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ORIGINAL ARTICLE

Abdominal wall component release is a sensible choice for patients requiring complicated closure of abdominal defects

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Abstract
Background Abdominal wall component release (AWCR) is an operation that frequently restores the abdominal wall integrity in both sick and anatomically complex patients. The patients reported herein are different from the widely reported but somewhat less complex trauma patient, such as following damage control laparotomy. AWCR has acceptable postoperative outcomes in terms of infection, hernia, and fistula rates.
Methods We describe the application of AWCR in 63 consecutive patients, in whom only 11 (17%) had complementary prosthesis use. Unlike many previous reports of AWCR in trauma patients, 47 (75%) of these patients had permanent stomas. These patients had undergone a total of 103 prior abdominal operations (mean 1.7 operations, range 0–7); 29 patients had cancer (46%), 11 of which were recurrent, and 16 patients (22%) had serious complications of prior surgery. Interestingly, 20 patients (32%) had both prior abdominal operations and underlying cancer.
Results In a median follow-up of 32 months (range 16–120 months), only 15 patients (5 of whom had a stoma) developed recurrent abdominal wall hernias with 5 of those being peristomal. No correlation was found between prior abdominal operations, intestinal stomas, and contamination source at time of surgery with recurrence of hernia ($p>0.05$). The 41 patients (86%) with an intact abdominal wall (free of recurrent hernia) had a median follow-up of 27 months (range 13–117 months). Twelve patients (19%) had a source of abdominal/abdominal wall contamination present at the time of AWCR. Only 1 of the 11 patients in whom complementary prosthesis was used developed infection. Other infectious complications were noted in 12 patients (19%), including fistula in 1 patient who required reoperation.
Conclusions AWCR offers acceptable results in very high-risk patients with tolerable postoperative infection rates.

Keywords Component release · Mesh · Hernia · Infection

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Introduction

Reconstruction of an abdominal wall defect remains a difficult and common challenge for surgeons, with particular further risk for postoperative infection and fistula formation. The previous decades have witnessed the introduction of innovative techniques and synthetic materials for the management of these cases. The use of a prosthetic mesh and abdominal wall component release (AWCR) are two common methods for addressing abdominal wall defects when primary closure is unattainable. In any case, failure of repair using any method is more common than often recognized and dually reported [1, 2].

Currently, the use of a prosthetic mesh has been largely accepted as preferable to primary suture repair and is the most widely used method in reported abdominal wall closure [1, 3]. However, the use of mesh has its own array of various complications such as infection [4], enterocutaneous fistula formation and extrusion, seroma and adhesion formation, and a lack of pliability in the abdominal wall [5]. In addition, the use of prosthetic materials may be associated with a recurrence of abdominal defects in as many as 32% of patients [1, 2, 6–8]. Finally, the costs of synthetic biomaterials used in abdominal wall closure are significant and regularly underestimated (Table 1). These apparent complications and expenses associated with mesh repair have raised thoughtful questions regarding its real versus perceived benefits.

As an alternative to prosthetic mesh, Ramirez was among the first to describe the AWCR technique in 1990 as a way to repair abdominal defects that could not be primarily closed [1, 2, 8–10]. AWCR is a complex operation which aims to restore abdominal wall integrity by sliding a myofascial flap to close large ventral wounds and relieve tension without the implantation of prostheses [10]. This method provides fascial continuity while preserving innervation of the rectus muscle and leaving a dynamic and functional abdominal wall [11, 12].

Numerous studies discuss the benefits of using the AWCR technique. Girotto et al. [13] illustrated AWCR as being advantageous when infection is present, concomitant bowel surgery is indicated, and multiple recurrent hernias are found within a patient. Efforts to restore abdominal wall integrity, such as after hernia repair, are hindered by postoperative infection which compromises healing. In this regard, postoperative infection rates in AWCR compare favorably to prosthetic mesh, and at least one report indicates fewer adverse consequences using component release alone [14]. The safety and effectiveness of this operation is supported with recurrence rates of 10% in patients who require abdominal wall closure [11, 15–19]. While prosthetic mesh is necessary in some abdominal wall procedures, there is now sufficient evidence to proclaim AWCR's special effectiveness in such high-risk, complex cases where infection, fistula, stomas, prior radiation, and contamination are of primary concern.

