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Abdominal wall reconstruction: a case series of ventral hernia repair using the component separation technique with biologic mesh

Keith Hood, M.D.*, Keith Millikan, M.D., Troy Pittman, M.D., Matthew Zelhart, B.S., Brian Secemsky, B.S., Meenakshi Rajan, B.S., Jonathan Myers, M.D., Minh Luu, M.D.

Department of General Surgery, Rush University Medical Center, 1653 West Congress Parkway, Chicago, IL 60612, USA

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Ventral hernia repair;
Separation of components;
Biologic mesh onlay

Abstract

BACKGROUND: Sixty-eight consecutive patients from October 2008 until February 2012 were selected for this retrospective review.

METHODS: A midline fascial closure with component separation was completed using biologic mesh onlay in all cases. Recurrence rates of the hernias, complication rates, patient satisfaction, and time to return to work/normal activities were investigated.

RESULTS: The recurrence rate was 1.5% (n = 65) with ongoing follow-ups (mean = 20 months). The average age was 57 years, and the average body mass index was 36 kg/m^2 (range 22 to 60). The average hernia defect was 20 cm (range 12 to 26) transversely. Wound infection and/or breakdown occurred in 32%, and seroma formation occurred in 9% of patients. Patient satisfaction was 3.63 of 4. The average time to return to work/normal activities was 16 weeks (range 1 to 76 weeks).

CONCLUSIONS: Large complex ventral hernias can be reliably repaired using the component separation technique. The short-term recurrence rate is significantly reduced in this case series using a biologic mesh onlay.

The reconstruction and repair of large abdominal wall hernias have evolved over the past few decades; however, no consensus has been reached on the optimal method of closure. Complex abdominal wall hernia repair has long been associated with high morbidity and recurrence rates. Also, a growing number of patients are surviving intra-abdominal catastrophes with subsequent abdominal wall defects and the resultant chronic infection, enterocutaneous fistulas, and so on. Therefore, the need for a reliable method of abdominal wall reconstruction with reduced morbidity and recurrence is evident.

For primary repairs, recurrence rates initially reported ranged from 24% to 54%,[1] with seemingly high recurrence rates after mesh (24%) and suture repairs (43%).[2] Although mesh repairs have led to improved recurrence rates overall, the placement of mesh has been associated with various co-morbidities.[3] To improve on these recurrence rates and reduce the morbidity of abdominal wall reconstruction, the component separation technique was introduced. The autogenous technique was first described in a cadaveric model in 1990 by Ramirez et al,[4] and since that time there have been multiple variations used to repair complex abdominal wall defects. The procedure relies on the bilateral release of the external oblique and fascia, allowing for medial

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* Corresponding author. Tel.: +1-402-578-6611; fax: +1-312-942-2867.

E-mail address: Keith_Hood@rush.edu

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mobilization of the rectus muscles to achieve a midline closure. Many of the initial reports published regarding the use of the component separation technique arose from the trauma literature and the long-term management of intra-abdominal catastrophes after abdominal trauma. These reports describe a staged reconstruction[5]; more recent reports detail an immediate reconstruction. The autogenous component separation technique appears ideal when abdominal wall defects are massive, when the wound site is contaminated, when bowel surgery is required, or when the patient has previously undergone incisional hernia repairs or failed mesh repairs.

Numerous studies have investigated the autogenous separation of component repair of abdominal wall defects while using various types of mesh. Recurrence rates are reported to range from 7% to 30%, and wound complication rates are observed in 10% to 62%.[6,7] The largest and one of the most recent reports from Ko et al[7] reported a recurrence rate of 22% and a wound complication rate of 43%. The results of these studies are summarized in Table 1. Multiple types of mesh have been studied to augment the component separation repair, however, almost exclusively of the synthetic variety. Our case series used a biologic mesh onlay over the autologous separation of component technique to repair abdominal wall defects. In this retrospective review, we examined whether the use of biologic mesh further reduced hernia recurrence rates without increasing wound complications as previously reported.

