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Multiple pedicled flaps cover for large defects following resection of malignant tumors with partition concept

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Abstract

Large defects after skin malignant tumors resection were difficult to repair. We introduced a partition concept, in which the large defects were divided into several subunits, and each subunit was repaired by a certain pedicled flap to achieve a complete coverage.

Between May 2012 and Oct 2016, 8 patients with skin malignant tumors underwent radical resection. Prior to surgery, the dimension of the potential defect after tumor ablation was estimated and outlined. After evaluation, the partition concept was applied and the defects were divided into several subunits. Also, the rationality of the choice of pedicled flap was evaluated. Each flap was used to cover its specific subunits defect.

After excision, the defect areas were from 13 × 17 cm to 36 × 23 cm. Each subunit was designed to be repaired with a pedicled flap, which included local random flap, superficial iliac artery flap, transverse rectus abdominis myocutaneous (TRAM) flap, lateral thoracic advanced island flap, anterolateral thigh (ALT) flap, anteromedial thigh (AMT) flap, and deep circumflex iliac artery (DCIA) flap. Primary closure of both donor and recipient sites was achieved in all patients. All the flaps survived. Flap necrosis was not observed.

Reconstruction of large defects following resection of malignant tumors with multiple pedicled flaps was a reliable method. The partition concept is useful in the reconstruction of large tumor wounds in 1-stage operation.

Abbreviations: ALT = flap anterolateral thigh (ALT) flap, AMT = flap anteromedial thigh (AMT) flap, CT = computerized tomographic scanning, DCIA = flap deep circumflex iliac artery (DCIA) flap, MRI = magnetic resonance imaging, PET = positron emission tomography, pSCC = penile squamous cell carcinoma (pSCC), TRAM = flap transverse rectus abdominis myocutaneous flap.

Keywords: large defect, malignant tumor, partition concept, pedicled flap

1. Introduction

The reconstruction of large wound after skin malignant tumor excision is a challenge in reconstructive surgery and surgical oncology.[1] Primary reconstruction has been shown to reduce the incidence of wound infections and dehiscence. Factors, such as postoperative radiochemotherapy, hospitalization period, cost of treating, also forced immediate reconstruction. Review of literature shows a number of studies reconstructing large defect.[2–6] The various options available are skin grafting, artificial dermis, pedicled myocutaneous flaps, and free flaps. To date, a single all-round method has yet to emerge to deal with all sorts of wounds. For instance, skin grafting, where mismatched skin color, loss of elasticity, and graft retraction make it difficult to provide a functional cover and tolerate high dose of postoperative radiotherapy, requires a long dressing time and therefore an extended hospitalization time. Free flap transfers have revolutionized oncologic surgery. Even in the most experienced hands, they are time consuming and often require more technical expertise. Irradiation, previous surgery, and comorbidities can make these operations challenging and less predictable.

Pedicled skin flap[7,8] is heavily applied in oncologic and reconstructive surgery with the advantages of simplified procedure and reliable blood supply. However, in many cases, a giant defect or a large defect cannot be covered or covered properly with a certain single pedicled flap. In these situations, high tension, tissue retraction, local tissue deformity, or incomplete coverage may occur. For the above reasons, we introduced a partition concept. In this concept, the oncologic defect was divided into several subunits, and each subunit was repaired by a single pedicled flap. We think this method is especially suitable for the large defect after resection of malignant tumor. Our experience and literature review are presented.

2. Patients and methods

This study had been approved by the Ethics Committee of Sun Yat-sen Memorial Hospital. The cases with oncologic defect which could not be reconstructed with a single pedicled flap were recruited. Between May 2012 and Oct 2016, the partition concept was applied in 8 patients for reconstruction of large oncologic defects located at various anatomical sites. Four females and 3 males with a mean age of 53.125 years (range, 39–65 years) were included in this study. The oncologic tumors

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contained carcinoma of vulva (n=2), dermatofibrosarcoma protuberans (n=2), advanced breast cancer (n=3), and advanced penile carcinoma (n=1). The follow-up was from 1 month to 12 month.

3. Operative technique

Prior to surgery, the dimension of the potential defect after tumor ablation was estimated and outlined. The sites included perineal region (n=2), abdomen (n=1), groin (n=1), chest wall (n=2), oxter-chest wall (n=1), and lower abdomen-perineum (n=1). After evaluation, the defects were divided into several subunits. In each of the cases, the primary defect was divided into 2 (n=6) or 3 subunits (n=2).

