Rectus abdominis myocutaneous flaps for perineal reconstruction: modifications to the technique based on a large single-centre experience

DM McMenamin[1], D Clements[1], TJ Edwards[1], AR Fitton[2], WJP Douie[1]

Departments of [1]Colorectal Surgery and [2]Plastic and Reconstructive Surgery, Derriford Hospital, Plymouth, UK

ABSTRACT

INTRODUCTION Perineal wound breakdown with delayed wound healing represents a significant cause of morbidity following surgery and radiotherapy to the perineum. The rectus abdominis myocutaneous (RAM) flap has been used increasingly to reconstruct the perineum with good effect. We describe our six-year experience of reconstruction of the perineum with the RAM flap and share some surgical adjuncts we believe are useful.

METHODS We conducted a retrospective case note review of all patients who underwent a reconstruction of the perineum using the RAM flap between August 2003 and October 2009. Indications for the flap, complication rates and outcomes were all observed.

RESULTS We conducted 16 RAM flap procedures, 15 of which (94%) were primary repairs and 1 (6%) a secondary repair. Three (19%) developed donor site hernias, two (12.5%) developed minor perineal wound infections, eight (50%) developed minor perineal wound breakdown and in one (6%) flap failure was observed. No perineal hernias were observed. There were no surgical mortalities.

CONCLUSIONS The RAM flap has a high success rate and an acceptable morbidity rate and is a useful tool in the reconstruction of complex perineal wounds. Modifications to the standard surgical technique may reduce complications and improve the versatility of this flap.

CORRESPONDENCE TO

Walter Douie, Consultant Colorectal Surgeon, Derriford Hospital, Derriford Road, Crownhill, Plymouth PL6 8DH, UK
E: walter.douie@phnt.swest.nhs.uk

Since Miles first described the operation of abdominoperineal resection (APR) in 1908,[1] delayed perineal wound healing has been recognised as a problem. Over the last few decades, based on documented reduced local recurrence rates,[2] there has been an increased utilisation of pelvic radiotherapy in the treatment of anal and rectal carcinomas. This has had a detrimental effect on wound healing in those patients subsequently coming to surgery. More recently, the adoption of the cylindrical extralevator abdominoperineal excision with resultant larger perineal defects and pelvic dead space may also have compounded the problem. There can be considerable morbidity from these perineal wounds and their increased use has demanded newer strategies to deal with the problem. One such strategy is the use of myocutaneous or myofascial flaps to fill these defects.

First described by Mathes and Bostwick in 1977,[3] the rectus abdominis myocutaneous (RAM) flap has been used in the reconstruction of surgical defects at various sites of the body.[4–6] Its use in filling complex perineal defects, however, was first described by Shkula and Hughes in 1984[7] and

later popularised by Tobin and Day.[8] Due to its robustness, simplicity in execution and versatility, the RAM flap is now an established technique in the armamentarium of many colorectal and reconstructive surgeons across the UK.

We present our experience of this technique in a large teaching hospital over a six-year period and highlight various modifications to the technique in an attempt to minimise morbidity based on our growing experience, which others may find useful in their practice.

Methods

Patients who had undergone an APR and had reconstruction with a RAM flap over a six-year period between August 2003 and October 2009 were identified from an operative database. The case notes of these patients were reviewed. Patient demographics and the utilisation of neoadjuvant radiotherapy were recorded. The surgical diagnosis and whether the flap was employed with the primary surgery or as a secondary salvage procedure was also noted.

MCMENAMIN CLEMENTS EDWARDS FITTON DOUIE

RECTUS ABDOMINIS MYOCUTANEOUS FLAPS FOR PERINEAL RECONSTRUCTION: MODIFICATIONS TO THE TECHNIQUE BASED ON A LARGE SINGLE-CENTRE EXPERIENCE