Methods

A comprehensive retrospective medical record review was performed on all patients who underwent the component separation technique for abdominal wall defects performed by the 2 surgeons in this review. All procedures were performed at Rush University Medical Center, Chicago, IL, between October 17, 2008, and May 27, 2011. For all of the patients, the medial aspects of the rectus abdominis muscles were approximated in the midline without any additional releases or fascial turnovers. Sixty-eight consecutive patients (26 men and 42 women) were included in the study. No patients during this timeframe were excluded. Patient characteristics including age, body mass index (BMI), medical comorbidities, cause of the initial hernia, previous hernia surgeries with or without mesh, hernia/defect size, operative details, postoperative results, hospital stay, drain duration, return to work, and patient satisfaction were examined. Follow-up data were obtained from analysis of the surgeons' office records, the patients' hospital and outpatient electronic medical records, and a patient survey conducted via telephone. Follow-up appointments were typically done at 2 weeks, 4 weeks, 2 months, 3 months and 6 months. Hernia recurrence was diagnosed by physical examinations, which were performed serially in the inpatient and outpatient setting. Every patient was called and given the opportunity to participate in the survey, and a standard form and questions were used. Informed consent was obtained from the patients in all cases, and this study was approved by the Institutional Review Board of Rush University Medical Center.

A transverse or vertical midline incision was used around the umbilicus and hernia defect. Subcutaneous flaps are raised down to the pubis inferiorly, to the anterior superior iliac spine laterally, and above the costal margins bilaterally. The abdomen was entered, and the abdominal viscera were cleared from the undersurface of the hernia sac and the abdominal wall. The hernia sac, excess pannus, and skin were removed. If a previous mesh repair was performed, the mesh was removed at this time. Once the fascial edges were cleared and easily identified, the hernia defect was measured, and the abdominal contents were returned to the peritoneal cavity. The release of the external obliques bilaterally was performed to raise the myocutaneous flaps necessary for the component separation technique. The semilunar lines were elevated bluntly, and the external oblique aponeurosis was divided bilaterally ($<$1 cm lateral to the insertion of the rectus muscle and the anterior rectus fascia). This was done superior to the costal margin and carried down to the iliac crest under direct visualization. The release was completed inferiorly to the level of the pubic symphysis to achieve complete mobilization of the tissues. Blunt dissection was performed widely to separate the internal and external oblique in the avascular plane between the 2 muscles. There were no other releases performed in this

Table 1 Previous component separation case reports

Reference	No. of patients	Wound complications (%)	Recurrence (%)	Follow-up
DiBello and Moore[8]	35	5 (14)	3 (9)	22 (1–43)
Ewart et al[9]	11	3 (27)	1 (9)	10 (1–60)
de Vries Reilingh et al[10]	43	14 (33)	13 (30)	16 (12–30)
Ennis et al[11]	10	1 (10)	1 (10)	27 (1–53)
Lowe et al[6]	30	6 (20)	3 (10)	10 (1–26)
van Geffen et al[12]	26	5 (19)	2 (8)	45 (13–78)
Gonzalez et al[13]	42	14 (33)	3 (7)	
Ko et al[7]	200	86 (43)	43 (22)	
DiCocco et al[14]	34	21 (62)	6 (18)	

Complication and recurrence rates are reported with percentages of the total patient population. Follow-up data provided, if available, with a mean in months and range in parenthesis.

