Primary Abdominal Wall Reinforcement With Synthetic Mesh Following Harvesting of Vertical Rectus Abdominis Myocutaneous Flaps in Multivisceral Pelvic Resections

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Abstract

Following multivisceral pelvic resections, the pelvis and perineum are often reconstructed using myocutaneous flaps. Abdominal wall defects after harvesting rectus abdominis flaps can be reinforced with mesh. Primary reconstruction using synthetic mesh was presently evaluated. Fifty-eight patients who underwent multivisceral pelvic resection and perineal reconstruction with a vertical rectus abdominis myocutaneous (VRAM) flap, January 2004 to February 2014, were retrospectively reviewed. The abdominal wall was reinforced in 26. Demographics, treatment procedures, surgical procedures, length of hospital and ICU stay, early and late morbidity at the recipient and donor sites were recorded. Patients with mesh reinforcement were significantly younger than those without. There were no further significant differences in patient demographics or treatment procedures between the two groups. In 31% of the patients with mesh, surgery was performed on two consecutive days, although total operating time did not differ significantly. Patients without mesh bled more. Surgery was associated with considerable morbidity, without significant differences in overall complication rate between the two groups. At the recipient site, wound infection/ dehiscence was the most common early complication. The group with mesh had higher rate of total flap necrosis necessitating re-operation. At the donor site, wound infection /dehiscence, hernia, or bulge were recorded. Patients with mesh had lower rates of donor site morbidity. Perineal reconstruction with VRAM flap and primary abdominal wall reinforcement with mesh is feasible after multivisceral resection. Our study indicates that primary use of mesh can be applied in potentially contaminated surgical fields in oncologic patients without increasing morbidity and with improved long-term cosmetic results.

Introduction

Multivisceral pelvic exenteration often represents the only option for sustainable treatment of patients with primary or recurrent advanced pelvic malignancy (1,2). Musculocutaneous flaps are commonly used to fill the resulting intra-abdominal void created by the exenteration and to reconstruct the pelvic floor and perineum. VRAM flaps weaken the abdominal wall, which can be reinforced using mesh (3,4). Due to potential contamination of the surgical field, there has been considerable controversy regarding implantation of foreign material, primarily, in the abdominal wall (5).

The aim of the present study was to ascertain whether primary reconstruction of the abdominal wall with mesh after pelvic exenteration and harvesting of VRAM flaps is associated with increased risk of complications. An additional objective was to determine whether patient demographics or treatment procedures could identify specific indications for use of abdominal wall reinforcement in this setting.

Patients and Methods

We conducted an observational retrospective cohort study of all patients at our hospital who underwent extended perineal resection for pelvic malignancy and received a VRAM flap for perineal reconstruction. Prior to the surgery, the patients were given radiotherapy (50–60 Gy) in the lower pelvis and perineum and concomitant chemotherapy. Surgery was planned five weeks later and was performed on average 41 days (range 38-46 d) after neoadjuvant treatment. A total of 58 patients were operated between January 2004 and January 2014. No reinforcement of the flap donor site was done during the period 2004–2009 (32 patients), whereas from 2009 to 2014 the abdominal wall was reinforced using synthetic mesh (26 patients).

All in- and out-patient medical records were systematically reviewed, and data on the two groups (i.e., those with and those without mesh reinforcement) were analyzed. Clinical data on patient demographic characteristics, comorbidity status, and tumor histology are shown in Table 1. There were fewer female patients in the group without mesh reinforcement. The patients with mesh were significantly younger, and one fourth of them were receiving immunosuppressive therapy other than the oncological chemotherapy. There were no differences in BMI or comorbidity between the two groups. Tumors were either adenocarcinomas of the rectum or anal squamous cell carcinomas.

Surgical Techniques

Operations were conducted as one- or two-session procedures depending on the duration of the oncological part of the surgery and the expected duration of the reconstruction. In two- session procedures, the first stage (day 1) included removal of the tumor, and the second stage (day 2) comprised reconstruction of the perineum and reinforcement of the abdominal wall as appropriate. Perineal resection was performed with the patient in prone jackknife position. Patients were kept on a ventilator in the intensive care unit (ICU) during the non- procedural overnight interval.