In this report, we studied the preferential implementation of the AWCR procedure to repair the abdominal wall in high-risk patients with histories of previous abdominal surgery, radiation therapy, intestinal stoma, and infection. In addition, we studied the postoperative complication rates for occurrence of hernia, infection, and fistula after AWCR procedure. Understanding how AWCR benefits these complex patients may contribute to improved surgical management leading to lower recurrence rates of adverse outcomes.

Table 1 2010 hospital costs for commercial abdominal wall repair material

Material	Size (cm)	Cost (U.S.D)
Prolene®	10×10	342
Parietex®	20×25	1,347
Dual-facing polyester absorbable hydrophilic film	20×30	1,842
Vicryl®	12×12	640
Polyglactin dual mesh by Gore®	20×30	1,789
Proceed®	20×25	1,358
Oxidized cellulose Prolene soft	26×34	2,099
Strattice® tissue matrix	20×20	10,069
Alloderm®	8×16	4,233
Regenerative tissue matrix	16×20	10,099

Personal communication to Susan Galandiuk, MD, 21 December 2010

U.S.D U.S. dollars

Patients and methods

Patient demographics and surgical technique

In this retrospective cohort study, we examined the implementation of AWCR in 63 consecutive patients from a single surgeon's practice. The patient profile included 62 (98%) Caucasians and 1 (2%) African-American patient. Patients were operated on between 1995 and 2010. Thirty-four patients in this group were women (54%) and 29 were men (46%). Seventeen of these patients (27%) were current smokers, and 22 (35%) were former smokers, but 24 (38%) had never previously smoked. Twenty (32%) patients had a history of heart disease and an additional 6 (10%) were diabetic, of which 5 were insulin dependent. Seven patients (11%) had asthma. AWCR was performed as illustrated in Figs. 1, 2, and 3. In all patients, intraoperative peak airway pressures were assessed prior to and after abdominal wall repair to ascertain that there was no undue increase in respiratory effort.

Database

This study was approved by the University of Louisville Institutional Review Board. Written informed consent was obtained from all subjects, and the information was stored in a password-protected, prospectively maintained database. Patients were derived from a clinically previously described university-based colon and rectal surgery practice, along with hospital records from University of Louisville Hospital and two other affiliated teaching hospitals in the same downtown medical center in Louisville, Kentucky [20].

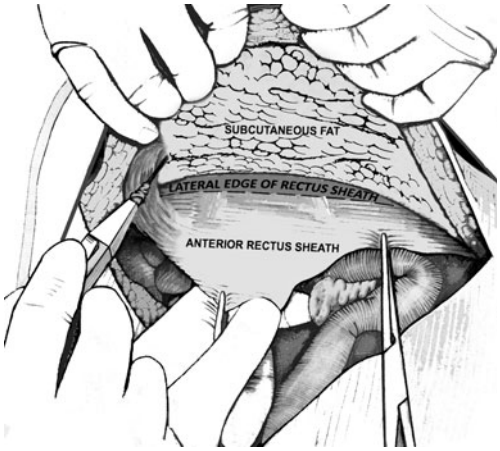

Fig. 1 A schematic drawing showing separation technique in a complex patient

Underlying patient conditions

Unlike several previous reports of AWCR in trauma patients, 47 (75%) patients included in this study had permanent stomas. These patients had undergone a total of 103 prior abdominal operations (mean 2 operations, range 0–7); 29 patients had cancer (46%), 11 of which were recurrent, and 16 (22%) had serious complications of prior surgery. Interestingly, another 20 (32%) patients had both prior abdominal operations and underlying cancer. Two patients had sustained complications after trauma and 17 (27%) had Crohn's disease. In addition, we reviewed our patient records for preoperative factors such as previous radiation therapy, intestinal stomas, previous abdominal operations, and infection, which might influence the integrity of the abdominal wall and affect postoperative outcomes.