series. Midline closure of the rectus muscles was performed using 0-Polydioxanone (PDS) sutures in a running fashion. Depending on the size of the original defect, varying sizes of AlloMax (Davol Inc, Warwick, RI, USA) biologic mesh onlays were sewed to reinforce the midline closure. Five centimeters of overlap was sought on either side of the midline closure. The most commonly used size of mesh was 15 × 13 cm; however, in cases in which 1 piece would not span the entire midline closure, 2 pieces of mesh were sutured together. The biologic mesh onlay was sewed down in a running fashion at the midline with 1-PDS and on its edges with interrupted 1-PDS sutures approximately 2 cm apart. A minimum of 2 closed-suction drains and a maximum of 4 were then placed superior to the myocutaneous flaps and inferior to the subcutaneous tissues. Drains, typically a total of 4, were placed in both the lateral tunnels and over the midline AlloMax biologic mesh. The skin was then closed with a combination of interrupted 2-0 Polypropylene vertical mattress sutures and surgical staples. All cases were classified as clean-contaminated. Criteria for drain removal were on a patient-to-patient basis. Typically, the first set of drains (usually 2) was removed before hospital discharge. The remaining 2 were removed when the output was <25 to 30 mL of drainage over a 24-hour period. Typically, 1 drain was removed at the 2-week follow-up, and the last drain was removed at the 4-week follow-up. All patients were contacted and given the opportunity to participate in a postoperative survey to gauge several aspects of their overall satisfaction with the surgery. A standardized script was used by the caller. Questions asked were whether or not they subjectively felt the repair remained intact, how long it took them to return to work, how they would grade the cosmetic result on a scale from 1 to 4, how they would grade their overall outcome on a scale from 1 to 4, have they had any further surgeries, did they smoke in the 2 months after surgery, and would they have the surgery again. Patients were made aware of the study and assured all answers would be kept confidential.

Results

A total of 68 patients underwent a ventral hernia repair using the component separation technique with an Allomax mesh onlay. The majority of patients were women (42/68 [62%] women and 26/68 [38%] men). The average age was 56.6 years (range 26 to 82 years), and the average BMI was 36.1 kg/m^2 (range 22.32 to 60.20 kg/m^2). Associated comorbid conditions included diabetes mellitus in 22 (32%) of the patients, whereas 4 (6%) were actively smoking at the time of surgery. The average operative time in all cases was just over 3 hours (182 minutes). Incisional hernias from a previous surgery (65/68 patients [96%]) accounted for the vast majority of cases. Of the 65 patients with incisional hernias, 48 (74%) had undergone a previous hernia repair. Of those 48 patients, mesh was used in 40 (83%). A primary repair was performed in the other 8 patients. During the initial repair or surgery, there were 18 (26%) formal bowel resections, 10 (15%) ostomy creations of various types, and 7 (10%) of these patients had an enterocutaneous fistula that complicated their course before our repair.

Recurrence rates and wound complication rates are summarized in Table 2. Three patients died from hospital complications postoperatively. One patient suffered from prolonged intubation and an inability to be liberated from the ventilator and developed ventilator-associated pneumonia. A second patient suffered from complications associated with *Clostridium difficile* colitis and ultimately sepsis. A third patient suffered a fatal arrhythmia 3 weeks postoperatively. Follow-up for the 65 patients is ongoing with a mean time since surgery of 20 months. Consistent and routine follow-up has been done for all patients since surgery. The overall hernia recurrence rate is 1.5% (n = 1). This diagnosis of hernia recurrence was made by physical examination while the patient was being followed in the outpatient setting. Wound complications were observed in 42% of patients (n = 27). Of these complications, 32% (n = 21) had a postoperative wound infection, with 12 (18%) requiring wound vac placement and 3 (5%) needing formal debridement in the operating room. Seroma formation was noted in 9% (n = 6) of patients. No patients required further bowel or any other intra-abdominal surgery. The 1 recurrence was taken back to the operating room for standard permanent mesh underlay repair. The mean operative time was 182.6 minutes, and the average mobilization of the rectus abdominis muscle to the midline was 19.94 cm (range 12 to 26 cm). The hernia defect size was calculated by the mobilization required to achieve primary midline closure. The average hospital stay postoperatively was 9.8 days. The average time postoperatively when the first drain was removed was 7.3 days (range 2 to 26 days), typically before hospital discharge. The average time when the final drain was removed was 33.8 days (range 6 to 150 days) postoperatively. This is summarized in Table 2. Of the 65 who underwent ventral hernia repair with the component separation technique with an Allomax onlay, 66% (n = 43) agreed to be interviewed via telephone. When the patients were asked if they felt subjectively their repair remained intact, 42 (98%) responded "yes" and 1 responded "no." The average cosmetic result was 2.9 (range 1 to 4); however, when asked to evaluate the overall outcome of the surgery using the same scale, the average was 3.6 (range 1 to 4). Forty (93%) of the patients said they would go through the surgery again. The average time to return to work and/or normal daily activities was 16.3 weeks (range 1 to 76 weeks). Four (9%) patients began smoking or returned to smoking within 2 months of surgery.

