Clinical Science

Radical tumor excision and immediate abdominal wall reconstruction in patients with aggressive neoplasm compromised full-thickness lower abdominal wall

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Abstract

BACKGROUND: Radical tumor resection and immediate lower abdominal wall reconstruction in patients with aggressive neoplasm invading full-thickness abdominal wall are challenging because of their close proximity and possible invasion to bone and great vessels, as well as consequent giant defect.

METHODS: Data on 16 patients were reviewed retrospectively. Radical neoplasm resection and immediate abdominal wall reconstruction using the combined technique of intraperitoneal mesh placement, sublay technique, pedicled great omentum flap, and rotation skin graft were performed.

RESULTS: Sixteen patients underwent radical abdominal wall neoplasm resection, achieving clear margin of >3 cm. The mean size of consequent giant defect was 226.5 ± 65.5 cm^2, with a mean polypropylene mesh size of 160.7 ± 40.5 cm^2 and a mean compound mesh size of 330.8 ± 100.2 cm^2. Sixteen patients had a mean follow-up duration of 32.5 ± 12.5 months. Four patients developed incisional infections, and 1 patient died of several metastatic lesions 24 months postoperatively. No ventral hernia and abdominal wall recurrence were observed.

CONCLUSIONS: Radical neoplasm resection and immediate abdominal wall reconstruction are appropriate for patients with aggressive neoplasm in the lower abdominal wall.
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Aggressive neoplasms of the abdominal wall are composed of malignant metastasis and borderline tumors with aggressive biologic behavior derived from abdominal wall structures, such as desmoid tumors and dermatofibrosarcomas. These neoplasms are uncommonly encountered clinically because of their rarity. Limited studies have demonstrated that surgical resection with adequate clear margin is the optimal treatment choice.[1,2] However, lesions occurring in the lower abdominal wall and compromising its full thickness make tumor resection and abdominal wall recon-

struction extremely challenging because of their close proximity and possible invasion of bone and great vessels, as well as consequent giant defect with loss of multilayered abdominal structures after extensive resection.

Various synthetic materials and techniques have been reported to restore the integrity of the abdominal wall. Sublay technique with polypropylene prosthetic placement in the retromuscular and prefascial space is the gold-standard method to repair ventral defects.[3,4] Polypropylene material can evoke intense fibrovascular infiltration and promote good incorporation into the surrounding tissue to provide a strong repair. However, because of its associated severe morbidities of adhesions to the viscera and even bowel erosion, isolation from intra-abdominal viscera is mandatory when using this prosthetic material.[4,5] Composite mesh is an alternative in the

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Table 1 Patients' demographic and preoperative data

Variable	Value
Men/women	7/9
Age (y)	50.5 ± 15.5
Pathologic results of neoplasm	
Metastatic bladder adenocarcinoma	2
Metastatic hysterocarcinoma	2
Metastatic colon adenocarcinoma	3
Desmoid tumor	6
Dermatofibrosarcoma	3
Patients with previous resection	10
Patients with concomitant neoplasm	
recurrence in the abdominal cavity	5
Size of tumor in the abdominal wall (cm^2)	105.6 ± 40.2

Data are expressed as numbers or as mean ± SD.

reconstruction of the abdominal wall, which has a permanent or absorbable barrier membrane joined to a sheet of polypropylene, such as an extended polytetrafluoroethylene in the Bard Composix E/X patch (C. R. Bard, Inc, Murray Hill, NJ) and an oxidized regenerated cellulose in the Ethicon Proceed patch (Ethicon Endo-Surgery, Blue Ash, OH), providing a proven safe plane to contact the viscera.[6,7] The pedicled omentum is an autogenic tissue flap with abundant blood vessels and connective and lymphatic tissues.[8] It has been a special choice to reconstruct the abdominal wall, because of its angiogenic and immunologic properties.[9]

However, the techniques and prosthetics mentioned above provide a substitute for the loss of only 1 or 2 layers of the multilayered abdominal wall, rather than its full thickness. Accordingly, we combined these techniques, associated with rotation skin graft, into a compound reconstructive procedure to repair giant full-thickness defect after extensive resection of aggressive neoplasm in the lower abdominal wall.