In all procedures, general anesthesia was combined with epidural analgesia. When possible, VRAM flaps were rised from the contralateral to the stoma site as described by Tei et al. (6). The flaps consisted of muscle and the overlying adipose tissue and skin, and were raised based on the inferior epigastric artery, including the medial but sparing the lateral perforating vessels. The flap was rotated intra-abdominally to fill the pelvic defect, with the skin paddle oriented vertically, to

Table 1. Demographics of the 58 patients who received VRAM flaps for abdominal wall reconstruction with and without mesh reinforcement

		No mesh n = 32	Mesh n = 26	
Gender	Female n (%)	18 (56)	20 (77)	
Age (years)	Median (range)	67 (50–83)	63 (32–79)	p < 0.05
BMI	Median(range) > 30 (n)	23.7 (15.6–36.0)3	24.0 (19.4–36.6)4	
Comorbidity (n)				
	Lung disease	4	2	
	Heart disease	5	9	
	Kidney disease	1	1	
	CVI	5	2	
	Diabetes	2	1	
Smoking (n)		18	11	
Immunosuppression (n)	Steroids Other	2 0	5 2	
Histological tumor type (n)	Adenocarcinoma	25	16	
	Squamous cell carcinoma	7	10	

Fisher's exact probability test

provide ample tissue for reconstruction of the pelvic floor and the vagina as necessary.

The abdominal wall at the donor site was reinforced with polypropylene/PVDF mesh (Dynamesh, Fek Textiltechnik mbH, Aachen, Germany) using a variation of the Rives-Stoppa sublay technique (7). The fascial plane between the rectus muscle and the posterior rectus sheath was dissected on either side of the midline incision as far laterally as possible, including the stomas and sparing the lateral perforating vessels and nerves. The posterior rectus sheath and the peritoneum below the arcuate line were re-approximated with running monofilament suture. The mesh was cut to size and anchored in the posterior sheath by interrupted non-absorbable sutures in the periphery and running suture in the midline. The anterior rectus sheath was closed either in the midline or

by further running sutures on the mesh to ensure minimal tension. The fatty tissue and skin were approximated with running sutures and clips, respectively. Suction drains were placed subcutaneously and kept in place a median of 60h (range 36- 108h) post operatively.

All patients were treated with low-molecular-weight heparin and a prophylactic antibiotic regimen on the day of the procedure and until drain removal in cases of donor site reconstruction. Patients operated between 2004 and 2009 received intravenous dextran (Macrodex, Pharmacia, Uppsala, Sweden) 1, 3, and 5 days after surgery.

Surgical data included the type of donor site reconstruction, as well as the type of extended resection, duration of operation, and blood loss. Length

of hospital stay, number and type of complications, and unplanned return to surgery were recorded, as were complications at the donor and the recipient site. The complications were categorized as early or late (i.e., occurring within 30 days post-operatively or during follow-up, respectively), and were identified by physical examination and CT scans.

Post-Operative Regimen

After surgery, the patients were instructed to lie in supine or lateral position on an air-fluidized therapy mattress. Torso elevation of maximum 45 degrees was accepted the first 15 days, and standing and walking, but not sitting, were permitted during the same period. Thereafter, sitting was allowed for gradually increasing lengths of time several times a day. Patients with no reinforcement of the abdominal wall were given an abdominal brace for optional use after discharge from the hospital.

Follow-up assessments were conducted every 6 months. CT scanning of the chest, abdomen, and pelvis or a CT-PET was performed twice a year for up to 2 years and thereafter once a year for another 5 years. Follow-up data were available for 55 patients. The median follow-up time for late complications at the donor and recipient sites was 12 months (range 7–48 months).

Statistical Analyses

Continuous data are presented as median (range). Intergroup comparison was carried out using Fisher's exact probability test and Levene's test for equality of variances. Statistical significance was set at a level of 5%. Statistical analyses were conducted using SPSS software (SPSS Inc., Chicago, IL, USA).

Results

Table 2 lists the types of surgical procedure used for tumor removal and the preoperative treatment given. The majority of patients had received radiation at the recipient site. There were no significant differences between the patients with and those without abdominal wall reinforcement in terms of the defects created after the various oncological procedures. There were more patients with sacral resection in the group without mesh reinforcement, whereas there were more vaginal resections in the group with reinforcement.

Procedures performed without mesh reinforcement led to significantly greater blood loss. However, there was no difference in the duration of the surgical

Table 2. Surgery and preoperative treatment in the 58 patients		No mesh n = 32	Mesh n = 26
		n	n
Surgery	TPE	5	8
	PPE	9	4
	Resection of the bony pelvis	7	4
	APR	9	3
	APR + resection of vagina	2	8
Preoperative treatment			
	Radiation	1	2
	Chemoradiation	29	23

Abbreviations:

APR = abdominoperineal resection;
TPE = total pelvic exenteration (en bloc resection of the pelvic viscera in the anterior and posterior urogenital compartments);
PPE = posterior pelvic exenteration (en bloc resection of the genital viscera and rectum);
VRAM = vertical rectus abdominis myocutaneous flap.

procedures between the two groups, but significantly more patients underwent a two-session procedure in the mesh group (31 versus 6%). Differences between the groups with regard to the number of days of hospital stay were not statistically significant (Table 3).

site was the most common early complication. Total flap necrosis necessitating re-operation occurred in two patients in the group without mesh and in five patients in the group with mesh. Late complications observed at follow-up included delayed wound healing and

Table 3. VRAM flap and abdominal wall reconstruction: details of surgical procedures

	No mesh n = 32	Mesh n = 26	
Blood loss (mL), median (range)	1500 (350–19000)	1350(200–3000)	P < 0.05
Operation time (min), median range)	725 (365–1800)	690 (445–1100)	
Two-session procedure, n (%)	2 (6)	8 (31)	P < 0.05
Hospital stay (days), median (range)	28 (14–77)	33 (16–110)	

Fisher's exact probability test

Table 4 shows early and late morbidity after VRAM flap and abdominal wall reconstruction. The procedures were associated with considerable morbidity, although there was no statistically significant difference in overall complication rate between the two groups.