Comments

The component separation technique is an ideal hernia repair for large ventral defects because it releases the

Table 2 Results of component separation with biologic mesh onlay

		Percent of total
Hernia recurrence	1	1.5
Hernia reoperation	1	1.5
Further bowel surgery	0	0.0
Wound complications	27	41.5
Wound infection	21	32.3
Seroma	6	9.2
Wound debridement	3	4.6
Wound vac placement	12	18.5
	Mean	**Range**
Operative time (min)	182.6	120–480
Mobilization (cm)	19.94	12–26
Mobilization from each side (cm)	9.97	6–13
Hospital stay (d)	9.75	4–41
Duration of drains		
First drain removed (d)	7.3	4–26
Last drain removed (d)	33.8	6–150
Postoperative interview results		
Telephone responders		43
Repair remained intact		42 yes, 1 no
Return to work/normal activity (mean in weeks)		16.3
Cosmetic result (1–4) (mean)		2.9
Overall outcome (1–4) (mean)		3.6
Smoking within 2 months of surgery		4
Would go through again		40 yes, 3 nos

contracted sides of the abdominal wall to augment the midline repair. Increased lateral wall compliance may reverse the lateral abdominal wall disuse atrophy and fibrosis seen in animal incisional hernia models. A hernia recurrence occurs when the midline repair ruptures before the lateral abdominal wall becomes more elastic; therefore, an increase in lateral abdominal wall compliance may be significantly protective.

Human acellular cadaveric non–cross-linked dermis (Allomax) was used in all patients as an onlay reinforcement of the midline fascial closure. Biologic mesh is used in this series, specifically Allomax, because it has been shown to promote angiogenesis before collagen deposition, allowing for a more dynamic abdominal wall in the long-term.[15] The macroporosity inherent in the scaffolding of the mesh allows for cellular ingrowth early after placement. The suprafascial vascular bed is better, whereas inferior to the fascia the peritoneum acts as a significant barrier and restricts blood flow, thereby limiting angiogenesis and tissue incorporation of the mesh. One of the concerns with previous cadaveric and prosthetic onlay mesh was impedance of blood flow to the midline repair. This inhibits wound healing and collagen deposition and overall is a setup for hernia recurrence. With inadequate vascularization in this region, in addition to the mesh impeding what flow there is, appropriate remodeling of the mesh cannot occur and therefore does not have the potential benefit one might have hoped for. The advantage of the Allomax mesh is that is has shown early cellular infiltration and neovascularization as early as 7 days after implant and has shown evidence of vascular integration within 3 months.[15,16] These data points are far superior to integration and ingrowth rates noted with previous types of mesh. Because of the superiority of the suprafascial vascularity, a mesh onlay would have better remodeling and tissue incorporation. We believe these 2 advantages of our repair, the type of mesh used and using the suprafascial vascular bed, are essential to our results. We believe our repair is superior because of the earlier tissue ingrowth for the reasons stated previously leading to a reduced recurrence rate and high patient satisfaction.

Our series of patients represents one of the largest reported on the component separation repair of the ventral hernia, and this series is ongoing and rapidly growing. The evolution of the component separation technique over the past 20 years has been 2-fold: how to improve the strength of the midline closure to prevent hernia recurrence and how to reduce wound complications. As shown in Table 1, there have been multiple variations on the repair as the process continues to develop. The midline mobilization of tissue toward the midline with the component separation technique permits the excision of all scarred and inflamed tissue at the time of the repair. This leaves only healthy tissue and minimizes the potential for wound infection. Because of this, it is likely that hernia recurrences are related more to the chronic forces on the abdominal wall across time rather

