reconstruction following pelvic exenterative surgery and found that at baseline, patients requiring flap reconstruction reported significantly lower scores for general health, physical component health summary, bodily pain and mental health. While scores improve for patients without (or minor) complications, patients with major flap complications (including long-term complications such as IH and PSH) scored significantly more negatively at 6 months for the area 'role physical' [26].

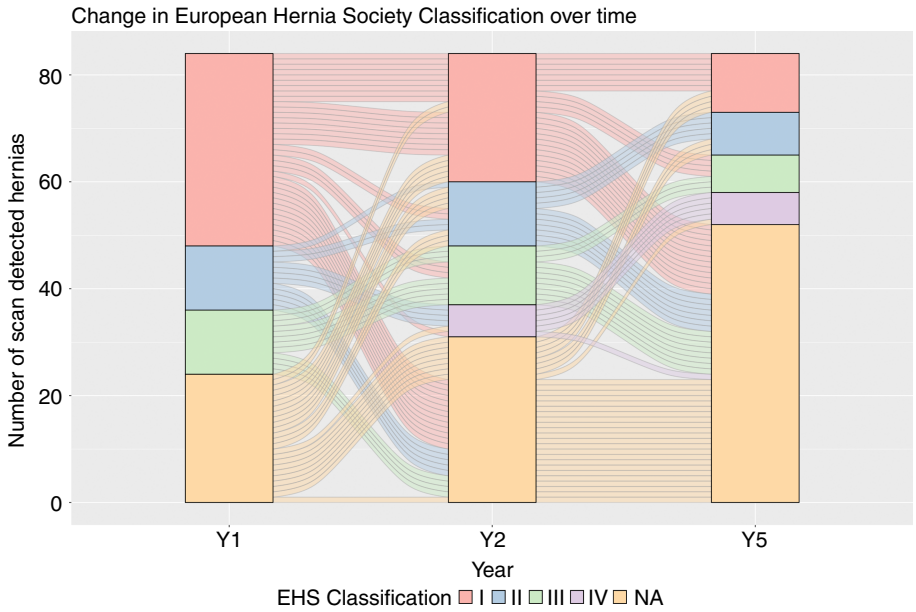

FIGURE 3 The change in European Hernia Society (EHS) classification for parastomal hernias with time

Several studies have reported on improved QoL outcomes in patients with IH following repair, although these are not necessarily cancer specific [27–30]. Jensen et al. [31] conducted a nationwide registry study on QoL specifically in CRC survivors. A total of 2466 patients were assessed using the European Organisation for Research and Treatment of Cancer (EORTC QLQ-C30) questionnaire and surgical repair was associated with improved scores in physical and role functioning [31]. Similarly, a cohort study by Feng et al. [32], which examined the QoL outcomes in patients with abdominal malignancy (not CRC-specific), found that in the 46 patients who underwent repair of their IH there was improvement in both abdominal wall specific (HerQLes) and cancer specific (FACT-G) QoL scores [32].

While we suggest that an improved diagnosis of hernia is important, our data do not support that this necessarily translates into clinical significance. We do acknowledge that no QoL assessments have been reported in this cohort of patients. As hernia surgery is carried out with the aim of improving the patient's QoL, diligent documentation on the presence of an IH or PSH and presence (or absence) of symptoms during the follow-up process is desirable, as well as evaluation of the extent of the impact on the patient's QoL.

This study aims to contribute to the available literature but is limited by its retrospective nature. While the length of follow-up extends to 10 years, follow-up is often carried out by surgical teams in the patient's local hospitals and the reporting of complications can be variable and not accurately captured. There is also a limitation in the interpretation of our results in the fact that most recurrences of colorectal or anal cancers tend to occur in the first 2 years [33–36] which could skew the data presented.

CONCLUSION

An understanding of the natural history and accurate knowledge of incidence of donor site IH and PSH following VRAM reconstruction offers benefits for preoperative counselling. While the use of CT imaging improves the diagnosis of donor-site IH and PSH, the clinical significance of this is unknown. The results from this study indicate that while the VRAM reconstruction technique remains a satisfactory option for reconstruction of perineal defects in colorectal surgery, IH and PSH continue to have a significant impact on abdominal wall function and QoL. Further work is required on hernia prevention in this patient group.

AUTHOR CONTRIBUTIONS

AT, GT, DM, PD, RLH conceptualised and designed the study. Data analysis and interpretation was performed by AT and RLH. AT, GT, PD and RLH were involved in the drafting and critical revisions of the article. All authors approved the final manuscript submitted for publication.

CONFLICT OF INTEREST

The authors have nothing to declare.

ETHICAL STATEMENT

The study protocol was reviewed by Swansea Bay University Health Board and deemed to be a service evaluation.

FUNDING INFORMATION

No funding was received for this work.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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