Retrospective Cohort Study

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Effect of differing flap reconstruction strategies in perineal closure following advanced pelvic oncological resection: a retrospective cohort study

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Introduction: Advancing approaches to locally invasive pelvic malignancy creates a large tissue defect resulting in perineal wound complications, dehiscence, and perineal hernia. Use of reconstructive flaps such as vertical rectus abdominus myocutaneous (VRAM) flap, gracilis, anterolateral thigh and gluteal flaps have been utilised in our institution to address perineal closure. The authors compared outcomes using different flap techniques along with primary perineal closure in advanced pelvic oncological resection.
Methods: A prospectively maintained database of patients undergoing advanced pelvic oncological resection in a single tertiary hospital was retrospectively analysed. This study included consecutive patients between 2014 and 2021 according to the Strengthening The Reporting of Cohort Studies in Surgery (STROCSS) criteria. Primary outcome measures were the frequency of postoperative perineal complications between primary closure, VRAM, gluteal and thigh (anterolateral thigh and gracilis) reconstruction.
Results: One hundred twenty-two patients underwent advanced pelvic resection with perineal closure. Of these, 40 patients underwent extra-levator abdominoperineal resection, and 70 patients underwent pelvic exenteration. Sixty-four patients received reconstructive flap closure, which included VRAM (22), gluteal (21) and thigh flaps (19). Perineal infection and dehiscence rates were low. Infection rates were lower in the flap group despite a higher rate of radiotherapy ($P < 0.050$). Reoperation rates were infrequent (< 10%) but specific for each flap, such as donor-site hernia following VRAM and flap dehiscence after thigh flap reconstruction.
Conclusions: In patients who are at high risk of postoperative perineal infections, reconstructive flap closure offers acceptable outcomes. VRAM, gluteal and thigh flaps offer comparable outcomes and can be tailored to the individual patient.

Keywords: abdominoperineal resection, ALT, flap reconstruction, gluteal, gracilis, pelvic exenteration, perineal reconstruction, VRAM

Introduction

Locally advanced pelvic malignancy has led to increasingly complex and radical surgery, often requiring excision of the whole pelvic floor. Practices including sacrectomy and lateral pelvic sidewall dissection to achieve R0 resection[1–3]. These procedures result in significant tissue loss, with heterogeneity in the perineal defects to be closed[4,5]. Patients undergoing pelvic oncological resection are frequently affected by complications relating to their perineal wound[2,6]. Common strategies to reduce the burden of such complications include biological mesh placement, and flap reconstruction[7]. While there are no specific American College of Colon and Rectal Surgeons (ASCRS) guidelines for this problem, Association of Coloproctology in Great Britain and Ireland (ACPGBI) published a position

HIGHLIGHTS

- In pelvic exenteration, reconstructive flaps aim to fill the pelvic dead space.
- Flap reconstruction was more frequently performed in patients at higher risk for perineal complications.
- Despite the higher risk, flap reconstruction was associated with lower rates of infection compared with primary closure.
- Vertical rectus abdominus myocutaneous, gluteal and thigh flaps each provide specific benefits and limitations.
- Flap reconstruction had low complications and selection should be tailored to patient needs.

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statement for closure of the perineal defect after abdominoperineal resection, concluding there was insufficient evidence to permit strong guidance on optimum closure techniques[8]. The BIOPEX study found that biological mesh did not improve wound healing or quality of life at 1-year follow-up; however, a recent report did conclude a reduction in perineal hernia rate at 5-year follow-up compared with primary closure[9]. Different centres have compared their techniques for flap reconstruction of the perineum in both extra-levator abdominoperineal resection (ELAPE) and pelvic exenteration cohorts[10–12]. This area is limited by the quality of evidence due to heterogeneity in terms of the disease and type of resection, the retrospective nature of data collection, and access to Plastic surgical support. The most frequently used flap techniques include vertical rectus abdominus myocutaneous flap (VRAM), gluteal, and thigh flaps such as gracilis and anterolateral thigh (ALT) flaps[13–15]. In this analysis of our patient cohort over a 7-year period, we investigated the techniques used for perineal closure from a prospectively maintained database in a tertiary referral centre for advanced pelvic oncology. The regional pelvic oncology surgical service was restructured in 2015, to co-site general and plastic surgical services. Our aim is to compare the use of flap closure compared with primary closure in advanced pelvic oncological resection and review clinical outcomes for both. Focus is given to comparing VRAM, gluteal and thigh (ALT or gracilis) flaps in patients undergoing ELAPE and pelvic exenteration.

