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Case Report

Reconstruction of Pelvic Exenteration Defects Using the Combined Method With Extended Vertical Rectus Abdominus Flap and Vacuum-Assisted Suction Drainage

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Introduction: Pelvic exenteration is a highly invasive procedure, with a reported rate of 20%–80% for serious complications. Thus, the prevention of postoperative complications is a major issue. Many previous reports have emphasized the importance of filling the dead space to prevent postoperative complications. In addition to filling the dead space, we believe that achieving sufficient drainage is extremely important. In this paper, we present a new combined method of the extended rectus abdominis myocutaneous flap and vacuum drainage with multiple drains, which achieved a lower frequency of complications.

Case Presentation: The subjects were 6 patients who underwent reconstruction following pelvic exenteration during a 7-year period between April 2005 and September 2013. We retrospectively measured the volume of the pelvic cavity and that of the rectus abdominis flap on lateral computed tomography (CT) scans to calculate the percentage of the dead space that was filled by the flap. There were no problems with flap engraftment in any of the patients. There were no serious complications, and no patient required additional surgery. The percentage of the dead space filled ranged from 25% to 46% (mean: 32%).

Conclusion: The rectus flap + vacuum drainage method, which uses an extended rectus abdominis myocutaneous flap to decrease the pelvic dead space and multiple vacuum suction drains, was associated with the prevention of serious complications.

Key words: Reconstruction – Rectus abdominus flap – Suction drain – Negative pressure wound therapy (NPWT)

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Pelvic exenteration is performed in patients with various types of advanced cancer, such as cancer of the rectum, sigmoid colon, uterus, vagina, or bladder. It may result in an extensive skin defect and massive dead space in the pelvic cavity. Pelvic exenteration is a highly invasive procedure, with a reported rate of 20%–80%[1] for serious complications like infection, wound dehiscence, inflammation of the pelvic dead space, ileus, intestinal occlusion, vascular, and neurologic complications. Thus, the prevention of postoperative complications is a major issue.[1,2] Many previous reports have emphasized the importance of filling the dead space to prevent postoperative complications.[3] However, we believe that achieving sufficient drainage is extremely important, in addition to filling the dead space. Here we report, along with a review of the literature, on the use of an extended rectus abdominis myocutaneous flap to fill the pelvic dead space, as well as vacuum drainage with multiple drains, which achieved a lower frequency of complications.

Materials and Methods

The subjects were 6 patients who underwent reconstructive operations following pelvic exenteration during a 7-year period from April 2005 to September 2013. The patients included 4 men and 2 women, ranging in age between 40 and 84 years (mean age: 55 years). Primary diseases included rectal cancer in 3 patients, sigmoid colon cancer in 1 patient, and anal canal cancer in 2 patients. We performed transplantation of a pedicled extended rectus abdominis musculocutaneous flap and placement of 4 to 5 (average: 4.1) vacuum suction drains in all patients (the rectus flap + vacuum drainage method).

We retrospectively measured the volume of the pelvic cavity and the rectus abdominis flap using lateral computed tomography (CT) scans to calculate the percentage of the dead space that was filled by the flap.

Following combined resection of the perineal skin and pelvic exenteration by the oncologic surgery department, reconstruction was performed with a pedicled extended rectus abdominis musculocutaneous flap. We raised the pedicled rectus abdominis musculocutaneous flap while preserving the inferior epigastric vessels, which extend over the muscle belly, according to the report by Taylor about rectus abdominis musculocutaneous flaps based on angiosomes. The rectus abdominis muscle was freed at both ends to form a complete musculocutaneous island flap. Then the flap comprising rectus abdominis muscle, subcutaneous fatty tissue, and partially de-epithelialized skin was placed inside the pelvic dead space through ipsilateral inguinal triangle, and the perineal defect was reconstructed with the cutaneous island flap. We then placed 4 to 5 vacuum suction drains (average: 4.1 drains) on the both sides as well as the roof and floor of the pelvic cavity. The drains were pulled out one by one when the drain fluid volume had decreased to less than 20 mL. The last drain was left to provide a negative pressure effect for approximately 2 weeks.

Measurements were performed on a workstation with a general-purpose diagnostic imaging unit (Ziostation, Ziosoft Inc, Tokyo, Japan).

From preoperative CT scans, we calculated the volume of the lesser pelvic cavity (the cavity was defined as the region below the pelvic linea terminalis), as well as the lateral volume of the rectus abdominis muscle plus the subcutaneous adipose tissue of the flap.

The percentage of dead space filled was then calculated as follows: (lateral volume of the rectus abdominis muscle + subcutaneous adipose tissue)/(preoperative volume of the lesser pelvic cavity).

Results

There were no problems with flap engraftment in any of the cases.

