The American Journal of Surgery 193 (2007) 651–655
Scientific paper

Bilateral anterior abdominal bipedicle flap with permanent prosthesis for the massive abdominal skin-grafted hernia

Stephen R. Sullivan, M.D.[a], Loren H. Engrav, M.D.[a], Daniel A. Anaya, M.D.[b], Eileen M. Bulger, M.D.[b], Hugh M. Foy, M.D.[b,*]

[a]*Division of Plastic and Reconstructive Surgery, University of Washington, Harborville Medical Center, 325 9th Avenue, Box 359796, Seattle, WA 98104–9796, USA*

[b]*Department of Surgery, Harborview Medical Center, Box 359796, 325 Ninth Ave., Seattle, WA 98104-9796, USA*

Manuscript received December 6, 2006; revised manuscript December 11, 2006

Presented at the 93rd Annual Meeting of the North Pacific Surgical Association, Spokane, WA, November 10–11, 2006

Abstract

Background: Fascial closure after damage control or decompression laparotomy is not always possible. The result is a ventral hernia covered with skin grafts. Massive hernias impair bowel, bladder, and respiratory function and are displeasing aesthetically. Most repair methods provide inadequate closure of large full-thickness abdominal wall defects. We describe our method of repair using bilateral anterior abdominal bipedicle flaps over permanent mesh.

Methods: We reviewed 6 patients who underwent this repair method. This staged repair first involves flap elevation followed by delay. In the next stage, the hernia skin graft is excised, mesh is placed, and flaps are advanced to midline to cover the mesh.

Results: The average hernia size was 885 ± 274 cm^2 (28-cm wide × 31-cm vertical), with a range of up to 37-cm wide. An average of 3 surgeries were required for closure, with a mean hospital stay of 22 days. No patients developed hernia recurrence with a mean follow-up period of 23 months.

Conclusions: This method provides successful and durable closure of massive skin-grafted hernias.

Keywords: Hernia; Abdomen; Reconstruction; Mesh; Flap

Trauma patients with massive intra-abdominal injuries often require damage control laparotomy and critically ill patients who develop abdominal compartment syndrome often require decompressive laparotomy. Soft-tissue and bowel edema can prevent primary closure of the abdominal fascia [1]. A variety of temporary abdominal wall closure methods have been described with varying success in achieving secondary fascial closure [2–5]. We previously reported our use of nylon-reinforced elastomer sheeting, which resulted in a 75% rate of secondary fascia closure [6]. However, in the other 25% of our patients, the abdominal wall fascia could not be closed, leaving the patient with a massive and complete abdominal wall defect. These defects are contained with mesh, covered with skin grafts, and become both aesthetically and functionally debilitating (Fig. 1) [7]. Patients complain of bowel and bladder dysfunction caused by loss of Valsalva, respiratory compromise, difficulty lifting, and impaired ambulation.

Rohrich et al [8] described a repair algorithm for abdominal wall defects. In their patients with complete defects and inadequate skin, they recommended delayed reconstruction using polypropylene prosthetic mesh covered with skin grafts, which is associated with a high complication rate [9]. Closure of abdominal wall defects with innervated muscle flaps that provide dynamic abdominal support is preferable when possible, but is limited to smaller defects [7,10,11]. Other abdominal wall reconstruction methods include component separation [12] and muscle and fascia flaps including rectus femoris [10] and tensor fascia lata [7]. We have discovered that complete defects greater than 20-cm wide present a particularly challenging problem, and have found these previously described methods to be inadequate because of lateral fixation of abdominal wall fascia and muscle, as well as inadequate skin and soft-tissue coverage. To

* Corresponding author. Tel.: +1-206-731-5882; fax: +1-206-731-3656.

E-mail address: hughfoy@u.washington.edu

0002-9610/07/$ – see front matter
doi:10.1016/j.amjsurg.2006.12.029

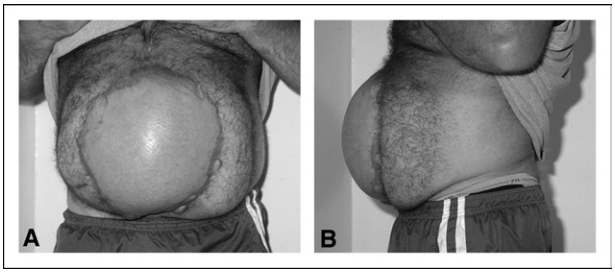

Fig. 1. Massive anterior abdominal skin-grafted hernia: (A) anterior view, (B) lateral view.

address these challenges we developed a repair using permanent polypropylene mesh covered with bilateral anterior abdominal bipedicle skin and subcutaneous tissue flaps.