Materials and methods

A prospectively maintained electronic clinical database at a single centre tertiary referral centre for advanced pelvic oncology service was utilised for data collection according to the Strengthening The Reporting of Cohort Studies in Surgery (STROCSS) criteria[16], Supplemental Digital Content 1, http://links.lww.com/JS9/A955. Inclusion criteria included patients referred for consideration of advanced oncological resection requiring beyond total mesorectal excisionl; extra-anatomical; or multi-visceral resection; consecutively from March 2014 until March 2021. This study was registered with the appropriate Caldicott guardian, with ethical approval for this audit was provided by the local NHS health board. This study was registered with clinicaltrials.gov and with ResearchRegistry.com. Study design is demonstrated in Supplementary Figure 1, Supplemental Digital Content 2, http://links.lww.com/JS9/A956.

Clinicopathologic data were accessed via electronic health care records and was fully anonymised. These data were corroborated by retrospective review of inpatient medical notes, clinic letters, and imaging reports. Data of interest included: patient demographics; recurrence status; neoadjuvant radiotherapy or chemotherapy; procedure details including flap reconstruction details; and complications.

Definitions

Abdominoperineal resection for rectal cancer was defined as total mesorectal excision to the pelvic floor including a perineal dissection outside the sphincter muscle complex. ELAPE is defined as above, but with a wide resection of the levator any muscles at their origins, thus leaving a larger pelvic floor defect[8]. Total pelvic exenteration was defined as complete en-bloc resection of the rectum, genitourinary organs, internal reproductive organs with associated regional lymph nodes and peritoneum. Anterior pelvic exenteration was defined as a resection including the bladder and internal reproductive organs (uterus, vagina, cervix, prostate, seminal vesicles). Posterior pelvic exenteration included resection of the rectum and resection of the internal reproductive organs without resection of the bladder[3]. All operations in this cohort were using an open approach and no minimally invasive cases were included.

Flap reconstruction

The requirement for flap reconstruction was assessed by the operating surgeon during the clinic consultation, in discussion with a consultant Plastic Surgeon with a specialist interest in perineal reconstruction. Patients were assessed preoperatively by the Plastic and Reconstructive team to permit a proposed plan for reconstruction and informed consent. No mesh repairs were used for perineal defect reconstruction. All flaps were pedicled and no free flaps were used.

VRAM flaps were raised on the deep inferior epigastric vessels from the abdominal musculature. The width of paddle taken was determined by the operator based on the defect to be filled and redundancy in the abdominal wall. The flap is raised with identification of the Deep inferior epigastric perforators, with an anterior rectus sheath preserving approach. The flap was then rotated into the pelvis. The muscle component is usually used to restore the pelvic floor, and the skin component may be de-epithelialised to obturate the pelvic cavity or for posterior wall of vagina reconstruction. The skin is almost never required to restore the perineal skin deficit. VRAM flaps are not used when bilateral stomata are indicated such as in total exenterations.

Gluteal V-Y flaps were raised based on doppler identification of superior or inferior gluteal artery perforator vessels. The medial portion of the flap may be de-epithelialised to permit rotation into the pelvic cavity to ensure obliteration of dead space.

Gracilis flaps were raised on the ascending branch of the medial circumflex femoral artery. This is a versatile flap that can be used in the setting of bilateral stomata; however, its small size means that often the ALT flap is preferred. The ALT flap is based on the lateral circumflex descending artery as a better option for filling dead space in larger pelvic defects. Composite ALT flaps were often taken with portions of vastus lateralis muscle and fascia lata, to help obturate pelvic dead space. The ALT flap is raised and tunnelled under the rectus femoris and sartorius muscles to reach the perineum. Representative images are shown in Fig. 1. Written informed consent was obtained from the patient for publication and any accompanying images, which are anonymised and not identifiable. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Endpoints

The primary endpoint was frequency of complications relating to reconstructive flap use comparing VRAM, gluteal and thigh flaps. Specific complications recorded included wound infection, flap dehiscence, flap sinus, flap necrosis, need for reoperation for the flap (<30 or >30 d following index operation), flap failure and perineal hernia. Secondary endpoints included frequency of complications with primary closure alone when compared with flap reconstruction, and a