Methods

We retrospectively reviewed 16 patients with aggressive neoplasm invading full thickness in the lower abdominal wall who underwent radical resection and immediate abdominal wall reconstruction using combined technique by a single medical team from May 2006 to May 2010. There were 7 men and 9 women aged 32 to 66 years. The pathology of neoplasms was as follows: metastatic bladder adenocarcinoma (n = 2), metastatic ovarian cancer (n = 2), metastatic colon adenocarcinoma (n = 3), desmoid tumor (n = 6), and dermatofibrosarcoma (n = 3). Ten patients had previous tumor resection, and 5 patients were noted to have concomitant recurrence of compromised intra-abdominal viscera at this presentation. Demographics, past surgeries, and present conditions related to primary neoplasm, operative and mesh information, and postoperative complications were all evaluated. Descriptive statistical data are presented as mean ± SD (Table 1).

Operative technique

Patients were placed in the supine position and given general anesthesia with tracheal intubation. A Foley urethral catheter was placed to identify the bladder with palpable saccule. Intravenous vecuronium bromide was administrated every 30 minutes to achieve maximum muscle relaxation. A circumferential incision compassing the abdominal wall lesion with 3 cm across the border of the neoplasm was used. Each layer of the abdominal wall was resected respectively, and clear margin of ≥3 cm was guaranteed through verification of rapid pathologic frozen section. Commonly, adequate negative margin could not be achieved at the posterior border because of close proximity and possible invasion to the iliac vessels and pubis. In this case, vessel skeletonization and pubis cauterization were necessary to ensure thorough neoplasm elimination. After entering the abdominal cavity, compromised structures in the abdominal cavity were exposed and removed as far as possible.

Extensive abdominal wall neoplasm resection would inevitably result in a giant full-thickness defect, positioning from the symphysis pubis to the supraumbilicus. The prevesical space of Retzius was carefully prepared, and the peritoneum lateral to the bladder was dissected. As a result, the bladder was taken down, and the posterior aspect of the pubic bone, Cooper's ligaments, and bilateral inferior epigastric vessels were exposed. The posterior aspect of a composite mesh was introduced 5 cm into the Retzius space and attached to the posterior aspect of the pubic bone. Interrupted 2–0 polypropylene sutures for mesh fixation were placed on the periosteum of the posterior part of the symphysis pubis and bilateral Cooper's ligaments, respectively. Additionally, there were also 2 running polypropylene sutures on the edge of mesh and the edge of myofascial defect, except the upper side of the defect, because to date, giant composite mesh enough to cover the total defect with adequate overlapping on every side is not available. The upper side of the defect without composite mesh coverage was left to serve as an orifice to introduce the omentum flap, which was commonly prepared on the pedicle of the right or left gastroepiploic artery.

Subsequently, the retromuscular and prefascial space in the upper side of the defect was prepared, and a lightweight polypropylene mesh was implanted to cover this portion of the defect and overlap the composite mesh for 3 cm, isolating from the viscera with the underlying omentum flap. Circumferential fixation of the polypropylene mesh was performed on surrounding tissues and composite mesh using interrupted polypropylene sutures. Closed suction drains were placed on the surface of the meshes and omentum flap. A rotation skin flap was adopted to cover these grafts.

Intravenous broad-spectrum antibiotics was used for 7 days. Draining output < 10 mL/d was an indication for removal of the drains. Routine B-mode ultrasound examination was performed to detect seromas on the 7th day postoperatively, and sterile aspiration was used if measured

volume was >20 mL. An abdominal binder was applied continuously until 3 months postoperatively.

Follow-up and data

All patients were required to return to the consulting room in the outpatient clinic for a follow-up physical examination at an interval of 3 months after surgery by an independent doctor. Any abnormality observed was confirmed further by computed tomography. The mean follow-up duration was 32.5 ± 12.5 months. Descriptive statistics, including means and standard deviations or counts and percentages, were calculated using SPSS version 13.0 (SPSS, Inc, Chicago, IL).