than to bacteria at the time of the surgery. This would explain the significant risk that elevated BMI poses for hernia recurrence.[7] This series shows our attempt to augment the strength of the midline closure with a biologic mesh onlay over the repair. Previous studies[17,18] initially showed that acellular cadaveric dermis did not incite intestinal adhesions and could be used as a fascial replacement in abdominal wall reconstruction. Its use in abdominal wall repair as an intra-abdominal midline reinforcement has been questioned. Both Ko et al[7] and Lowe et al[6] state that cadaveric dermis alone does not provide long-lasting or durable results in abdominal wall reconstruction and, therefore, should be reserved for contaminated wounds in which a prosthetic mesh is best avoided. Biologic mesh underlay repairs have been studied, and there has been no consensus on this type of repair. However, no studies have specifically looked at biologic (human graft) mesh as onlay over the midline closure. In addition to the reasons already stated, an onlay mesh allows for direct visualization of placement to prevent improper mesh placement or malpositioning such as "wrinkling." This technique also avoids any intra-abdominal complication that may arise with mesh prosthetic. A biologic mesh offers several advantages over a synthetic mesh such as Vicryl (Ethicon Inc, Somerville, NJ, USA) or polypropylene. Most importantly, the biologic mesh allows for the patient to regain a dynamic abdomen after the repair. The biologic mesh used in this series provides a macroporous scaffold for cellular ingrowth to occur as previously mentioned. This allows for angiogenesis, collagen deposition, and tissue incorporation to sufficiently occur before the mesh disappears after 6 to 9 months. Also, the biologic mesh elicits a minimal foreign body response, can be used in contaminated cases, and does not have to be excised if a wound infection occurs. A Vicryl mesh disappears in 2 to 3 weeks, which is not nearly long enough for the scaffolding to have significant tissue ingrowth. Without adequate collagen deposition, hernia recurrences have the potential to occur. Polypropylene mesh incites an increased foreign body response, and because it is not absorbable it has an amplified risk of mesh infection requiring reoperation and excision. Because of its inherently stiff properties, this type of mesh will never allow the patient to have a dynamic abdomen. For the reasons stated earlier and the results of this series, biologic mesh has numerous advantages over other types of mesh.

In this series, our repair of complex abdominal wall defects with component separation using Allomax onlay mesh displayed a significant improvement in hernia recurrence compared with previous reports. In our series of 65 patients with ongoing follow-up, there only has been 1 recurrence (1.5%). Compared with previous reports, primary repair recurrence rates initially ranged from 24% to 54%,[1] with seemingly high recurrence rates after mesh (24%) and suture repairs (43%).[2] Other studies investigating the component separation technique with various types of mesh reported recurrence rates from 7% to 30% and wound complication rates from 10% to 62%.[6,7] Although there has been some concern for increased wound and skin complications as a result of the biologic mesh onlay, our wound complication rates are similar to those previously reported. One potential disadvantage of the onlay technique is the risk of mesh infection given the high incidence of wound complications observed in the component separation case series reports. The proximity of the mesh to the surgical wound would inherently place it at risk if a wound infection or other complication occurred. In this series, none of the patients who had wound complications suffered a long-term infection involving the mesh onlay. Because the biologic mesh is broken down and gone in 6 to 9 months, there is no risk for long-term mesh infections requiring reoperation or excision. Aggressive management of wound infections or complications and the use of biologic mesh in this series resulted in no mesh infections despite using an onlay technique.

A major lesson learned in performing this operation is the importance of minimizing wound complications, especially in patients with an elevated BMI. Wide undermining of the skin to release the oblique musculature disrupts the perforator blood flow to the midline abdominal skin, thereby contributing to wound complications in these patients. Modifications proposed by Maas et al[19] and as seen in laparoscopic component separation techniques aim to resolve this issue by better maintaining and maximizing blood flow to the midline. This approach as well as the endoscopic-assisted and periumbilical sparing techniques have been described as alternatives in efforts to minimize wound complications when performing a component separation. A major limitation of these techniques is the lack of mobilization of the hernia edges achieved to the midline. It is being consistently reported that only 6 to 8 cm of mobilization is seen. In our series of patients, an average of 10 cm from each release was achieved. Although the laparoscopic and endoscopic approaches offer an alternative, the patients in our series had too large of a hernia defect to be reliably corrected in this manner. An alternative technique is to perform a panniculectomy at the time of component separation for morbidly obese patients with infraumbilical hernias. This practice has become common in our series of patients.