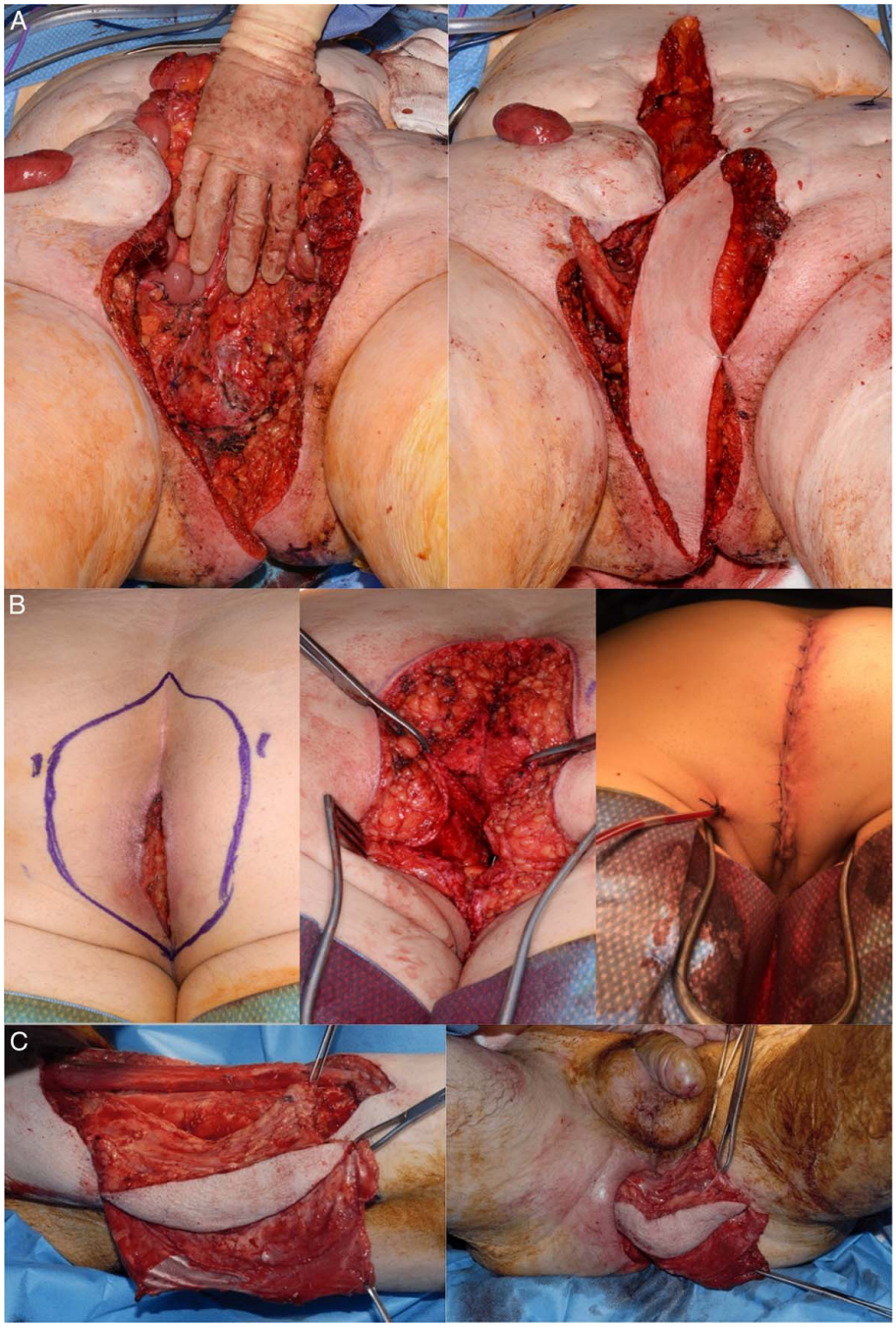

Figure 1. Representative example images of flap reconstructions. (A) Anterolateral thigh (ALT) with vastus lateralis combined flap. (B) Gluteal advancement flap. (C) ALT-vastus lateralis with fascia lata.

subgroup analysis to determine optimal flap use in patients undergoing ELAPE and pelvic exenteration.

Statistical analysis

Data are presented as mean with standard deviation. Categorical variables were analysed using χ^2 tests or Fisher's exact test, where appropriate. Continuous variables were determined with unpaired two-sided Student's *t*-tests or ANOVA. Analysis was performed using IBM SPSS Version 29.

Results

There were 311 patients identified from the advanced pelvic oncology database between March 2014 and March 2021. After excluding patients who did not proceed to surgical resection and patients who did not have sufficient data available, 199 patients were identified as having undergone major resection, and after exclusion of patients that did not require perineal closure, this left 122 patients for analysis (Table 1). This included 12 patients undergoing abdominoperineal resection, 40 patients undergoing ELAPE and 70

Table 1

Patient demographics in patients undergoing pelvic oncological surgery.