Methods

We reviewed a consecutive series of patients at Harborview Medical Center (Seattle, WA) between September 2002 and January 2005 who had chronic, skin-grafted hernias that were not amenable to other known reconstructive methods because of massive full-thickness abdominal wall defects. Data collected from the medical records included patient demographics, cause of injury, hernia size, time from skin grafting to bipedicle flap repair, number of surgeries, length of hospital stay, complications, and follow-up duration. The University of Washington Institution Review Board approved this study.

Surgical technique

The first stage of repair was the creation of the bilateral bipedicle flaps followed by delay (Fig. 2). Skin and subcutaneous bipedicle flaps were designed lateral and parallel to the bilateral hernia edges with adequate width to cover the hernia. The length to width ratio of the flaps initially was 2:1. A vertical incision (usually 24–30 cm) was made through the skin and subcutaneous tissue down to the fascia of the external abdominal oblique, and the flaps were undermined from the lateral incision toward the hernia by dissection anterior to the external abdominal oblique and rectus fascia. Complete flap elevation and mobilization was

Fig. 2. Design of the bilateral anterior abdominal bipedicle skin and subcutaneous tissue flaps lateral to the hernia.

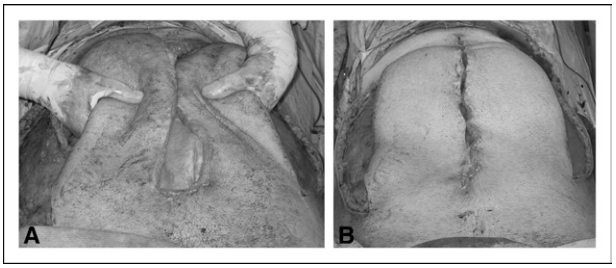

Fig. 3. (A) Midline flap mobilization over the mesh. (B) Bilateral flaps are coapted to provide full-thickness soft-tissue coverage of the mesh.

delayed because the flap blood supply was random, with contribution from the superficial epigastric, superficial circumflex iliac, and lateral thoracic arteries [13]. The flaps then were laid back in their original position, closed suction drains were placed, and the incisions were closed.

Four to 7 days after the initial flap elevation, patients returned to the operating room for further vertical extension of the bilateral abdominal wall incisions and further undermining of the flap superiorly and inferiorly. Flap perfusion was evaluated at each operation with a Wood's lamp 10 to 15 minutes after an intravenous fluorescein injection. Patients had to show complete flap perfusion before proceeding to hernia closure, and a third surgery for further elevation and delay was performed if necessary.

The final surgery began with confirmation of a flap blood supply when the flaps were advanced to the midline. If the flaps approximated at midline without tension or ischemia, we proceeded with excision of the fully matured hernia skin graft. This step took up to several hours and was the most tedious because of adhesions to the underlying viscera and because it required precise dissection to avoid enterotomy. The rectus sheath then was opened along the medial edge and the rectus muscle was dissected from the posterior sheath and peritoneum to create a space for the mesh placement. Heterotopic ossification in the perixiphoid region was common and was removed when present. Knitted monofilament polypropylene mesh (Trelex; Boston Scientific Corp., Natick, MA) was used as a permanent fascial prosthesis. The mesh was sutured superiorly at the subxiphoid, inferiorly at the pubic symphysis, and laterally between the rectus muscle and the posterior rectus sheath as described by Stoppa et al [14]. The mesh was sutured under moderate tension every 4 cm by using interrupted, long-term, absorbable polyglycolic acid 1-0 suture. Care was taken to interpose the omentum, when available, between the viscera and mesh. The bilateral bipedicle flaps then were mobilized to the midline and coapted in 2 layers to cover the mesh completely (Fig. 3). Bilateral closed suction drains were placed between the mesh and the flaps. The lateral edges of the bipedicle flaps were fixed to the external abdominal oblique aponeuroses with interrupted absorbable polyglycolic acid 2-0 suture. The lateral abdominal wall flap donor site defects were covered with skin grafts meshed at a 2:1 ratio.