Results

Sixteen patients underwent radical lower abdominal wall neoplasm resection and reconstruction with the combined technique successfully. The mean size of the consequent giant full-thickness defects in the lower abdominal wall was 226.5 ± 65.5 cm^2, with a mean polypropylene mesh size of 160.7 ± 40.5 cm^2 used in the sublay technique and a mean composite mesh size of 330.8 ± 100.2 cm^2 used in the intraperitoneal onlay mesh technique. The Ethicon Proceed patch was preferred in the condition of contaminated or infected lesions in 6 patients, and the Bard Composix E/X patch was adopted in 10 patients with sterile neoplasm presentation. The mean operative time was 210.0 ± 45.2 minutes, and the mean hospital stay was 16.5 ± 10.5 days. Sixteen patients had a mean follow-up duration of 32.5 ± 12.5 months. Four patients developed incisional infections, 3 cured by local dressing change and intravenous antibiotics, and 1 received vacuum-assisted closure and free skin graft, without removal of prosthetics. Three patients were noted to have seroma with volume > 20 mL and were treated by sterile aspiration through B-mode ultrasound evaluation and guidance. One patient with colonic cancer seeding metastasis in the abdominal wall and local recurrence compromising the left common iliac vessels and ureter developed several metastatic lesions in the liver and lungs 6 months after radical resection of abdominal wall neoplasm and palliative resection of intra-abdominal involvement and died 24 months postoperatively. Of the other 15 patients, 4 received chemotherapy and 6 underwent radiotherapy postoperatively. Although 2 patients, including 1 with ovarian cancer and 1 with colon adenocarcinoma, developed local recurrence in the abdominal cavity, no ventral hernia and recurrence related to the abdominal wall were observed in the follow-up period (Table 2).

Case example

The operative technique is illustrated through 1 patient example. A 59-year-old woman sought care for her recur-

Table 2   Patients' operative and postoperative results

Variable	Value
Defect size (cm^2)	226.5 ± 65.5
Operative time (anesthesia plus surgery time, min)	210.0 ± 45.2
Polypropylene mesh size (cm^2)	160.7 ± 40.5
Composite mesh size (cm^2)	330.8 ± 100.2
Length of hospital stay (d)	16.5 ± 10.5
Follow-up time (mo)	32.5 ± 12.5
Complications	
Mortality	1
Serious incisional infection	1
Seroma	3
Recurrence in the abdominal cavity	2
Recurrence in the abdominal wall	0
Hernia	0

Data are expressed as mean ± SD or as numbers.

rent giant mass, measuring 15 × 8 cm, with ulcer formation and infectious presentation in the lower abdominal wall (Fig. 1). She had 2 related surgeries of a bilateral oophorectomy with a pathologic result of ovarian serous cystadenoma 7 years before and a metastatic neoplasm resection in the abdominal wall with a result of serous cystadenocarcinoma 2 years before. Preoperative computed tomography demonstrated a neoplasm compromising the full-thickness abdominal wall and underlying bowels, as well as additional recurrence invading her uterus (Fig. 2). The patient underwent radical neoplasm resection and immediate abdominal wall reconstruction under general anesthesia. The compromised full-thickness abdominal wall, bowels, and uterus were all removed, with a clear margin of >3 cm. The iliac vessels were skeletonized, and the surface of the pubic bone was cauterized to eliminate possible residual carcinoma tissue (Fig. 3). A consequent full-thickness defect measuring 25 × 15 cm was left, and a combined reconstructive technique was performed with composite mesh (Ethicon Proceed) inserted into the Retzius space and polypropylene mesh (Atrium Medical Corporation, Hudson, NH) overlaid the upper portion of defect, associated with interpositional omentum flap and rotation skin graft (Figs. 4 and 5). This patient developed serious incisional infection and was cured by local dressing change, vacuum-assisted closure, and free skin graft (Figs. 6 and 7).