	Primary closure $n=58$	Reconstructive flap $n=64$	P
Age, mean (SD)	63.2 (10.5)	55.7 (13.9)	0.001
Sex			
Male	35	25	
Female	23	39	0.029
Cancer type			
Rectal adenocarcinoma	35	40	
Anal squamous cell carcinoma	3	21	
GIST	5	0	
Leiomyosarcoma	1	2	
Other	14	1	0.001
Primary/recurrence			
Primary	40	38	
Recurrent	18	26	0.255
Neoadjuvant			
Chemotherapy	29	41	
Nil	29	23	0.094
Radiotherapy	25	42	
Nil	33	22	0.023
Smoker			
No	36	30	
Former	10	22	
Current	12	12	0.032
BMI, mean (SD)	31.1 (20.9)	25.6 (6.1)	0.073
ASA			
1	2	2	
2	33	40	
3	23	21	
4	0	1	0.689
Operation type			
Abdominoperineal resection	8	4	
Extra-levator abdominoperineal excision	8	32	
Pelvic exenteration	42	28	<0.001
Urinary diversion	32	18	0.002
Sacrectomy	4	13	0.033
Vaginal reconstruction	0	29	N/A
Intraoperative blood transfusion			
Units transfused, median (range)	2.4 (3.7)	0.85 (2.2)	0.118
Blood loss (ml), mean (SD)	2203.9 (2472.4)	1657.8 (1757.6)	0.236
Critical care stay, mean (SD)			
ICU (level 3)	1.0 (2.3)	0.98 (2.7)	0.970
HDU (level 2)	6.6 (11.5)	5.6 (4.4)	0.545
Length of stay, mean (SD)	24.9 (21.7)	24.9 (21.7)	0.691

ASA, American Society of Anesthesiologists; HDU, High Dependency Unit; GIST, Gastro-intestinal stromal tumour.

patients undergoing pelvic exenteration. Underlying pathology was rectal adenocarcinoma in 61.5%, and 36.1% of patients were undergoing resection due to recurrent disease. In 54.9% of patients, preoperative radiotherapy was administered. No patients were re-irradiated prior to surgery. Mean follow-up for all patients in the cohort was 3.6 years (ranging from 396 to 2560 days).

Flap reconstruction patient characteristics

Sixty-four patients underwent flap reconstruction of their perineal defect, which represented a third of the patient cohort (Table 2). Patients who received flaps had a higher proportion of female patients ($P=0.029$), and higher rates of prior radiotherapy, compared with those undergoing primary closure ($P=0.023$). Of the patients undergoing ELAPE, 32 (80.0%) had a flap reconstruction, and 28 (40.0%) of patients undergoing pelvic exenteration had a flap reconstruction. Flap reconstruction consisted of VRAM in 21 patients, gluteal in 22, and thigh flaps in 19 patients (gracilis 12, ALT 3, ALT/vastus lateralis (VL)/fascia lata 3, VL 1). One patient had an oblique rectus abdominus flap, and one patient had multiple flaps including VRAM and bilateral gluteal flaps. Patients undergoing resection for salvage anal squamous cell carcinoma (SCC) were more likely to require a flap compared with other pathologies ($P\leq0.001$). Patients undergoing ELAPE were more likely to have a VRAM flap or gluteal flap, whereby patients undergoing pelvic exenteration by virtue of unavailability of the abdominal skin for flap use, were more likely to have a thigh flap ($P\leq0.001$). The mean BMI appeared to be slightly higher in patients receiving gluteal flaps when compared with the VRAM and thigh flap cohorts ($P=0.059$). Patient demographics for ELAPE and pelvic exenteration are displayed in Supplementary Tables 1, Supplemental Digital Content 3, http://links.lww.com/JS9/A957 and 2 respectively, Supplemental Digital Content 3, http://links.lww.com/JS9/A957. Thigh flap subgroup characteristics and outcomes are shown in Supplementary Tables 6, Supplemental Digital Content 3, http://links.lww.com/JS9/A957 and 7, Supplemental Digital Content 3, http://links.lww.com/JS9/A957, respectively.

Primary outcome assessment

In patients undergoing flap reconstruction, rates of postoperative infection were 7.9% which were equivalent between each group ($P=0.963$) (Supplementary Table 3, Supplemental Digital Content 3, http://links.lww.com/JS9/A957). Flap necrosis, failure and sinus formation were very uncommon in all patients who underwent flap reconstruction. Flap dehiscence occurred in 9.4% of patients; 3 dehiscence's occurred in patients with thigh flaps (15.0%), compared with only 1 patient in the VRAM and 2 in the gluteal flap cohorts ($P=0.790$). Only 1 occurrence of perineal hernia occurred in each flap cohort (all $\leq5.0\%$). Donor-site complications that were unique to the VRAM flap include incisional hernia (two patients, 9.5% of VRAM cohort). In one patient, this was identified by computed tomography scanning during an episode of postoperative obstruction but managed conservatively. The other patient had an elective incisional hernia repair with composite mesh. Reoperation was required in five patients in relation to their flap reconstruction. Two of these were in the VRAM cohort, both of which were elective re-operations beyond 30 days (Supplementary Table 4, Supplemental Digital Content 3, http://links.lww.com/JS9/A957). The other three patients all underwent reoperation during the same admission, of which one was for gluteal flap reconstruction and two in the thigh flap group. There were 17 patients that underwent sacrectomy (of which 10 were pelvic exenterations, Table 2). Four patients underwent S5 sacrectomy where no reconstructive flap was used, where no significant perineal dissection was required. In the 13 patients with sacrectomy who underwent flap reconstruction, the sacrectomy levels were S3 ($n=2$), S4 ($n=3$) and S5 ($n=8$). There were no high sacrectomy (S1/S2) cases in this cohort and for the cases with S3 sacrectomy VRAM flaps were generally used. Thirteen (76%) of the 17 patients with sacrectomy had flap reconstruction, Of the 10 pelvic exenteration patients undergoing sacrectomy, 8 (80%) had flap construction. Primary closure did not permit vaginal reconstruction, but vaginal reconstruction was