Figure 1 Finished rectus abdominis myocutaneous flap with the addition of interrupted nylon sutures to bolster the flap to withstand the shearing forces created by sitting
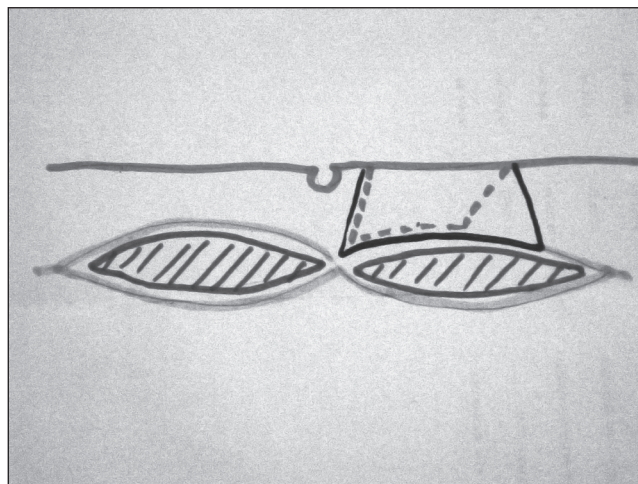
Figure 2 Schematic diagram to show the modification developed taking only the medial part of the rectus sheath. This is to reduce the incidence of incisional hernias. Dotted line indicates the modified incision.

The initial APR technique was supine. However, the authors have since changed their technique to prone APR and have not found this to be an impedance to using a RAM flap. The perineal part is an extralevator cylindrical dissection in all patients. After mobilising the flap, it is sutured in the correct orientation to the specimen. The abdomen is closed and the patient is turned. On completion of the perineal part of the operation, the specimen is extracted and the flap is delivered with it. The suture will have held it in the correct orientation.

A standard technique for flap reconstruction was employed and any variations on this technique along with the reasons for this variation were recorded. The patients were followed up in the outpatient clinic according to the standard cancer protocol in our institution. They were seen at six weeks after surgery and then every three months for the first year and every six months for the second year. Following this, the patients were reviewed annually until discharge at five years after the resection.

Postoperative data on general or specific complications were noted. Specific data sought included perineal wound breakdown, perineal wound infection, flap necrosis and flap failure. Furthermore, donor site incisional hernias and functional defects left from removal of the rectus muscle were also specifically sought at follow up and the presence of perineal hernias was documented. Recurrence of disease in the case of carcinoma diagnosis was recorded.

Our standard technique

A RAM flap based on the deep inferior epigastric artery and vein was employed. A marked skin paddle was incised starting at the level of the umbilicus and extending cephalad to the costal margin. The width of the skin paddle was determined by a combination of the size of the perineal defect to be filled and the mobility of the abdominal wall so that the resultant defect could be closed. The subcutaneous fat

was incised to the anterior rectus sheath. The rectus sheath was incised as an ellipse, extending the incision inferiorly to expose the whole of the rectus muscle. The muscle was divided by coagulation several centimetres superior to the skin and fascial paddle.

The flap was raised out of the rectus sheath from superior to inferior. At the level of the arcuate line, the inferior epigastric artery and vein was identified as it enters the muscle laterally. The attachment of the rectus muscle to the symphysis pubis is generally left intact to add support to the inferior epigastric vessel and prevent 'bowstringing' and twisting of this vessel. An incision was made in the peritoneum suprapubically to create a gutter for the flap to lie in and the flap was rotated through a 270° somersault to reach the pelvic floor. The flap was sutured in place with subcuticular sutures and reinforced with interrupted nylon sutures.

The abdominal wall was closed with nylon sutures, incorporating the anterior and posterior rectus sheath from where the rectus muscle had been removed. This was always possible and was made easier if not too large a fascial defect had been created in the anterior rectus sheath at the site of flap elevation as the flap can survive adequately on the umbilical perforators alone. Care was again taken when incorporating the posterior peritoneal layer below the arcu-

Table 1 Initial diagnosis	
Initial diagnosis	**Numbers involved**
Low rectal carcinoma	9 (56%)
Anal canal squamous carcinoma	4 (25%)
Rectal/perianal Crohn's disease	1 (6%)
Vulval carcinoma	1 (6%)
Ischiorectal sarcoma	1 (6%)

MCMENAMIN   CLEMENTS   EDWARDS   FITTON   DOUIE

RECTUS ABDOMINIS MYOCUTANEOUS FLAPS FOR PERINEAL RECONSTRUCTION: MODIFICATIONS TO THE TECHNIQUE BASED ON A LARGE SINGLE-CENTRE EXPERIENCE