Comments

Aggressive neoplasms involving the abdominal wall include metastatic malignant tumors and borderline tumors. Desmoid tumor is the most common borderline tumor derived from the abdominal wall, with a high local recurrence rate of 25% and a propensity for distant metastasis.[10] Consensus has been reached that wide excision with clear margins should always be the treatment goal for desmoid tu-

Figure 1 Preoperative view of a giant neoplasm with ulcer and inflammation in the lower abdominal wall.

Figure 3 Cauterized pubic bone (A), skeletonized external iliac vessels (B), exposure of the Retzius space (C), and preparation of the bladder (D).

mors.[11] Rock et al[12] studied 194 patients with desmoid tumors and found a greater tendency for local recurrence in lesions treated with intralesional or marginal excision compared with those with wide resection, consistent with Ballo et al's[13] results. Dermatofibrosarcoma is a low-grade sarcoma recognized for its locally infiltrative nature. Wide gross margin was also recommended as performing resection for this tumor, on the basis of Gloster's[14] findings that dermatofibrosarcoma presented a histologic characteristic of clinically unapparent fingerlike projections of tumor cells blending into the tumor's periphery. Ovarian serous borderline neoplasm has a great tendency toward recurrence and aggravation. Silva et al[15] investigated 80 patients with this tumor and found that 35 (44%) developed recurrence and 27 (34%) aggravated into low-grade serous carcinoma after follow-up of 5 to 31 years. Kane et al[16] reported that these patients, even with repeated relapse, could also benefit from secondary surgery with negative resected margin. Bladder cancer is a common malignant neoplasm of the urinary system with an isolated local recurrence incidence of 7.5%
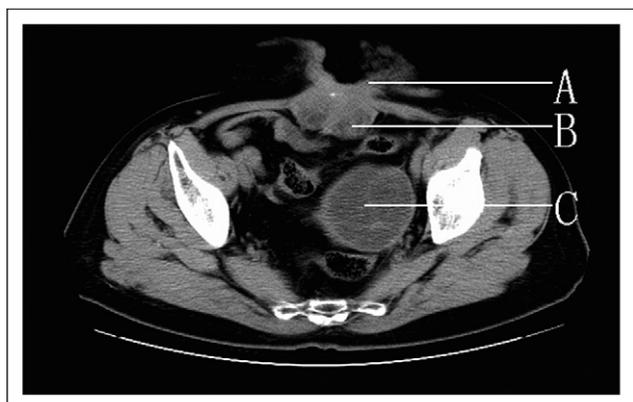
and a 13-month survival duration after local recurrence. In these patients, surgery for the local recurrence tumor was likely to be effective if a negative margin was achieved in surgical specimens according to the results of Fukuta et al.[17] In colorectal cancer, the incidence of abdominal wall metastasis was 4.4%,[18] and the survival period after the diagnosis of abdominal wall colorectal metastasis is 1 to 34 months.[19] However, Alexandrescu et al[20] described 2 cases of large abdominal wall metastasis after primary colon cancer resection. At the time of reporting, the patients had survived for 22 months and 12 months, respectively, after wide local excision.

Thus, aggressive neoplasms involving full-thickness abdominal wall are the indication for radical resection with wide clear margin. But reconstruction of the consequent giant defect after radical procedure is a formidable problem because of close proximity to the pubic bone and iliac

Figure 2 Computed tomographic scan demonstrating neoplasm compromised full-thickness abdominal wall (A), bowels (B), and uterus (C).

Figure 4 Acquisition of combined reconstruction, exposing a composite patch (A), a polypropylene mesh (B), and an interpositional omentum flap (C).

Figure 5   Presentation of rotation skin graft.

Figure 7   View before discharge.

vessels. Bendavid[21] introduced a technique for repair of suprapubic defect in 1990, using polypropylene mesh implantation into the Retzius space and fixation on the pubis and Cooper's ligaments, as well as full-thickness sutures. But morbidities associated with polypropylene prosthetic application have been recognized gradually, such as bowel adhesion,[22] esophageal erosion,[23] and infertility arising from mesh obstructive azoospermia.[24] On the basis of these suspicions, we have adopted composite mesh to contact the bladder directly in the Retzius space. The composite mesh had a permanent or absorbable barrier membrane joined to a sheet of polypropylene, such as an extended polytetrafluoroethylene in the Bard Composix E/X patch and an oxidized regenerated cellulose in the Ethicon Proceed patch, providing a proven safe plane to contact the viscera.[6] Transfascial fixation is possibly effective in case of mesh immigration. However, there is a significant association between use of transfascial sutures and postoperative chronic pain.[25] According to our experience, the periosteum in the posterior

Figure 6   Presentation of vacuum-assisted closure for infectious incision.

aspect of the symphysis pubis and Cooper's ligaments are enough strong to hold the implanted mesh, eliminating the risk for refractory pain as well.