Table 2

Patient demographics for patients receiving flaps in pelvic oncological surgery.

	VRAM *n* = 21	Gluteal *n* = 22	Thigh *n* = 19	Composite *n* = 1	*P*
Age, mean (SD)	56.8 (12.9)	58.1 (13.5)	52.5 (14.3)	64.4	0.445
Sex					
Male	7	11	7	0	
Female	14	11	12	1	0.606
Cancer type					
Rectal adenocarcinoma	15	10	12	1	
Carcinoma unknown primary	1	1	0	0	
Anal squamous cell carcinoma	6	10	3	0	
Cervical leiomyosarcoma	0	1	1	0	
Other	0	0	3	0	0.658
Primary/recurrence					
Primary	15	13	9	1	
Recurrent	6	9	10	0	0.328
Neoadjuvant					
Chemotherapy	13	14	12	1	
Nil	8	8	7	0	0.872
Radiotherapy	14	16	11	1	
Nil	7	6	7	0	0.564
Smoker					
No	8	9	13	0	
Former	3	4	5	0	
Current	10	9	1	1	0.270
BMI, mean (SD)	23.3 (6.2)	28.6 (5.1)	25.2 (6.2)	18	0.059
ASA					
1	0	2	0	0	
2	13	14	13	0	
3	8	6	5	1	
4	0	0	1	0	0.535
Operation type					
Abdominoperineal resection	2	1	0	0	
Extra-levator abdominoperineal excision	17	15	0	0	
Pelvic exenteration	2	6	19	1	< 0.001
Urinary diversion	0	3	15	0	< 0.001
Internal iliac artery division	2	2	8[a]	0	0.011
Sacrectomy	5	3	5	0	0.791
Vaginal reconstruction	13	8	7	1	0.171
Intraoperative units transfused, mean (SD)	0.2 (0.5)	0.2 (0.4)	2.75 (3.7)	0	0.001
Blood loss (ml), mean (SD)	1062 (990)	875 (577)	2770 (2255)	Unknown	0.006
ICU (Level 3)	1.3 (2.7)	0.4 (1.8)	1.3 (2.2)	0	0.661
HDU (Level 2)	4.9 (2.7)	6.2 (4.9)	6.8 (6.0)	5.0	0.593
Length of stay, mean (range)	22.3 (12.9)	20.3 (12.4)	33.8 (33.156)	24	0.303

[a]Four of eight cases with IIA division were specifically the distal branches or anterior division of IIA only.
ASA, American Society of Anesthesiologists; HDU, High Dependency Unit; IIA, internal iliac artery; VRAM, vertical rectus abdominus myocutaneous.

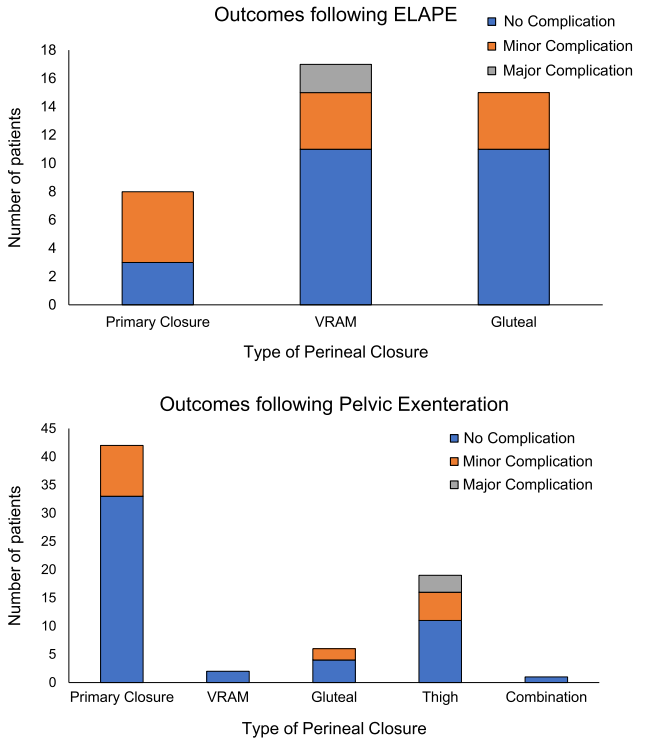

Figure 2. Outcomes with reconstructive flap closure after ELAPE and pelvic Exenteration. ELAPE, extra-levator abdominoperineal resection; VRAM, vertical rectus abdominus myocutaneous.