Patient demographics were not associated with the frequency of complications neither at the donor nor the recipient site. (Levene´s test). Larger numbers of patients with mesh reinforcement required ICU care.

Morbidity at the recipient site is outlined in Table 5. Wound infection/dehiscence at this

discrepancy in flap size. There was no statistically significant difference in recipient-site morbidity between the two groups.

Donor-site complications were wound infection with or without dehiscence (early), and hernia or bulge (late), as shown in Table 6. One patient without mesh reinforcement was returned to the operating room due to wound infection, and another was re-operated for an incarcerated hernia at the stoma. One patient with mesh required secondary suture of the abdominal incision. The bulge rate was significantly higher in patients without mesh. No mesh had to be removed due to any complication.

Table 4. Morbidity after VRAM flap and abdominal wall reconstruction in the 58 patients with pelvic tumors

	No mesh n = 32	Mesh n = 26	
	n (incidence %)	n (incidence %)	
Early complications (< 30 days)	23 (71.8)	15 (57.6)	
Late complications (> 30 days)	18 (56.2)	8 (31.0)	
ICU	3 (9.3)	11 (42.3)	P < 0.05

Fisher's exact probability test

Table 5. Recipient-site morbidity after VRAM flap and abdominal wall reconstruction in the 58 patients with pelvic tumors.

		No mesh n = 32	Mesh n = 26
		n (incidence %)	n (incidence %)
Early complications (< 30 days)	Partial flap ischemia	5 (15.6)	4 (15.4)
	Flap necrosis	2 (6.3)	5 (18.0)
	Wound infection/ dehiscence	9 (28.0)	5 (18.0)
	Reoperation	3 (9.3)	5 (18.0)
Late complications (> 30 days)	Delayed healing	6 (18.7)	5 (18.0)
	Size incongruence	1 (3.1)	3 (11.1)

Table 6 Donor-site morbidity after VRAM flap and abdominal wall reconstruction in the 58 patients with pelvic tumors

		No mesh n=32	Mesh n=26	
		n (incidence %)	n (incidence %)	
Early complications (< 30 days)	Wound infection/ dehiscence	7 (21.8)	1 (3.8)	
	Re-operation	2 (6.3)	1 (3.8)	
Late complications (> 30 days)	Hernia	8 (25.0)	2 (7.7)	
	Bulge	7 (21.8)	0	P < 0.05
	Delayed healing	1 (3.1)	3 (11.5)	

Fisher's exact probability test

Discussion

We studied patients with tumors of the rectum and anus to investigate the use of pedicled VRAM flaps for reconstruction of pelvic floor defects and implantation of non-absorbable mesh for reinforcement of the abdominal wall. The data we obtained show that harvest of rectus abdominis muscle was not associated with undue major morbidity at either the donor or the recipient site. The use of synthetic mesh in the primary closure of the abdominal wall after colorectal procedures did not increase the incidence of wound infection and in stead led to fewer hernias and better body contour in the long run. However, our results did not identify a specific group of patients that would probably benefit from simultaneous perineal and abdominal wall reconstruction.

VRAM flaps have been used in association with removal of advanced pelvic tumors involving wide perineal resection (8,9). The resulting large pelvic and perineal defects create wounds in irradiated, poorly vascularized tissue that are prone to infection and

delayed healing (3,10,11,12). As shown in earlier investigations (9,13,14), a VRAM flap introduces well-vascularized tissue that fills the pelvic defect, providing structural support for internal organs and interposing healthy skin in the perineal wound. Maricevich et al. (15) demonstrated that VRAM flaps represent a reliable option for reconstruction of the large-volume defects that arise after sacrectomies. In the series evaluated by those authors, skin dehiscence was 25% at the recipient site and 5.4% at the donor site, whereas wound infection was 9.6% and 8.1%, respectively. Preoperative chemotherapy and radiotherapy did not affect early morbidity. Sunesen et al. (13) observed no major perineal wound complications and no major wound infections when using VRAM flaps after pelvic salvage surgery. Nevertheless, in contemporary studies of large cohorts (10,16), VRAM flaps were found to be associated with 11% major perineal wound dehiscence requiring secondary sutures or vacuum dressings. Also, in yet another study (17), it was demonstrated that wound healing was adversely affected by overweight, diabetes, and malignancy, but not by previous irradiation of the recipient site.