Patient care and follow-up

All of our included patients were cared for by a single surgeon who provided personal follow-up over a 15-year period. During follow-up, we defined hernias as any fascial defect in the midline incision, parastomal hernias, or relative fascial weakness or bulging at the flap harvest site.

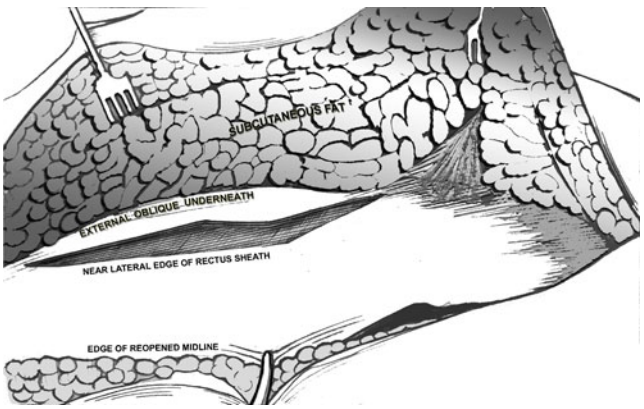

Fig. 2 Another drawing showing separation technique anteriorly at a further stage

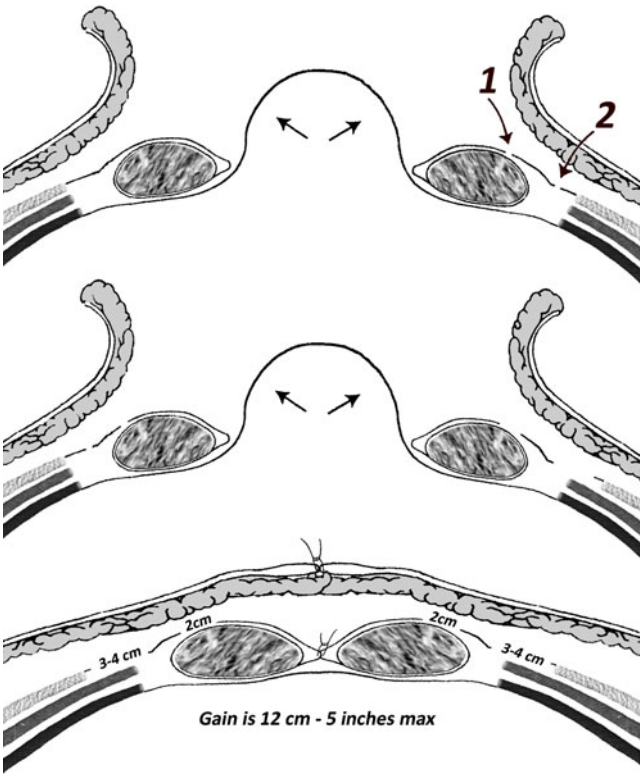

Fig. 3 Cross-sectional view of stages of abdominal wall component release. Modified from Jernigan et al. [29]

Statistical methods

Comparison of categorical data was performed by chi-square test and Fisher's exact test. Comparison of continuous data was performed by *t* test. All statistical analyses were performed with SAS statistical software v 9.2 (SAS Institute Inc., Cary, NC, USA). A *p* value of less than 0.05 was considered to be significant.

Results

Of the total 63 patients, 52 underwent AWCR only and 11 had a combination of new mesh application and AWCR. Patients were then evaluated postoperatively for occurrence of four adverse outcomes: fistula, infection, hernia, and "any" (where "any" means at least one of the aforementioned adverse outcomes) (Table 2). The postoperative adverse outcomes were distributed as follows: 12 patients (19%) with postoperative infection, 15 (24%) patients with recurrent hernia, and 1 with fistula (2%). At least one adverse outcome occurred in 26 patients (41%). The mean follow-up time was 38±3 months.