Results

Six patients with massive skin-grafted hernias underwent attempted closure using this method (Table 1). An average

Table 1
Patient demographic characteristics

Characteristic	Patients						Mean	SD
Age at injury, y	27	47	23	48	25	24	32	12
Sex	Man	Man	Man	Man	Man	Man		
Cause of injury	Motor vehicle collision	Motorcycle collision	Fall	Gun shot wound	Gun shot wound	Motorcycle collision		
Hernia size, cm*	28 × 20	27 × 45	27 × 35	37 × 30	20 × 28	27 × 34	28 × 32	5 × 8
Hernia size, cm^2	560	1215	945	1110	560	918	885	274
Age at hernia repair, y	29	48	26	52	29	26	35	12
Time from temporary skin graft coverage to hernia repair, d	779	304	809	730	1229	495	770	328
Number of hernia repair surgeries	4	3	3†	6‡	3	3	3	1
Length of hospital stay, d	42	20	NA	17	15	16	22	11
Duration of follow-up period	20	24	NA†	31	20	22	23	5
Complications			Hematoma†	Wound infection, sinus‡	Pulmonary embolus			

* First number is transverse, second is vertical dimension.
† Complication occurred during flap creation, patient elected not to complete hernia repair.
‡ Complication occurred during flap creation, required return to operating room.

of 3 surgeries were required for each patient, with an average hospital length of stay of 22 days. Five of 6 patients had a successful hernia closure with strong abdominal wall support and complete skin coverage (Fig. 4). No patient has developed recurrence. The mean follow-up period was 23 ± 5 months.

Early postoperative complications included wound infection and hematoma. The wound infection occurred during flap delay and was treated by irrigation and debridement. The patient returned to the operating room 9 months later for re-elevation of the flaps, followed 7 days later by prosthetic herniorrhaphy and flap closure. The hematoma also occurred during flap delay and was treated by drainage. This patient chose to abandon attempts at hernia closure.

Late complications included a wound sinus tract at a suture at the lateral edge of a flap. This was treated initially with antibiotics and wound care, and later required surgical debridement and closure. The sinus did not extend to the polypropylene prosthesis. Another complication that occurred was a nonlethal pulmonary embolus in a patient with a prior history of deep venous thrombosis who was on heparin subcutaneously for prophylaxis throughout the hospital course. This required hospitalization and long-term coumadin therapy.

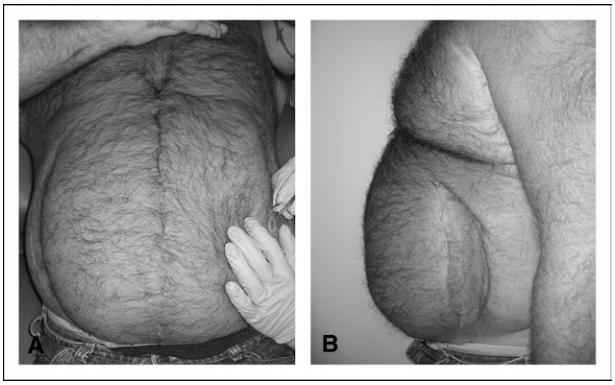

Fig. 4. Successful hernia closure at 30 days postoperatively: (A) anterior view, (B) lateral view.

Comments

We found bilateral anterior abdominal bipedicle skin and subcutaneous flaps over permanent mesh to be a strong and successful closure method of massive and complete abdominal wall defects. These massive hernias result from failed fascial closure after laparotomy. Repair is necessary because of the considerable debility and unsightly appearance of these hernias, but complete coverage with innervated muscle flaps is not always possible.

Several definitive reconstructive options of abdominal wall hernias have been described [7,10,12,15]. However, most methods fail to address complete abdominal wall defects with a lack of both fascia and overlying skin and soft-tissue coverage. The component separation technique described by Ramirez et al [12], provides fascial coverage for hernias up to 20-cm wide. Jernigan et al [16] described a modified component separation that provides coverage for a width up to 30 cm. Reviews using these methods, however, reported relatively small hernias [11,17]. In addition, although these methods provide fascial coverage, they fail to provide the necessary skin and soft-tissue coverage in the patients we presented. Tissue expansion has been described for overlying soft-tissue coverage of hernias with a mean defect of 515 cm^2 [15] and with a width greater than 20 cm [18]. Although useful for some defects, these methods provide insufficient fascial coverage for some of the massive abdominal wall hernias we have described.