Perioperative complications amounted to a small fistula in 4 patients, all of which were closed with conservative treatment. No serious complications occurred, and none of the patients required additional surgery. Bacterial culture examination of the drain tips detected MRSA in 1 patient, *Pseudomonas aeruginosa* in 2 patients, and *Enterococcus faecium* in 2 patients. The donor site was closed by reefing in 5 cases and skin grafting in 1 case. No donor site complications, such as abdominal muscle laxity or incisional hernia, were observed (Table 1).

The percentage of the dead space filled ranged from 25% to 46% (mean: 30%).

Case Report

Case 1: a 44-year-old man

Total colectomy, abdominoperineal proctectomy, and construction of an artificial anus were performed for sigmoid colon cancer, resulting in a perineal skin defect and massive pelvic dead space. The patient underwent reconstruction to reduce the

Table 1 Case summary

Case	Age, y	Sex	Primary disease	No. of drains	Drain removed, day	Culture of the drain tip	Major complication	Donor closure	Percentage of the dead space filled
1	44	Male	Crohn's disease sigmoid colon cancer	4	11	MRSA *Enterococcus faecium* *Escherichia coli* *Bacteroides fragilis*	None	Primary	31
2	84	Female	Anal canal cancer	5	17	*Stapylococcus Epidermis* *Candida albicans* *Corynebacterium spesis*	None	Primary	25
3	40	Male	Crohn's disease rectal cancer	4	14	*Enterococus faecalis* *Enterococcus raffinosus*	None	Graft	25
4	60	Male	Rectal cancer	4	14	*Stapylococcus warner*	None	Primary	46
5	53	Male	Rectal cancer	4	11	*Pseudomonasaeruginosa*	None	Primary	29
6	60	Female	Anal canal cancer	4	13	*Stapylococcusepidermis* *Pseudomonasaeruginosa*	None	Primary	27

dead space and to cover the skin defect. An extended rectus abdominis musculocutaneous flap was raised with an island of skin extending toward the axilla. The rectus abdominis muscle was freed at both ends to create a complete cutaneous island flap. Then the flap comprising rectus abdominis muscle, subcutaneous fatty tissue, and partially de-epithelialized skin was placed into the pelvic dead space, and the perineal defect was reconstructed with the cutaneous island flap. In this patient, 31% of the dead space was filled. To achieve sufficient drainage, a total of 4 vacuum suction drains were placed (pelvic floor, both sides of the pelvis, and under the abdominal skin). All drains were removed by the 11th postoperative day. The entire flap remained viable, but a small fistula occurred at the suture line. This fistula was closed with conservative treatment. Bacterial culture examination of the drain tips detected MRSA, *Enterococcus faecium, Escherichia coli*, and *Bacteroides fragilis*, but no signs of infection were observed. Postoperative CT scans revealed no residual dead space, and there was no evidence of hernia or fistula.

Case 2: an 84-year-old woman

Abdominoperineal proctectomy and adnexectomy were performed for anal canal cancer, resulting in a perineal skin defect and massive dead space in the pelvis. The dead space was filled, and reconstruction was performed using an extended rectus abdominis musculocutaneous flap. In this patient, 25% of the pelvic dead space was filled. A total of 5 vacuum suction drains were placed (both sides of the pelvis, roof and floor of the pelvis, and under the abdominal skin) (Fig. 1). All 5 drains were removed by the 17th day. No complications such as infection or fistula formation were observed in her postoperative course (Fig. 2).

Discussion

Pelvic exenteration is performed as a radical operation for various types of advanced cancer, such as cancer of the rectum, sigmoid colon, uterus, vagina, and bladder, but the procedure results in extensive skin defects and massive pelvic dead space. Complications of pelvic exenteration include infection, inflammation of the pelvic dead space, pelvic abscess, fistula, ileus, anastomotic leakage, and wound dehiscence, and complications occur at a very high rate of 20%–80%.[1] The reason for this high frequency of complications following pelvic exenteration is related to the presence of the pelvic dead space and to tension at the suture lines. Closure of the skin defect by suturing under excessive tension can result in wound dehiscence or contracture, whereas the presence of a large pelvic dead space can lead to pelvic infection, fistula, or ileus. These complications are sometimes life threatening, lead to prolonged hospitalization, and interfere with the performance of postoperative radiation therapy, chemotherapy, and/or rehabilitation. Therefore, reconstruction of the skin defect by transplantation of a skin flap and filling the pelvic dead space are important in preventing such complications. Previous authors have largely focused on filling the dead space by skin flap transplantation, and there are numerous reports describing methods of filling the dead space inside