Table 2 Adverse outcomes after AWCR surgery

Adverse outcome	Total (*N*=63)		With AWCR only (*N*=52)		With AWCR and mesh (*N*=11)	
	N (%)	95% Cl	*N* (%)	95% Cl	*N* (%)	95% Cl
Fistula	1 (2)	0–9	0	Cannot be calculated	1 (9)	0–41
Infection	12 (19)	10–31	11 (21)	11–35	1 (9)	0–41
Recurrent Hernia	15 (24)	14–36	11 (21)	11–35	4 (36)	11–69
Any	26 (41)	29–54	21 (40)	17–77	5 (46)	17–77

In the 52 patients who were treated with AWCR only, 21 (40%) experienced at least one postoperative adverse event. Among these 52 patients, 11 had recurrence of hernia, none developed new fistulas, and 11 (21%) developed postoperative infection, all of whom recovered.

A total of 11 patients were treated with combined AWCR and mesh application. Five patients who underwent this treatment experienced at least one postoperative adverse outcome. Of this most complicated group, one patient developed an intestinal fistula, another developed infection after surgery, and four patients had recurrence of hernia.

Among all of our patients, 35 (56%) had previous radiation therapy, 47 (75%) had an intestinal stoma present at the end of surgery, 48 (76%) had previous abdominal operations, and 16 (25%) had an infection but no abscess discovered at operation, obviously constituting a very complex group of patients.

We evaluated hernia presence at the time of last follow-up in terms of the aforementioned patient risk factors. Age at time of operation was a significant determinant of recurrent or persistent abdominal wall defects (p=0.02). The mean age at time of surgery for our patient population was 52±2 years. Of the 15 patients who developed a recurrent hernia, the mean age was 58±2 years, while for the 48 patients who maintained an intact abdominal wall, the mean age was 49±3 years. Previous radiation therapy was not found to have an effect on hernia recurrence rate (p=0.24) (Table 3). To account for multiple prior conditions in each patient, we used a weighted risk score for abdominal wall reconstruction based on pre-existing factors like age, obesity, previous abdominal surgery, radiation therapy, infection at time of surgery, or a previous stoma. Our personal follow-up is, of course, a relatively brief mean of 38 months. Our analysis of multiple risk factors showed that 11 of 15 who developed recurrent abdominal wall defects had two to three risk factors present (p>0.05).

Discussion

Current practice and prosthetic material use

The relatively recent adoption of biosynthetic mesh in abdominal wall reconstruction presents the modern surgeon with expanding operative choices, yet the admitted lack of randomized controlled trials to compare operative outcomes makes reaching a dependable standard of care elusive [2, 21]. Although biotechnology manufacturers parade a continuous array of prosthetic meshes for use in abdominal repair, there has yet to be a general consensus of any one product, method of implantation, or definitive conclusions as to the risk of recurrence and complication using these devices [22, 23]. Despite its perceived advantages, prosthetic mesh application carries considerable implications for the patient, including risk of infection [24, 25] and lack of dynamic support for the abdominal wall [26]. Additionally, the cost of prosthetic mesh use is substantial (Table 1). AWCR is a less expensive, and we think, safer procedure for eventual closure of the abdominal wall, especially in patients with particularly large and complex defects where mesh application is not optimal [27]. The clinical judgment involved in making intraoperative choices of methods of repair is obviously an ongoing major issue, as such continuing evaluation of personal outcomes is essential.

AWCR in the high-risk, complex patient

Management of abdominal wall defects remains a relatively common problem for surgeons. Since the early report of the AWCR technique, discussions over the ensuing years regarding reconstruction of the abdominal wall using prosthetic materials have become controversial. The literature supports the use of AWCR in younger trauma patients with favorable outcomes [27–30] but, from our review, does not address its application in highly complex patients such as reported herein with histories of prior surgery, radiation therapy, stomas, contamination, recurrent cancer, or fistula. The paucity of literature on AWCR application in this selected group underlines the difficulty of obtaining sufficient data for the clinician to make an informed decision.