We developed a massive hernia closure method to provide both fascial replacement using a permanent mesh and skin coverage using bipedicle skin and subcutaneous flaps. Others have described somewhat similar approaches. Zaccara et al [19] used direct fascial closure or fascial reconstruction using polytetrafluoroethylene (Gore-tex soft-tissue patch; W.L. Gore, Flagstaff, AZ) along with bipedicle skin flaps for omphaloceles in 2 newborns. The long-term reliability in newborns cannot be assessed from this report

because no follow-up evaluation beyond the acute period was described. Guy et al [20] described early 1-stage closure of abdominal wall defects using human acellular dermis (Alloderm; LifeCell Corp., Branchburg, NJ) for fascial replacement and bilateral bipedicle abdominal wall flaps for skin coverage. Unfortunately, the investigators did not describe the hernia size and drawings suggest smaller hernias than those we have described. In addition, there was no long-term follow-up evaluation for the patients treated with human acellular dermis, which we have found to be too thin, expensive, and inadequate as a sole fascial substitute. Sriussadaporn et al [21] described immediate visceral containment of the open abdomen using absorbable mesh covered by bilateral bipedicle anterior abdominal flaps. Fascial reconstruction with retrorectus nonabsorbable mesh was delayed for several months and was performed as a separate stage. They too found no hernia recurrence in their patients, with a median follow-up period of only 9 months.

We have chosen to avoid immediate mobilization of skin flaps because of our prior experience with ischemia at the critical wound edges in the upper midline, which would expose the permanent mesh. Immediate reconstruction also may require larger flaps than a delayed reconstruction if significant abdominal distention or inflammation is present. A better result may be obtained with a delayed and staged procedure [22]. In addition, waiting to mobilize bipedicle skin flaps until the time of hernia repair allows for safe dissection of viscera from a loose skin graft rather than the thick abdominal wall flaps, which technically may be more difficult, with an increased risk of enterotomy.

Hernia repair timing is dependent on skin graft maturation. Similar to Jernigan et al [16], we found that skin graft maturation takes longer than 6 months to become pliable and easily pinched and lifted from the underlying viscera, which allows safe dissection and avoidance of enterotomy. Waiting for skin graft maturation must be weighed against the progressive loss of abdominal domain over time as the fascia and abdominal wall musculature retract laterally. Jernigan et al [16] found that abdominal wall reconstruction should be accomplished within 6 to 12 months from the initial hospital discharge to aid in a tension-free and prosthetic-free repair. Our patients underwent repair at an average of 25 months after their initial hospital discharge, which may have contributed to the massive hernia size. Earlier repair may aid in ease or method of closure.

Our reconstruction method is both strong and reliable. No patient has developed hernia recurrence. Our method did suffer from both early and late complications. Wound infection, for example, occurred in 1 of our patients and is a potentially disastrous complication with mesh repair. Total autologous tissue repair can have infection rates from 21% to 42% [23], higher than the 6% to 26.7% infection rates after polypropylene repair reported by some [24–26]. Our method of full-thickness skin and subcutaneous tissue coverage reduces mesh exposure risk and may help prevent infectious complications.

Detriments to our method were that an average of 3 surgeries were required and the hospital stay was considerably longer than for other methods [7,23]. Most of the days of hospital stay occurred between flap elevation and delay. We were conservative in our management of patients during the development of this technique. Perhaps patients can be discharged safely between surgeries.

In summary, we have described a safe and reliable staged repair of massive and complete abdominal wall defects using bilateral anterior abdominal bipedicle flaps and a permanent prosthesis. This method provides both fascial and soft-tissue coverage for hernias not amenable to reconstruction by previously described techniques.