Table 2	Demographics and complications							
Case	Initial diagnosis	CT	RT	Other medical/ surgical treatment	Risk factors for healing	Surgical procedure	Complications	Recurrent disease	Age at operation
1	Low rectal carcinoma	No	Yes	Nil	RT	APR + 1° VRAM flap	Superficial wound breakdown	Nil	76
2	Sarcoma left buttock	No	No	Previous resection with positive margins	Nil	APR + 1° VRAM flap; sacrectomy	Superficial wound breakdown	Nil	68
3	Low rectal carcinoma	No	No	Previous APR with wound breakdown	Nil	Debridement + 2° VRAM flap	Nil	Nil	83
4	Advanced low rectal carcinoma	No	No	Defunctioning colostomy	Nil	APR + 1° VRAM flap	Low haemoglobin requiring 3-unit blood transfusion; superficial wound breakdown; flap failure	Developed pulmonary metastasis	29
5	Vulval carcinoma	Yes	Yes	Multiple vaginal dilatations	NIDDM	APR + 1° VRAM flap	Nil	Deep seated recurrence	69
6	Low rectal carcinoma	Yes	Yes	Nil	RT/CT	APR + 1° VRAM flap	Nil	Nil	63
7	Anal squamous cell carcinoma	Yes	Yes	Nil	RT/CT	APR + 1° VRAM flap	Superficial wound breakdown; abdominal wall hernia	Nil	80
8	Low rectal carcinoma	Yes	Yes	Nil	RT/CT	APR + 1° VRAM flap	Minor wound infection; abdominal wall hernia	Nil	75
9	Low rectal carcinoma involving vagina	Yes	Yes	Nil	RT/CT	APR + 1° VRAM flap; TAH	Nil	Nil	57
10	Anal squamous cell carcinoma	Yes	Yes	Nil	RT/CT	APR + 1° VRAM flap	Superficial wound breakdown	Nil	84
11	Anal squamous cell carcinoma, rectovaginal fistula	Yes	Yes	Nil	Nil	APR + 1° VRAM flap	Superficial wound breakdown	Pelvic recurrence; patient died	70
12	Low rectal carcinoma	No	Yes	Nil	Nil	Total proctocolectomy + 1° VRAM flap	Superficial wound breakdown	Nil	67
13	Crohn's disease	No	No	Laparotomy/ileostomy; seton – severe perineal disease	Long course steroids	Panproctocolectomy + 1° VRAM flap	Superficial wound breakdown	Nil	30
14	Anal squamous cell carcinoma	Yes	Yes	Nil	RT/CT	APR + 1° VRAM flap	Nil	Groin recurrence; patient died	59
15	Low rectal carcinoma	No	Yes	Defunctioning colostomy	RT	APR + 1° APR	Perineal abscess – drained	Nil	50
16	Low rectal carcinoma	Yes	No	Nil	CT	APR + 1° APR	Relaparotomy for small bowel hernia	Nil	54

APR = abdominoperineal resection; CT = chemotherapy; NIDDM = non-insulin-dependent diabetes mellitus; RT = radiotherapy; TAH = total abdominal hysterectomy; VRAM = vertical rectus abdominis myocutaneous

MCMENAMIN   CLEMENTS   EDWARDS   FITTON   DOUIE

**RECTUS ABDOMINIS MYOCUTANEOUS FLAPS FOR PERINEAL
RECONSTRUCTION: MODIFICATIONS TO THE TECHNIQUE BASED ON
A LARGE SINGLE-CENTRE EXPERIENCE**

Table 3 Complication rates	
Complication	**Numbers involved**
Minor perineal dehiscence	5 (31%)
Perineal cellulitis	4 (25%)
Postoperative bleeding from flap	1 (6%)
Flap failure	1 (6%)
Delayed donor site hernia	3 (19%)
Recurrence of carcinoma	5 (31%)
Deaths within 30 days	0 (0%)
Deaths after 30 days	3 (19%)

Figure 3   Rectus flap pedicle with the origin still attached to
the symphisis pubis

ate line so as not to compromise the flap, bearing in mind
that this layer would not add strength to the closure.