AWCR versus mesh application

To compare the effectiveness of AWCR to mesh application in our 63 consecutive patients, we examined the prevalence of significant adverse postoperative outcomes such as fistula, infection, and hernia. A comparison between patient

Table 3 Postoperative hernia in relation to BMI, age at surgery, and other preoperative conditions (in patients who had follow-up ≥8 months)

Variables	Subsequent hernia			
	Total, *N*=48 (%)	Yes, *N*=15 (%)	No, *N*=33 (%)	*p* value
Age at time of operation				
Mean±standard deviation	52±2	58±2	49±3	0.02[a]
Median (minimum–maximum)	54 (21–74)	60 (45–68)	51 (21–74)	
Body mass index				
Mean±standard deviation	27±1	29±1	26±1	0.09
Median (minimum–maximum)	26 (17–42)	29 (20–42)	24 (17–40)	
Smoking status				
Non-smoker	17 (35)	4 (27)	13 (39)	0.52
Smoker	31 (65)	11 (73)	20 (61)	
Previous abdominal operations				
Yes	37 (77)	11 (73)	26 (79)	0.72
No	11 (23)	4 (27)	7 (21)	
Stoma present at the end of operation				
Yes	37 (77)	13 (87)	24 (73)	0.46
No	11 (23)	2 (13)	9 (27)	
Infection/abscess found at operation				
Yes	13 (27)	4 (27)	9 (27)	1.00
No	35 (73)	11 (73)	24 (73)	
Previous radiation therapy				
Yes	26 (54)	10 (67)	16 (49)	0.24
No	22 (46)	5 (33)	17 (51)	

[a] *t* test based on unequal variance

groups who either underwent AWCR only or received prosthetic mesh in addition to AWCR provided some distinctions between these two treatments.

Overall, our personal results suggest no appreciable risk difference in our hands between implementation of AWCR alone or a combination of mesh and AWCR approaches in terms of reported adverse outcomes. The benefits of applying prosthetic mesh in complex, high-risk patients appear comparable to treating the abdominal defect with AWCR alone. Considering the cost and additional infection risk inherent in prosthesis use, we believe mesh provides little additional benefit to abdominal reconstruction for these selected patients. Conflicts of interest by the authors on the use of mesh or other devices are not regularly stated.

Recurrent or persistent abdominal wall defects

Risk factors for the development of abdominal wall incisional hernias may include the following: overweight, smoking, age greater than 60 years, wound infection, re-laparotomy, chronic medical conditions, and chronic steroid use. The relative ratio and amount of type I collagen may determine patients at risk [31]. Primary repair is usually rarely successful and has associated recurrence rates of 18% to 62% depending on the defect size [1, 2, 8, 9]. We focused on the recurrence of hernia postoperatively as one measure of successful treatment. This is supported by the fact that the success rate of ventral hernia repair declines with each progressive attempt; making abdominal wall repair successful on the first encounter is the most desirable treatment goal [32]. Several contributing patient factors that are implicated in failure have been outlined. In our study, we examined the influence of relevant perioperative factors on the recurrence of defects in patients who underwent AWCR surgery, viz infection rates, obesity and smoking, radiotherapy, previous abdominal surgeries, and stoma presence at the end of the abdominal wall repair procedure. The overall failure rate has been reported at least multiply in the recent literature and should be a note of caution for all surgeons [1, 2].

Wound infection is a primary risk factor and the most constant influence on hernia recurrence [33]. Proper wound management and administration of systemic prophylactic antibiotics have become standard protocol for hernia repair, particularly when using mesh [34]. The use of absorbable mesh is associated with a fourfold increase in infection rate [4]. Our faculty previously described, with reservations, the utility of absorbable mesh for abdominal wall closure [35]. Longer-term follow-up of those patients has disclosed even less satisfactory outcomes with near total ultimate recurrence of hernia.

By definition, we recognize that some patients in whom mesh is used have very large hernias where prosthesis application is warranted. It is yet unclear whether higher infection rates from mesh application are due to increased exposure during the longer operations for prosthesis implant or are a result of some altered immune response [4]. A comparison among patients who underwent AWCR only and those with AWCR and mesh combination failed to detect a difference in postoperative infection rates ($p>0.05$).