performed in 29 patients (45.3%) that underwent flap reconstruction. Of these, female patients undergoing flap reconstruction had vaginal reconstruction in 87% in the VRAM group, 80% of the gluteal group and 50% in the thigh flap group. Outcomes in ELAPE and pelvic exenteration patients are illustrated in Fig. 2.

Pelvic exenteration subgroup analysis

Those with anal SCC requiring salvage exenteration had high rates of flap formation due to wide perineal excision. Those exenteration patients that received flaps were often in the setting of re-operative surgery for recurrent disease [flaps in 14/43 patients undergoing surgery for primary disease (33%), compared with 13/26 patients with recurrent disease (50%)]. Of the exenteration patients that underwent flap reconstruction, higher rates of neoadjuvant chemotherapy and radiotherapy were used ($P < 0.05$). Exenteration patients requiring flap reconstruction were more likely to be female, compared with those undergoing primary closure. Wound infection rates in patients with flaps were 7.1% compared with 13.8% in the primary closure only group (Supplementary Table 5, Supplemental Digital Content 3, http://links.lww.com/JS9/A957). Only two cases of perineal hernia were observed in patients undergoing pelvic exenteration—with one patient in the primary closure group and one in the flap group.

Discussion

The present study compared the use of VRAM, gluteal and thigh flaps in the reconstruction of the perineal defect following major pelvic oncological resection. The use of some form of

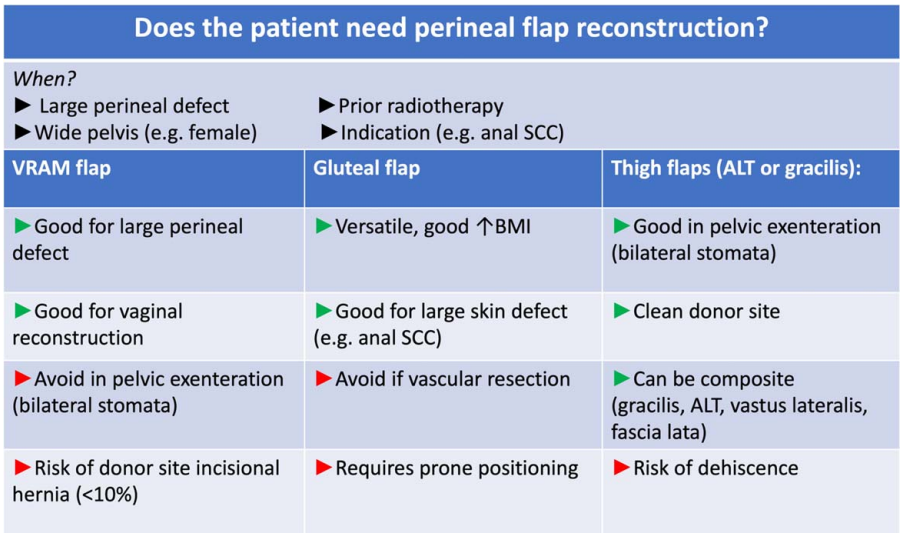

Figure 3. Summary for the use and selection of flap reconstruction in patients undergoing advanced pelvic oncological resection. ALT, anterolateral thigh; SCC, squamous cell carcinoma.

reconstructive flap was required in 80.0% of patients undergoing ELAPE and 40.0% in patients undergoing pelvic exenteration.