If the patient had had surgery such as an open appen-
dicectomy or a previous stoma brought through the rectus
abdominis muscle, preference was given to the use of the
other rectus muscle to create the flap. Where this was im-
practical, we reviewed the preoperative contrast enhanced
computed tomography with a radiologist and confirmed pa-
tency of the appropriate inferior epigastric vessel prior to
using this side for the flap.

Results

Patient demographics

Sixteen patients were identified. The mean age was 63.6
years (range: 29–83 years). All patients underwent a RAM
flap for reconstruction of their perineum. There were eight
men and eight women. One patient (6%) underwent surgery
for extensive perineal sepsis from Crohn's disease whereas
the remainder had surgery for a malignant process. The
most common diagnoses were low rectal carcinoma fol-
lowing radiotherapy or perineal squamous cell carcinoma
where chemoradiotherapy had failed to control the disease
(Table 1).

Fifteen patients (94%) underwent a primary repair and
one patient (6%) had a secondary repair two years after pri-
mary surgery. Six female patients had part of their posterior
vaginal wall excised and reconstructed with the flap. Two
of sixteen flaps were muscle-only flaps without the cutane-
ous paddle, one due to morbid obesity and the other due to
technical ease. Both were used for vaginal reconstruction
and both healed primarily. One RAM flap was an oblique
flap whereas the other fifteen flaps were vertical RAM flaps.
The oblique flap was fashioned as it allowed for a larger
cutaneous paddle than was possible with the vertical flap to
fill a particularly large cutaneous defect following excision
of a large vulval carcinoma.

Eleven patients (69%) had risk factors that would pre-
dict poor wound healing, nine having received preopera-
tive long course radiotherapy, one with diabetes and one on
long-term steroids. In three of the sixteen flaps, the origin of
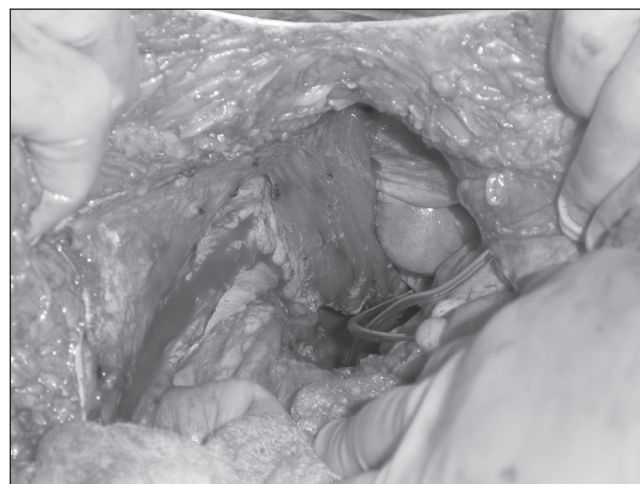the rectus abdominis muscle was detached from the pubic

tubercle to gain extra length, thus leaving the flap suspend-
ed on the vascular pedicle alone. In three patients the donor
site defect left after removal of the rectus muscle and sheath
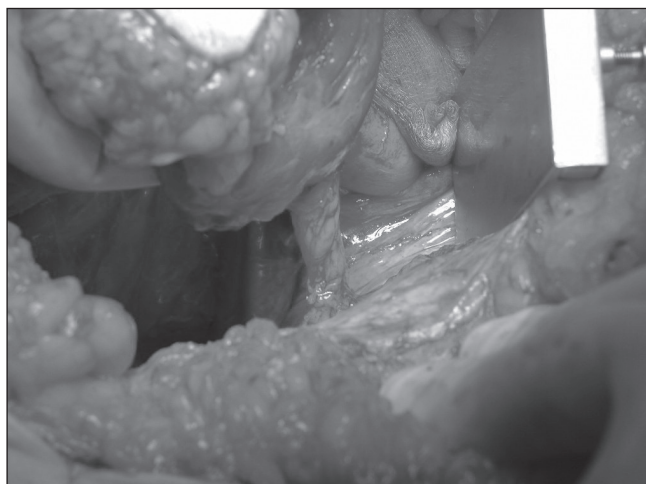was reinforced with a Prolene® mesh.