The above-mentioned findings are corroborated by our results showing a high frequency of wound infection at the recipient site in the early post-operative period and also delayed perineal healing. We observed major morbidity requiring re-operation in 12% of all cases. Early complications were apparently associated with flap ischemia or necrosis, indicating that irradiation was not a significant contributing factor. We did not find any correlations between complications and BMI, comorbidity, or smoking, possibly due to the small numbers of patients in the studied cohort.

The risk of morbidity at the donor site has been a drawback of the use of VRAM flaps. Improper healing and loss of muscle tissue can potentially cause abdominal wall incompetence or hernia, and several studies have noted fascia wall dehiscence and herniation

ranging from 9% to 17% (6,8,13,18). However, another investigation revealed no increase in complications related to the VRAM flap donor site (3).

In the present study, we observed a considerable number of wound infections at the VRAM flap donor site in patients without abdominal wall reconstruction, although the majority of those infections were minor and did not require re-intervention. This group also had longer operation time and increased peri-operative bleeding, which might account for a higher risk of contamination. Patients who underwent reconstruction with mesh received an extra dose of antibiotics prior to mesh implantation, and treatment was continued with a broader spectrum prophylactic regimen several days peri-operatively, which might have affected the bacterial flora at the site of the wound. A significantly higher number of patients with mesh reinforcement had undergone two-session procedures, but no adverse effects on wound healing were apparent in this group compared to the early morbidity noted in the group without reconstruction. Herniation and bulging accounted for almost half of the late complications in the patients without abdominal wall reconstruction, which is higher than the level reported by other investigators (10,17). No late morbidity due to incarceration was observed, and the abdominal brace that was provided was not used continuously by many of the patients.

Primary reinforcement of the abdominal wall with prosthetic mesh was introduced to circumvent abdominal wall deficiency during the later part of the present study period. In colorectal surgery, primary closure of the abdominal incision using non-absorbable mesh is still controversial due to potential contamination of the surgical field and an associated increase in the risk of infection (3,19). To our knowledge this is the first report comparing specifically the use of synthetic mesh for primary abdominal wall reinforcement after harvesting of the rectus muscle in pelvic cancer procedures. Although mesh reinforcement did not
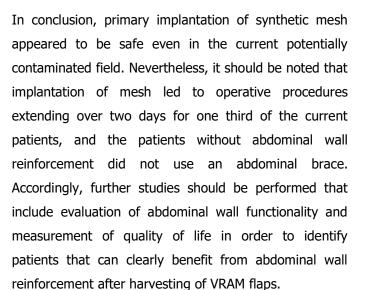
prolong operating time, significantly more patients with implanted mesh had two-session procedures and had to remain intubated in the ICU overnight. Furthermore, three patients with mesh were kept in the ICU for hemodynamic stabilization. Also, hospital stay was longer in patients with mesh than in those without such reinforcement, although this difference was not statistically significant.The patients were fully mobilized and could sit uninhibited before discharge which resulted in rather long hospital stay periods. Our data suggest that non-absorbable mesh can be applied without increasing wound infection or dehiscence. Even though the patients with mesh had undergone neoadjuvant chemoradiotherapy, and 27% of them were receiving systemic immunosuppressive therapy, there was no apparent abscess formation, and it was not necessary to explant any of the meshes. Long-term outcomes included significantly better body contour, as indicated by the absence of wall deficiency.

In a recent review of materials used for abdominal wall reinforcement, Lee et al. (20) noted that a wound infection rate of 6.4% and a hernia rate of 3.2% were associated with synthetic non-absorbable prosthetics in clean-contaminated cases, which confirms the present results.

We did not find any correlation between the rate of complications and comorbid conditions in our patients.

The present study had several limitations, one of which was the retrospective design with a relatively small number of patients. Also, there is an inherent bias in the outcomes, because the two groups of patients underwent surgery at different times with variable oncological procedures. Furthermore, the patients were not randomly assigned to receiving a VRAM flap or having abdominal wall reinforcement, and we did not evaluate outcomes with regard to restriction of abdominal wall strength.

Conclusion

In conclusion, primary implantation of synthetic mesh appeared to be safe even in the current potentially contaminated field. Nevertheless, it should be noted that implantation of mesh led to operative procedures extending over two days for one third of the current patients, and the patients without abdominal wall reinforcement did not use an abdominal brace. Accordingly, further studies should be performed that include evaluation of abdominal wall functionality and measurement of quality of life in order to identify patients that can clearly benefit from abdominal wall reinforcement after harvesting of VRAM flaps.

Competing Interests

The authors have no conflicts of interest in regard to this manuscript

Acknowledgments

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