The recommended 5-cm overlap of mesh across the margin of defect can be obtained readily in the inferior direction after entering the Retzius space. As a result, the upper portion of the defect would be inevitably vacant, and the omentum was introduced from this slit. Herein, the omentum served as rebuilding material of the abdominal wall[26] and an insulator of polypropylene material, which would be used in the sublay technique for repair of remaining defect. Li and Sheng[27] proved that the omentum adhering to the polypropylene mesh could not only prevent direct contact with viscera but promote formation of an epithelial layer to provide further protection for viscera.

Tang et al[28] presented their experience using a technique of tensor fasciae latae flap with or without human acellular dermal matrix to reconstruct the abdominal wall after neoplasm resection. During a relatively short follow-up period of 3 to 16 months, 33% of patients developed necrosis in the distal flap and needed debridement, and the same incidence of hernia formation also occurred. Carlson et al[29] considered that the abdominal wall reconstructed by myocutaneous flap could not tolerate the high intra-abdominal pressure, and the herniation rate after this procedure reached as high as approximately 42%. Shestak et al[30] also advocated that a solo autogenous myocutaneous flap was inappropriate for reconstruction of the abdominal wall. Necrosis at the edge may be another inherent complication in pedicled or free tensor fasciae latae flap, with an incidence of 50% according to Williams et al.[31] Human acellular dermal matrix is an absorbable biologic prosthesis with an advantage of resistance to infection. However, a unique complication of human acellular dermal matrix is the development of laxity of the prosthesis after implantation. Gupta et al[32] noted that 45% of patients who underwent reconstruction with this material in their review developed abdominal wall eventration at the repair site.

Of 16 patients in our cohort, 3 (18.8%) developed postoperative seroma, higher than the incidence of 5% reported by Carmine et al,[33] who presented a series of 100 patients with large incisional hernias repaired with intraperitoneal composite mesh. We speculate that the use of too much polypropylene mesh (polypropylene mesh was used in the Rives-Stoppa technique and polypropylene ingredient of the composite mesh in the intraperitoneal onlay mesh repair) was the reason for this complication. Morris-Stiff and Hughes[34] also thought that seroma formation had a strong association with polypropylene mesh size. One serious deep incisional infection may be the most formidable morbidity in our series, possibly secondary to preoperative neoplasm infection and excessive exudation from the omentum flap. Vacuum-assisted closure, consisting of a polyurethane sponge, a suction tube, and an occlusive drape, is effective to evacuate infectious fluid and prevent the loss of abdominal domain and accordingly promote wound healing. Free skin graft is another helpful supplementary method for management of this problem. In addition, the choice of composite mesh is essential to make this complication heal uneventfully, without removal of prosthetics. In the possibly contaminated or infected circumstance, we recommended using the Ethicon Proceed patch, which consisted of absorbable polydioxanone, oxidized regenerated cellulose, and large-pored polypropylene. These ingredients result in a property of resistance to infection. In contrast, the expanded polytetrafluoroethylene ingredient in the Bard Composix E/X patch is microporous and unabsorbable material, which makes removal of prosthetics inevitable once infected.

Conclusions

Radical resection in patients with aggressive neoplasm in the lower abdominal wall can produce satisfactory clinical results. A combined reconstructive procedure of intraperitoneal mesh placement, sublay technique, pedicled omentum flap, and rotation skin graft could provide the opportunity of immediate restoration of the lower abdominal wall. More cases and longer follow-up time are needed for further evaluation of this technique.

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