Complications

Five patients (31%) had a partial superficial wound dehis-
cence of the perineal wound in the early postoperative pe-
riod requiring resuturing under local anaesthesia. Four of
these (25%) occurred in our first eight patients and prompt-
ed a change from subcuticular absorbable sutures to bol-
stering the wound closure with interrupted nylon sutures to
deal with this problem. Four patients (25%) developed mi-
nor degrees of perineal cellulitis as judged clinically. These
were treated successfully with antibiotics. We experienced
one (6%) flap failure requiring excision of the flap. This oc-
curred in one of three patients who had the origin of the
rectus abdominis detached from the symphysis pubis, pos-
sibly resulting in tension or torsion to the vascular pedicle.
One patient (6%) developed early postoperative bleeding
from the flap in the perineum, requiring a three-unit blood
transfusion, a return to the operating theatre and diathermy
of the offending muscular branch.

Five of fifteen patients (33%) having surgery for a can-
cer diagnosis developed a recurrence of their disease: two
patients developed distant metastases (adenocarcinomas),
one a pelvic nodal recurrence (squamous carcinoma) and
two a deep pelvic local recurrence (one adenocarcinoma,
one squamous cell carcinoma). Three of these patients sub-
sequently died of their disease.

Donor site hernias were seen in three of our first eight
patients. There were no hernias evident in the latter eight
patients. We employed Prolene® mesh support on three of
the latter eight donor sites as well as making some technical
modifications to the harvest technique in these patients. To
date, we have had no donor site hernias in these patients. In
addition, we have had no instances of perineal hernias for the
duration of follow-up. No patients have reported functional

MCMENAMIN   CLEMENTS   EDWARDS   FITTON   DOUIE

RECTUS ABDOMINIS MYOCUTANEOUS FLAPS FOR PERINEAL
RECONSTRUCTION: MODIFICATIONS TO THE TECHNIQUE BASED ON
A LARGE SINGLE-CENTRE EXPERIENCE

Figure 4   Pedicle only after it has been detached from the symphisis pubis. The flap is shown at the top left hand side of the picture in the surgeon's hand. The vertical structure in the centre of the picture is the pedicle.

Figure 5   For reconstructing a very large defect a larger oblique rectus flap can be taken.

deficits from the loss of the rectus abdominis muscle used for the reconstruction. A summary of complications is given in Table 2, together with the rate of complications in Table 3.

Modifications to the technique

We have developed several technical modifications to the above described technique, which we believe are useful surgical adjuncts:

1. The addition of interrupted nylon sutures to the mono-filament subcuticular closure was employed due to the minor wound dehiscences that occurred. Since this modification to the technique, there have been no further dehiscences (Fig 1).
2. In order to reduce the incidence of incisional hernias, we have altered the way the flap is harvested. Instead of taking the anterior rectus sheath to correspond to the full width of the rectus muscle, we now take only the medial part of the sheath, leaving the lateral 50%. The flap therefore runs on fewer perforating vessels but the major perforators are preserved. In addition, we now occasionally reinforce the donor site with mesh in selected patients, which is sandwiched between the anterior and posterior rectus sheaths. Since this modification, we have had no incisional hernia occurrences (Fig 2).
3. If the flap will not comfortably reach the perineum and extra length is required, the muscle origin from the sym-physis pubis can be detached. This creates extra length but possibly makes the flap more vulnerable. Figure 3 shows the rectus flap pedicle with the origin still attached to the symphisis pubis and Figure 4 shows the pedicle after it has been detached.
4. When a very large defect needed to be reconstructed, then a larger flap could be taken, using a transverse or oblique RAM flap. The shape and size of the flap could be matched directly to the shape and size of the defect (Fig 5).
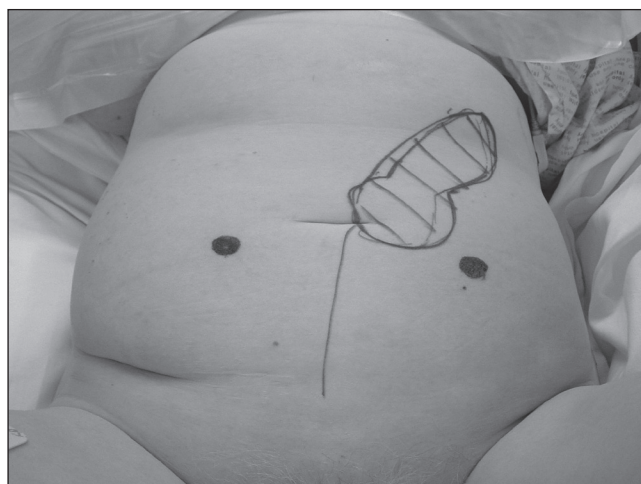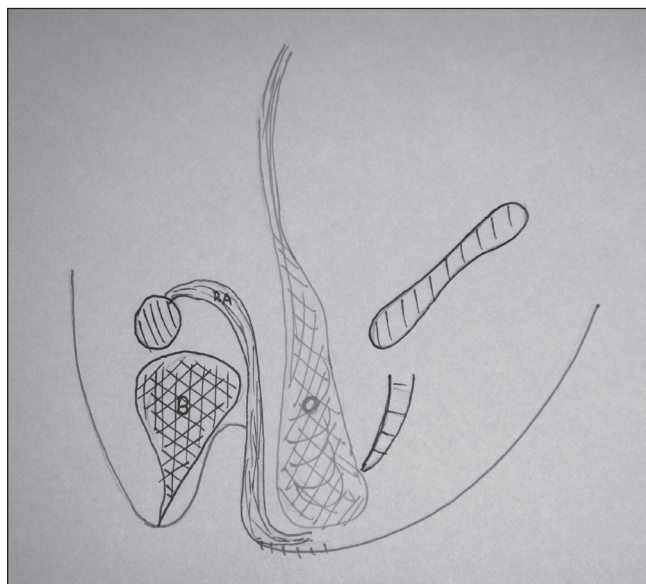
5. There are occasions when the posterior vaginal wall has been excised and the perineal defect is not very large. In this instance, we took a muscle-only flap to reconstruct the posterior vaginal wall (Fig 6). This technique is also useful in the very obese, where skin paddle necrosis is a significant risk, as was the case in one of our patients.

Discussion

Colorectal surgeons are encountering patients who have had neoadjuvant radiotherapy with increasing frequency. This is due to the results of several trials, of which the most recent was CR07.[2] The decrease in local recurrence achieved may be offset by the increase in wound morbidity seen in irradiated patients. While it is perfectly achievable to primarily close the perineum in non-irradiated patients or in those with a small defect, those patients post irradiation who have had an extralevator dissection pose a challenge in terms of wound closure and healing. It has been shown that a non-healing wound can complicate an APR in up to 51% of patients.[9] Bullard *et al* reported a major wound complication rate of 35% out of 160 APR patients.[10] These results have meant that advancements in surgical technique have been necessary to improve wound healing.

The transfer of vascularised non-irradiated tissue into the wound has been shown to improve healing and prevent wound dehiscence. This is due to the fact that blood flow to the area is increased, bringing with it oxygen and healthy, functioning leukocytes.[11]

The use of the RAM flap to close the perineal defect has been reported in 19 papers and in 5 of these outcomes were improved with the use of a RAM flap reconstruction. A series of 49 patients who had primary reconstruction with a RAM flap has been published,[9,12] with major wound breakdown occurring in only one patient. In the most recent paper published, this figure was 17% for all types of myocutaneous flaps.[13] Our results compare favourably with the above, with only one flap failure but otherwise no major wound break-

MCMENAMIN CLEMENTS EDWARDS FITTON DOUIE

RECTUS ABDOMINIS MYOCUTANEOUS FLAPS FOR PERINEAL
RECONSTRUCTION: MODIFICATIONS TO THE TECHNIQUE BASED ON
A LARGE SINGLE-CENTRE EXPERIENCE

Figure 6 Muscle-only flap for reconstructing the posterior vaginal wall. The 'O' indicates omentum, which has been mobilised and placed into the pelvis, and the muscle-only flap is indicated with 'RA' (rectus abdominis).

down and minor wound breakdown in 31%.