Multiple variables influence whether a flap is used in perineal reconstruction. Many of these are operator dependent and therefore add a degree of selection bias into any such study on flap reconstruction. Our institution does not use mesh to support the pelvic floor in this setting. Factors which are taken into consideration whether a flap should be used include size of perineal defect—specifically the width of the pelvic cavity—which is often wider in females explaining the higher use of flaps in this group. In smaller defects, omentum, residual bladder, or colon can sometimes obturate the space sufficiently. This is a collaborative decision between experienced surgical oncologists, reconstructive plastic surgeons and the patient. Other factors include the need for vaginal reconstruction and whether the patient preoperatively has indicated a preference to restore or maintain some degree of sexual function. Choice of flap type again is operator and institution dependent, as can be seen by the preference for ALT flaps in MD Anderson[17] and gluteal flaps in St Thomas' London[18]. In our institution, VRAM is often preferred for patients who require vaginal reconstruction as the skin paddle is ideally placed to reconstruct the posterior wall, with up to 87% of female patients with VRAM flaps receiving vaginal reconstruction. The ALT flap is used more frequently in total exenteration cases. Gracilis tends to be used in patients who have very narrow pelvic cavities, or in cases where there may be medical concerns about prolonged operating time as it is a very quick flap to raise and inset. We have summarised the use and selection of flap reconstructive options in Fig. 3. While the retrospective nature of this study precludes concluding definite recommendations, this illustration reflects our practice based on clinical experience and judgement, which is in part supported by the data provided.

The data herein demonstrate that in fact the patients who underwent primary closure had low rates of infection, dehiscence, reoperation and perineal hernia suggesting appropriate patient selection. Sexual function cannot be restored with primary closure, while skin flaps and VY flaps do allow some reconstruction of the vagina and are an important consideration given increasing number of young female patients requiring aggressive pelvic oncological resection[19]. While 40.0% may seem like a low rate of flap use in patients undergoing pelvic exenteration, this is likely to reflect primary site of tumours higher in the pelvis requiring multi-visceral resection and thus a smaller perineal defect when compared with ELAPE patients where aetiologies such as anal SCC result in a large perineal defect.

Flap reconstructions do come with limitations. The operative time is generally longer, there are additional incisions and risk to surrounding structures and they each carry their own unique set of risks and side effects. We prefer a combined approach to plastic and urological reconstruction to minimise anaesthetic exposure time and this influences flap choice given gluteal flaps are formed in the prone position. Most patients who had a VRAM flap had undergone ELAPE. These patients often have a sizeable perineal defect explaining the high rates of flap reconstruction. As they will have an end colostomy, which will be their only stoma, then a VRAM flap is a more optimal choice given the bulk and ability to fill dead space with this flap. Very few patients had infection or dehiscence in the postoperative period. Donor-site hernia is a concern with the VRAM flap, particularly given an open very large laparotomy incision which may often be a reoperation[20]. This occurred in 9.5% of the VRAM patients, and the same number of patients required a delayed reoperation which was on an elective basis. VRAM, as well as ALT flaps can be used to restore the anatomy of the pelvic floor preventing herniation into the resection space. The 'marine patch' principle applies where the flap lies on the side of hydrostatic pressure, so even if there is perineal skin breakdown then the muscle flap component still provides cover for the abdominal contents. Compared with Baird and colleagues, we reserved VRAM flaps for this reason to APR and ELAPE patients. VRAM is not used in exenteration in our centre due to two stomas being formed during urinary diversion[10]. Nevertheless, they found similar rates of incisional herniae at the abdominal donor site. VRAM flaps are likely to reduce in frequency over time given the upsurge in Robotic

assisted ELAPE. Such changes in surgical practice are reassuring for, reducing the burden of such large incisions. Additionally, our series has shown that gluteal and thigh alternatives are associated with comparable outcomes.

Gluteal flaps were more commonly used in patients undergoing ELAPE. Outcomes in our cohort were very acceptable, with infection, dehiscence, reoperation rate, perineal hernia rate all being under 10.0%. In our cohort, in patients with anal SCC a gluteal flap was used more frequently (10 patients in this cohort) compared with other patients. Gluteal flaps requiring pronation of the patient and the associated additional time and increased position related complications. In pelvic exenterations involving pelvic sidewall dissection and internal iliac artery ligation, gluteal flaps are not feasible due to resection of the blood supply and thus a thigh flap is preferred. Gluteal flaps appear to have the lowest rate of donor-site complications when compared with VRAM and thigh flaps.

Thigh flaps consisted of gracilis, ALT or a combination of thigh components and was popularized by Yu *et al.*[21]. This type of flap was used much more commonly in patients undergoing pelvic exenteration. The primary reason for this is that in patients requiring both a colostomy and an ileal conduit, this limits the use of the VRAM flap. By comparison, the donor site in the thigh is clean and separate from the abdominal and pelvic dissection. This was the flap of choice by our Plastic and Reconstructive team in 78.9% of patients undergoing total pelvic exenteration. Patients receiving thigh flaps were more likely to have undergone a large multi-visceral resection, will have undergone urinary diversion and have had higher rates of blood loss compared with patients receiving primary closure and other flap types. Three patients (15.8%) who had thigh flaps undergoing pelvic exenteration had dehiscence, with two patients requiring reoperation during the same admission. However, these are patients undergoing major surgical stress and a high frequency of pelvic collections and as such this rate of complication is low. The mean intraoperative blood loss may be considered high, with ELAPE patients losing ~1 l blood loss and exenterative patients up to 2.5 l. We believe this reflects the patients which are from a tertiary referral centre specialising in multi-visceral resection. These patients undergoing ELAPE are on the more complex spectrum where extended resection are often required such as sacrectomy, pre-sacral fascia, or pelvic sidewall resection and often in heavily irradiated field and/or reoperative setting.