Lifestyle factors may also influence failures. Obesity is a primary contributing factor in recurrence during the first year postoperatively [36]. A retrospective chart review during a 10-year study concluded that BMI>30 kg/m^2 is correlated with an increased reherniation rate [37]. However, we could not establish a correlation between BMI and hernia recurrence ($p>0.05$) (Table 3). Smoking is also an important risk factor in recurrence. A patient who regularly smokes is 1.5 times more likely to have postoperative wound infection, which eventually may cause higher rates of recurrence [38]. "Smoker's cough," if defined, is also likely to be an adverse outcome variable. Other research suggests that smokers may have irregular connective tissue metabolism leading to a weakening of the abdominal wall [38]. Our study did not show an effect of smoking on failure rates postoperatively ($p>0.05$). Previous exposure to radiation therapy weakens the integrity of the abdominal tissue and vasculature. However, we did not find a correlation between previous radiation therapy and postoperative failure after AWCR ($p=0.24$). Nonetheless, 10 of the 15 patients with recurrence of abdominal wall defects had previous radiation therapy. Previous abdominal operations and stoma presence at the end of surgery predispose to recurrence postoperatively. Multiple operations weaken the integrity of the abdominal wall, and stomas create a further weak site in the abdominal wall where both would predispose to hernia. Again, our data show no correlation between the aforementioned factors and failure of repair postoperatively ($p=0.72$ and 0.46, respectively) (Table 3).

Overall, the recurrence rate in our patient group was 24%. Previously, it has been reported that hernia recurrence rates using components separation technique range from 9% to 30%, depending on a number of patient risk factors, skill of the surgeon, and size of the hernia [39–41]. A review of the literature for open mesh repair suggests similar outcomes. Cassar and Munro describe 14 studies between 1996 and 2001 of mesh repair in incisional hernias with recurrence rates of 0–10% [33]. Burger et al. [2] conducted a randomized controlled trial where patients treated with mesh only were found to have a 32% recurrence rate of hernia during a 10-year follow-up period compared to 63% of cases by suture alone in the same time period. Their conclusions favored mesh and their actual follow-up period differed slightly (i.e., 75 months for suture and 81 months for prosthesis) [2]. These reports, in conjunction with our own findings, suggest that AWCR is a sensible treatment approach for abdominal wall defects in patients who are otherwise contraindicated for prosthetic implantation. AWCR does clearly not solve all of the problems such as those associated with massive fascial defects in which large areas of bowel may have been skin grafted. In such cases, biologic grafts or other materials may still be needed. AWCR is, however, a utilitarian procedure that can be used safely in patients with large fascial defects who also have contaminated wounds, fistulas, and/or enteric stomas.

In our patients, we found a significant correlation between age at the time of surgery and recurrence of hernia at postoperative follow-up ($p=0.02$). Our patients had a median age at AWCR of 52 years (range 21–74) at the time that other studies reported a younger patient group undergoing AWCR [19, 29, 30]. The relatively low rate of hernia recurrence among our very high-risk complex patients demonstrates AWCR as an effective method of treating these patients. Interestingly, we found that AWCR and mesh application together seem to provide little benefit compared to component release alone, albeit likely the most difficult scenario.

Intestinal fistula

Additional complications of abdominal reconstruction may include fistula formation, which to some degree suggests that the use of prosthetic mesh correlates with increased postoperative hernia and fistula formation [42, 43]. Our data show a single intestinal fistula (<2%) with no difference between AWCR and AWCR combination with mesh in terms of fistula formation.

The shortcomings of this article include the intraoperative decision-making, the relatively brief 38-month mean follow-up, and the need for reoperation in some patients with progression of their cancer. It could be that intra-abdominal pressure measurements could assist in judgment.

Conclusion

The data indicate that AWCR offers acceptable results in very high-risk complicated patients (many with stomas) with tolerable postoperative infection, hernia recurrence, and fistula formation. Every such decision taxes one's clinical judgment. While it is assumed by some that mesh repair is favorable for younger patients with traumatic abdominal injuries, prosthetic application in our patient group demonstrated no advantage. Particularly in a climate of rising health costs, not only for providers but also for those whom they treat, careful consideration is warranted

before using these very expensive materials. Our patient results demonstrate a comparable hernia recurrence between AWCR combination with mesh and AWCR alone during a relatively long personal follow-up. These findings raise serious questions about the cost-effectiveness of prosthesis use, specifically in the context of complicated patients. The common reaction to apply mesh in abdominal wall repair may not produce anticipated results.

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