We had only one flap loss (6%) in our series and this occurred in a patient in whom we divided the muscular attachment to the symphysis pubis and so the pedicle was unsupported. This is similar to the reported rate of 2% by Sunesen[12] and the <5% flap necrosis reported previously in the literature.[14] We believe that if the origin is divided, then the flap does need a suture to support it to the bladder or pelvic side wall to minimise traction on the pedicle. We have modified our technique to include this suture since we had the flap failure.

The only other major complication we experienced was an episode of postoperative bleeding from the flap, which required a return to theatre and diathermy of a small muscular branch. There were three instances of similar haemorrhage reported in the large review paper.[9]

One of the concerns regarding the raising of a RAM flap is the potential increase in abdominal wall complications. In the paper by Abbott *et al* abdominal wound dehiscence was reported.[15] However, this was a paper that looked exclusively at the oblique RAM flap. Nisar and Scott reported 10 fascial dehiscences in 385 patients.[9] This gave a dehiscence rate of 2%. Others have reported rates of between 0% and 11%.[12,16–18] In our series we had a 19% incisional hernia rate, which is comparable with the literature. As all of these (3) occurred in our first eight patients, we have adopted the practice of reinforcing the donor site with mesh if it appears to be at risk of an incisional hernia due to patient size, build or being under tension at closure. Mesh was used by Weiwei *et al* in all five of their reported cases[18] and Petrie *et al* in 50% of their cases.[11]

We experienced minor wound dehiscence in a few cases. This was due to the fact that the flap was exposed

to increased pressure and shearing forces from sitting. We therefore began closing the wound with subcuticular monofilament sutures followed by interrupted nylon, a technique not reported elsewhere. Since this modification, we have had no further problems with superficial dehiscence. The nylon interrupted sutures are removed after two weeks.

Abbott *et al* described the oblique RAM flap, taking a larger paddle of skin in an oblique direction in their case series of 16 patients.[15] We have also used this modification when there is a very large defect to close. In our series this occurred after the excision of a large vulval carcinoma.

We have also harvested a muscle-only flap in the case of vaginal reconstruction, leaving the fascia and the skin from the donor site intact. The muscle reconstruction is left to epithelialise itself over time. The reconstructed vagina is packed initially and the patient is taught subsequently to use dilators in order to prevent stenosis. This modification has not been described elsewhere.

During the course of the series of patients, we changed our technique from supine to prone APR. This has been thought to be a hinderance to using a RAM flap. However, we have developed a method of ensuring the flap remains in the correct orientation while the patient is turned on the operating table. Just before the abdomen is closed, the flap is sutured in the correct orientation to the specimen. When the specimen is delivered through the perineum, the flap is drawn through in the correct orientation. This modification has also not been described elsewhere.

There are alternative techniques to the RAM flap to reconstruct the perineum. The inferior gluteal artery flap has been described,[19] as has the use of biological mesh.[20] We have used both these techniques. The inferior gluteal artery flap, however, has no bulk to fill the pelvis and instead just covers over the defect. In addition, we found the use of biological mesh to be associated with a significant incidence of seroma formation and infection.

Conclusions

Comparison of our case series with previously published results is favourable, with complication rates similar to previously published series. The RAM flap is a robust solution to the problem of reconstructing the perineum after extralevator APR. We have presented our case series together with our modifications, which we feel are useful in the treatment of this difficult problem.

References

1. Miles WE. A method of performing abdominoperineal excision for carcinoma of the rectum and of the terminal portion of the pelvic colon. *Lancet* 1908; **2**: 1,812–1,813.
2. Sebag-Montefiore D, Steele R, Quirke P *et al*. Routine short course pre-op radiotherapy or selected post-op chemoradiotherapy for resectable rectal cancer? Preliminary results of the MRC CR07 randomised trial. *J Clin Oncol* 2006; **24**: 18S.
3. Mathes S, Bostwick J 3rd. A rectus abdominis myocutaneous flap to reconstruct abdominal wall defects. *Br J Plast Surg* 1977; **30**: 282–283.
4. Deo SV, Nootan KS, Niranjan B, Dinesh K. Vertical rectus abdominis myocutaneous flap cover for lower abdomen, chest wall, groin and thigh defects following resection of malignant tumours. *Indian J Cancer* 2001; **38**: 33–37.