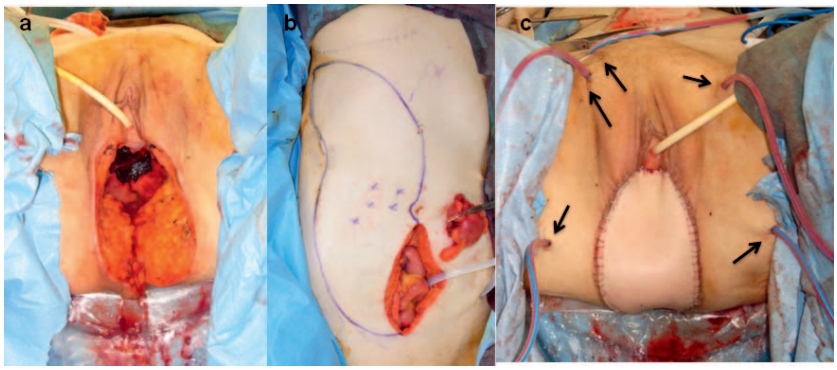

Fig. 1 Case 2: an 84-year-old woman. (a) Abdominoperineal proctectomy and adnexectomy were performed for anal canal cancer, resulting in a perineal skin defect and massive dead space in the pelvis. (b) An extended rectus abdominis musculocutaneous flap was designed. (c) The immediate result after reconstruction of the rectus abdominis muscle, subcutaneous fatty tissue, and partially de-epithelialized skin was placed into the pelvic dead space, and the perineal defect was reconstructed with the cutaneous island flap. A total of 5 vacuum suction drains were placed (right and left sides of the pelvis, roof and floor of the pelvis, and under the abdominal skin) (arrow).

the pelvis using a gracilis myocutaneous flap, anterolateral thigh flap, rectus abdominis myocutaneous flap, and so on.[2–7] Although such efforts have led to a decrease in the frequency of occurrence of complications, it remains true that serious complications still occur. We think that the difficulties associated with attempting to fill the entire pelvic dead space by using a skin flap, which are frequently encountered, may contribute to the high rate of complications. In fact, in the present series, the average percentage of dead space filled was only 32%, despite the transplantation of extended rectus abdominis myocutaneous flaps.

We considered that, when performing transplantation with an extended rectus abdominis myocutaneous flap, it might be possible to prevent such complications by ensuring sufficient drainage of the residual pelvic dead space with multiple vacuum suction drains. To this end, the rectus flap + vacuum drainage method was developed. Vacuum-assisted suction drainage has the following effects related to negative-pressure. (1) Tissues at the wound margin are pulled centripetally by negative pressure, thereby promoting minimization of the wound area. (2) Suction drainage allows maintenance of a relatively moist environment, which promotes cell proliferation, angiogenesis, and degradation of necrotic tissue. Minimization of tissue defects and an increase of blood flow around the wound with alleviation of inflammation and infection accelerate wound healing. (3) Suction removes excess fluid and improves local edema, while the reduction of edema increases blood flow around the wound, increases the tissue partial pressure of oxygen, and promotes the growth of granulation tissue. In infected or colonized wounds, suction also has the effect of directly removing bacteria and bacterial exotoxins. Inflammatory cytokines and metalloproteinases that

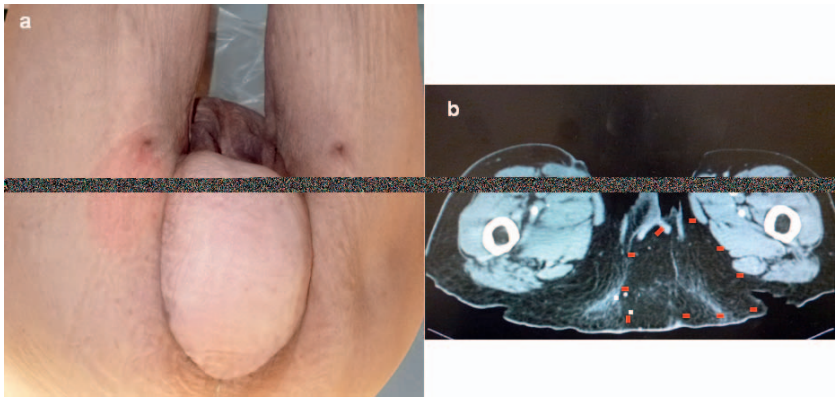

Fig. 2 (a) One-year postoperative appearance. (b) Postoperative CT scan.

are harmful to cells can also be removed. (4) Suction exerts mechanical stress on cells at the wound surface that activates various signaling pathways via its influence on the cytoskeleton, thus inducing cell proliferation. Such effects may promote the proliferation of fibroblasts, leading to minimization of tissue defects via growth of granulation tissue. They may also promote the proliferation of vascular endothelial cells, leading to increased blood flow in the wound region via angiogenesis.[8–11] Therefore, the rectus flap + vacuum drainage method can possibly prevent the occurrence of serious complications by achieving skin reconstruction, decreasing the pelvic dead space, ensuring sufficient drainage, and promoting more rapid wound healing. It is considered an effective method of reconstruction after pelvic exenteration.

Conclusions

The rectus flap and vacuum drainage method, which uses an extended rectus abdominis myocutaneous flap to decrease the pelvic dead space and multiple vacuum suction drains, leads to prevention of serious postoperative complications.

Therefore, this surgical procedure can be considered a useful method of reconstruction following pelvic exenteration.

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