Conclusions

The component separation technique is an effective treatment for large midline hernia defects that are the result of multiple etiologies. The patient population in whom these defects arise increases the morbidity of this operation. As the component separation technique continues to evolve to reduce recurrence rates and minimize the morbidity of the procedure, our results indicate that cadaveric non–cross-linked human dermis mesh (Allomax) is an effective reinforcement of the midline closure. Our recurrence rates using this method are lower than previously reported, wound complication rates are similar to previous reports, and our case series is one of the largest to date for this procedure.

Therefore, we believe a biologic mesh onlay provides superior strength and durability to minimize recurrence rates.

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Discussion

Dr James R. DeBord, M.D. (Peoria, IL): Years of experience with mesh reconstruction has led to the conventional wisdom that inlay mesh is the performed technique for mesh placement. Why did you use onlay technique although you did mention a few issues in your paper? Although wound complications are high in most series of this type, a lightweight large pore size polypropylene mesh is known to perform well in the presence of contamination, especially in the onlay position. Why then use the most expensive mesh available anywhere in the hospital for your repair when the polypropylene may well have been adequate in the way that you used it? Finally, how do you know that your results are not from a carefully and fully performed component separation alone?

Dr Keith Hood, M.D. (Chicago, IL): As far as the inlay versus the onlay, I mention that the peritoneum acts as a significant barrier to neovascularization. If you put a mesh in the abdomen versus using the vascular supply in the superficial region, you avoid any intra-abdominal complications or if they have to go back to the operating room for any type of back wound infection or complications so you can stay extraperitoneal. As far as cost, that is definitely one of the limitations of this type of mesh and this type of procedure. I think the main advantage of the biologic as opposed to the polypropylene is although wound complications are about the same, the dynamic abdomen is something that benefits the patient more than anything. The abdominal wall compliance is maintained with a biologic mesh as opposed to polypropylene, which is stiff and permanent and the patients do not have as good of a compliance or a dynamic abdomen, so that is the main advantage that we felt with the biologic.

Dr Christopher R. McHenry, M.D. (Cleveland, OH): I have 2 quick questions for you. The first thing that alarmed me was the high incidence of surgical site infection in your series. The second question is if you are going to use mesh as an onlay, what advantages of using biologic mesh really outweigh the cost? Because if you are using it as an onlay, the cost does not seem to really justify the benefits.

Dr Hood: Referring to the infection in the surgical site infection, again our wound complication rates were not significantly higher than in previous studies, but we did use antibiotic prophylaxis; the patients did not do any kind of shower preoperatively, but I think the main contributor to the wound morbidity in this series and in the component separation, in general, is the raising of the subcutaneous flaps and the devascularization of the tissues leading to necrosis, wound necrosis, and ultimately infection. As far as onlay, again, I will refer back to the dynamic abdomen; the biologic mesh is gone by 6 to 8 weeks and so by that time the midline closure is 80% of its maximum tensile strength and so not having that mesh there allows for the abdominal wall compliance and the patient has their dynamic abdomen back as opposed to a stiff polypropylene. I think that is the main advantage of the biologic mesh, whether or not you can justify that from a financial perspective has to be seen.

Dr William C. Cirocco, M.D. (Grosse Pointe, MI): Was the infection rate higher in those in whom you were taking

down stomas? Should we be avoiding mesh in patients who have a permanent stoma where you are repairing a large hernia?

Dr Hood: Our infection rate was not any higher in those who had enterocutaneous fistulas or stomas. Of the 68 patients, 12 of those patients did have a stoma and/or a fistula, and our data suggest that you do not have to avoid using a biologic mesh with concomitant bowel surgery.

Dr Samir Gupta, M.D. (Peoria, IL): If you are using the biologic mesh as a reinforcement of your component separation, then I agree with the other discussants; why not just use micromesh? It will disappear in 6 to 8 weeks, and you do not need to spend, put in the additional expense, a fairly expensive human product.

Dr Hood: Again, the biologic mesh is gone by 6 to 8 weeks. Some of the porcine dermis meshes and some of the more permanent meshes last for 6 to 9 months and have increased seroma formulation, which further increases wound morbidity. The reason we use this particular type of mesh is that it is gone so quickly.