MCMENAMIN CLEMENTS EDWARDS FITTON DOUIE

RECTUS ABDOMINIS MYOCUTANEOUS FLAPS FOR PERINEAL RECONSTRUCTION: MODIFICATIONS TO THE TECHNIQUE BASED ON A LARGE SINGLE-CENTRE EXPERIENCE

5. Brierly RD, Pereira JA, Arnstein PM. Use of a vertical rectus abdominis myocutaneous flap in bilateral groin dissection for recurrent carcinoma of the penis. *Urol Int* 1998; **61**: 243–246.

6. Sakai S, Takahashi H, Tanabe H. The extended vertical rectus abdominis myocutaneous flap for breast reconstruction. *Plast Reconstr Surg* 1989; **83**: 1,061–1,067.

7. Shkula HS, Hughes LE. The rectus abdominis flap for perineal wounds. *Ann R Coll Surg Engl* 1984; **66**: 337–339.

8. Tobin GR, Day TG. Vaginal and pelvic reconstruction with distally based rectus abdominis myocutaneous flaps. *Plast Reconstr Surg* 1988; **81**: 62–73.

9. Nisar PJ, Scott HJ. Myocutaneous flap reconstruction of the pelvis after abdominoperineal reconstruction. *Colorectal Dis* 2009; **11**: 806–816.

10. Bullard KM, Trudel JL, Baxter NN, Rothenberger DA. Primary perineal wound closure after preoperative radiotherapy and abdominoperineal resection has a high incidence of wound failure. *Dis Colon Rectum* 2005; **48**: 438–443.

11. Petrie N, Branagan G, McGuiness C *et al*. Reconstruction of the perineum following anorectal cancer excision. *Int J Colorectal Dis* 2009; **24**: 97–104.

12. Sunesen KG, Buntzen S, Tei T *et al*. Perineal healing and survival after anal cancer salvage surgery: 10-year experience with primary perineal reconstruction using the vertical rectus abdominis myocutaneous (VRAM) flap. *Ann Surg Oncol* 2009; **16**: 68–77.

13. Chan S, Miller M, Ng R *et al*. Use of myocutaneous flaps for perineal closure following abdominoperineal excision of the rectum for adenocarcinoma. *Colorectal Dis* 2010; **12**: 555–560.

14. Ghouti L, Houvenaeghel G, Moutardier V *et al*. Salvage abdominoperineal resection after failure of conservative treatment in anal epidermoid cancer. *Dis Colon Rectum* 2005; **48**: 16–22.

15. Abott DE, Halversn AL, Wayne JD *et al*. The oblique rectus abdominal myocutaneous flap for complex pelvic wound reconstruction. *Dis Colon Rectum* 2008; **51**: 1,237–1,241.

16. Pocard M, Tiret E, Nugent K *et al*. Results of salvage abdominoperineal resection for anal cancer after radiotherapy. *Dis Colon Rectum* 1998; **41**: 1,488–1,493.

17. Allal AS, Laurencent FM, Reymond MA *et al*. Effectiveness of surgical salvage therapy for patients with locally uncontrolled anal carcinoma after sphincter-conserving treatment. *Cancer* 1999; **86**: 405–409.

18. Weiwei L, Zhifei L, Ang Z *et al*. Vaginal reconstruction with the muscle-sparing vertical rectus abdominus myocutaneous flap. *J Plast Reconstr Aesthet Surg* 2009; **62**: 335–340.

19. Boccola MA, Rozen WM, Ek EW *et al*. Inferior gluteal artery myocutaneous island transposition flap reconstruction of irradiated perineal defects. *J Plast Reconstr Aesthet Surg* 2010; **63**: 1,169–1,175.

20. Wille-Jørgensen P, Pilsgaard B, Møller P. Reconstruction of the pelvic floor with a biological mesh after abdominoperineal excision for rectal cancer. *Int J Colorectal Dis* 2009; **24**: 323–325.