The rate of infection and flap failure is lower in this cohort when compared with Jacobs and colleagues[15]. It is of note that their rate of flap formation is 19%, and it may be that where flaps are used more routinely to close the perineal defects then outcomes are favourable. We report a similar number of thigh flaps compared with Tiernan and colleagues and other studies, however, in our cohort all the patients underwent exenteration rather than APR[11,22,23]. While they report a higher rate of minor complications such as dehiscence, the reoperation rate is similar to our findings. Our findings are also in keeping with a recent meta-analysis on flaps compared with primary closure in AP resection and pelvic exenteration[24].

The limitations of this study include the retrospective nature and as such one cannot compare directly compare outcomes between primary closure and flap reconstruction. The patient undergoing flap reconstruction has already been deemed to have a large perineal defect and thus is high risk from primary closure, compared with patients who have been deemed to have a defect appropriate for closure. In addition, in our cohort, patients who had previous radiotherapy were more likely to have a flap construction. However, these data are provided to demonstrate the denominator (patients not receiving flaps), reflecting the importance of patient selection. Despite this, the higher risk patients who required flap reconstruction have rates of infection, dehiscence, reoperation and perineal hernia which are as low as those that required only primary closure. Similarly, caution should be given when trying to compare different flap types due to the inherent bias of the type of patient deemed to need a thigh flap compared with a VRAM flap. As the patients who underwent flap reconstruction have plastic surgical follow-up with documented consultations relating to their wound, this is a potential source of bias as wound concerns are more likely to be recorded compared with patients with primary closure who will have follow-up with surgical oncology only. A further factor that one cannot control for is plastic surgical bias. Reconstructive surgeons are likely to have preferred techniques for perineal flap reconstruction depending on training and experience, which may vary between patients within this study as well as other institutions.

In summary, patients undergoing advanced pelvic oncologic resection continue to be at high risk of perineal wound complications. This report demonstrates the use of flap reconstruction in ~78% of ELAPE patients and 32% of pelvic exenteration patients, permitting low rates of complications in those undergoing flap reconstruction. VRAM flaps were reserved for ELAPE, with good outcomes with donor-site hernia rate of 9%. Thigh flaps were most frequently used in pelvic exenteration, and although a dehiscence rate of 16% was observed the reoperation rate was as low and no different from other flap groups. Gluteal flaps were versatile, used in ELAPE and exenteration, with equally low rates of infection, dehiscence, and reoperation. The authors view on flap selection is that there is not one preferred flap that suits all patients as a default. Increasingly, where a minimally invasive approach may be adopted, VRAMs are used less commonly to avoid donor-site complications which negate the MIS benefits. Gluteal flaps are generally selected for SSC cases when a wide perineal defect is anticipated. Thigh flaps such as ALT and VL are selected when smaller defects are anticipated. However, the factors affecting flap selection are complex, multifactorial and are influenced by disease factors, patient factors and surgeon factors. With such comparable outcomes, we advocate a bespoke approach to the selection and use of flap reconstruction based on margin of resection, stoma siting and defect size, which can be personalised to the patient and their wishes.

Ethical approval

Institutional approval by NHS Greater Glasgow and Clyde, Coldicott guardian approved (Ref: CGACK12102022). The study has been registered with clinicaltrials.gov (NCT0569 6002).

Consent

Written informed consent was obtained from the patient for publication and any accompanying images, which are anonymised and not identifiable. A copy of the written consent is

available for review by the Editor-in-Chief of this journal on request.

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Author contribution

Study design—N.G., C.S., M.Q. Data collection—N.G., C.M., L.D., J.L., M.H. Data analysis—N.G. Writing—N.G., C.S., M.H. Reviewing and editing manuscript—L.S., S.W., J.T., P.C., M.Q., C.W.

Conflicts of interest disclosure

There are no conflicts of interest by any of the authors relating to the work in this manuscript.

Research registration unique identifying number (UIN)

This study was registered with clinicaltrials.gov and with ResearchRegistry.com.

Guarantor

Norman Galbraith and Colin Steele.

Data availability

The data are derived from an, anonymised prospectively recorded clinical database and is available on request.

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Patient consent

All patients gave consent and for images specific written consent for publication was obtained. Written informed consent was obtained from the patient for publication and any accompanying images, which are anonymised and not identifiable. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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