References

[1] Mayberry JC. Prevention of the abdominal compartment syndrome. Lancet 1999;354:1749–50.
[2] Barker DE, Kaufman HJ, Smith LA, et al. Vacuum pack technique of temporary abdominal closure: a 7-year experience with 112 patients. J Trauma 2000;48:201–7.
[3] Fernandez L, Norwood S, Roettger R, et al. Temporary intravenous bag silo closure in severe abdominal trauma. J Trauma 1996;40:258–60.
[4] Losanoff JE, Richman BW, Jones JW. Temporary abdominal coverage and reclosure of the open abdomen: frequently asked questions. J Am Coll Surg 2002;195:105–15.
[5] Nagy KK, Fildes JJ, Mahr C, et al. Experience with three prosthetic materials in temporary abdominal wall closure. Am Surg 1996;62:331–5.
[6] Foy HM, Nathens AB, Maser B, et al. Reinforced silicone elastomer sheeting, an improved method of temporary abdominal closure in damage control laparotomy. Am J Surg 2003;185:498–501.
[7] Ninkovic M, Kronberger P, Harpf C, et al. Free innervated latissimus dorsi muscle flap for reconstruction of full-thickness abdominal wall defects. Plast Reconstr Surg 1998;101:971–8.
[8] Rohrich RJ, Lowe JB, Hackney FL, et al. An algorithm for abdominal wall reconstruction. Plast Reconstr Surg 2000;105:202–17.
[9] Voyles CR, Richardson JD, Bland KI, et al. Emergency abdominal wall reconstruction with polypropylene mesh: short-term benefits versus long-term complications. Ann Surg 1981;194:219–23.
[10] Ger R, Duboys E. The prevention and repair of large abdominal-wall defects by muscle transposition: a preliminary communication. Plast Reconstr Surg 1983;72:170–8.
[11] Girotto JA, Ko MJ, Redett R, et al. Closure of chronic abdominal wall defects: a long-term evaluation of the components separation method. Ann Plast Surg 1999;42:385–95.
[12] Ramirez OM, Ruas E, Dellon AL. "Components separation" method for closure of abdominal-wall defects: an anatomic and clinical study. Plast Reconstr Surg 1990;86:519–26.
[13] Hester TR Jr, Nahai F, Beegle PE, et al. Blood supply of the abdomen revisited, with emphasis on the superficial inferior epigastric artery. Plast Reconstr Surg 1984;74:657–70.
[14] Stoppa RE, Rives JL, Warlaumont CR, et al. The use of Dacron in the repair of hernias of the groin. Surg Clin North Am 1984;64:269–85.
[15] Tran NV, Petty PM, Bite U, et al. Tissue expansion-assisted closure of massive ventral hernias. J Am Coll Surg 2003;196:484–8.
[16] Jernigan TW, Fabian TC, Croce MA, et al. Staged management of giant abdominal wall defects: acute and long-term results. Ann Surg 2003;238:349–57.
[17] Shestak KC, Edington HJ, Johnson RR. The separation of anatomic components technique for the reconstruction of massive midline abdominal wall defects: anatomy, surgical technique, applications, and limitations revisited. Plast Reconstr Surg 2000;105:731–9.
[18] Jacobsen WM, Petty PM, Bite U, et al. Massive abdominal-wall hernia reconstruction with expanded external/internal oblique and transversalis musculofascia. Plast Reconstr Surg 1997;100:326–35.
[19] Zaccara A, Zama M, Trucchi A, et al. Bipedicled skin flaps for reconstruction of the abdominal wall in newborn omphalocele. J Pediatr Surg 2003;38:613–5.
[20] Guy JS, Miller R, Morris JA Jr, et al. Early one-stage closure in patients with abdominal compartment syndrome: fascial replacement with human acellular dermis and bipedicle flaps. Am Surg 2003;69:1025–9.
[21] Sriussadaporn S, Pak-Art R, Bunjongsat S. Immediate closure of the open abdomen with bilateral bipedicle anterior abdominal skin flaps

and subsequent retrorectus prosthetic mesh repair of the late giant ventral hernias. J Trauma 2003;54:1083–9.
[22] Gottlieb JR, Engrav LH, Walkinshaw MD, et al. Upper abdominal wall defects: immediate or staged reconstruction? Plast Reconstr Surg 1990;86:281–6.
[23] Girotto JA, Chiaramonte M, Menon NG, et al. Recalcitrant abdominal wall hernias: long-term superiority of autologous tissue repair. Plast Reconstr Surg 2003;112:106–14.
[24] Diaz JJ Jr, Gray BW, Dobson JM, et al. Repair of giant abdominal hernias: does the type of prosthesis matter? Am Surg 2004;70:396–402.
[25] Leber GE, Garb JL, Alexander AI, et al. Long-term complications associated with prosthetic repair of incisional hernias. Arch Surg 1998;133:378–82.
[26] Molloy RG, Moran KT, Waldron RP, et al. Massive incisional hernia: abdominal wall replacement with Marlex mesh. Br J Surg 1991;78: 242–4.