As to dermatofibrosarcoma protuberans, the operation consists of a wide local excision with 3–5 cm margins, as deep as reaching the layer of deep fascia (muscular fascia). In other cases, a 2 cm circumferential excision was made beyond the macroscopic affected margin, with vertical excision to the layer of deep fascia (muscular fascia). We marked 6 to 8 sites at margin of and 1 to 2 sites at base of excised specimen, tissue of which was sent to pathology. Apart from the case of recurrent carcinoma of penis, margins in other cases were all found negative. Patients in 2 carcinoma of vulva cases received inguinal lymphadenectomy (operated by gynecologists), whereas the patient in the case of recurrent carcinoma of penis received bilateral inguinal lymphadenectomy (operated by urologists).

The midline of wound or dividing line of anatomy (such as anterior line axilary, inguen) was usually be chosen as the boundary between 2 subunits. And then, the candidate pedicled flaps were selected and designed to match the size and shape of the subdefects. All the flaps were adjacent pedicled skin flap, which may be a known axial flap, a perforator flap or a random flap. Usually, the flaps should be frequently used and easy to harvest.

The rationality of the choice of skin flap was evaluated. Each flap was used to cover its specific subunits defect. Long distance jumping repairing should be avoided, neither the pedicles' overlapping, compression or overstretch. Preoperative Doppler examination was necessary for perforator flaps. A careful surgical procedure was important to ensure the blood supply of flap. Each flap was used to cover the corresponding subdefect. Each subunit was designed to be repaired with a pedicled flap, which included local random flap, superficial iliac artery flap, transverse rectus abdominis myocutaneous (TRAM) flap, lateral thoracic advanced island flap, anterolateral thigh (ALT) flap, anteromedial thigh (AMT) flap, and deep circumflex iliac artery (DCIA) flap.

4. Results

After wide excision, the defect sizes ranged from $13 \times 17\,cm^2$ to $36 \times 23\,cm^2$. Two cases were carcinoma of vulva, which repaired by bilateral anteromedial thigh flaps. Three cases were advanced breast cancer, which repaired by TRAM flap, lateral thoracic advanced island flap, and local rotational flap of proximal upper arm. Two cases were dermatofibrosarcoma protuberans, which repaired by ALT flap, DCIA flap, and superficial iliac artery flap. One case was local infiltration of advanced penile squamous cell carcinoma (pSCC), which was repaired by bilateral AMT flap and left DCIA flap.

Primary closure of both donor and recipient sites was achieved in all patients. All the flaps survived with no hematoma, seroma, flap necrosis, or infection observed. One case had fat liquefaction and partial wound dehiscence. In the follow-up period, long-term complications such as hernia, scar contracture, or malformation were not apparent in our observations.

The detailed documentations of the patients were reviewed retrospectively (Table 1).

5. Classical cases

5.1. Case 1

A 65-year-old woman with advanced recurring carcinoma of vulva experienced a progressively enlarged necrotic fester in her perineal region. She received vular squamous cell carcinoma resection and local radiotherapy before, but recrudescence was observed. In lithotomy position, the ulcer wound measured 8×9 cm over the vulvar area with an extensive infiltrating the urethra orifice and vaginal introitus. After extensive perineal resection, the defect was 16×17 cm. The whole perineal, monsveneris area and bilateral partial inguinal region was involved. The urethra and vaginal wall were partial removed. The defect was divided into 2 parts defined by the middle line, and bilateral pedicled AMT flaps were designed for the covering (Fig. 1).

5.2. Case 2

A 47-year-old woman with advanced recurring breast cancer who was about to get the recurring tumor removed. The pedicle TRAM flap was designed to repair the defect. Single pedicle TRAM flap had a risk of partial flap loss or fat necrosis[9] and the shape of bipedicle TRAM flap without a middle incision always could not fit the defect well. Also, the large thoracic wound could be reconstructed with V-Y latissimus dorsi musculocutaneous flap.[10,11] But skin elasticity of the back was not good as abdomen. So, the estimated defect was designed to be divided into 2 subunits. Each subunit closed by a single raising unilateral pedicle TRAM flap following the chimeric flap principle[12] (Fig. 2).

5.3. Case 3

A 51-year-old man presented with a large recurrent mass in the epigastric region that was identified as a dermatofibrosarcoma protuberans in previous surgery 2 years ago. The specimen was resected with a 5 cm margin. A circular large defect was left with the dimension of 21×22 cm. A single flap could not be easily found without skin grafting. And the skin of abdominal wall had a definite elasticity. So, bilateral superficial iliac artery flap was planed to cover the defect (Fig. 3).

5.4. Case 4

A 53-year-old woman presented with advanced recurring breast cancer. The resection range covered the whole left axilla, partial chest wall, and root of upper arm. The defect was divided into 3 parts defined by anterior axillary line, apical axillary region, which were repaired by left TRAM flap, lateral thoracic advanced flap and local flap of the upper arm (Fig. 4).

5.5. Case 5

A 39-year-old patient presented with an extensive putrescent ulceration of abdominoperineal region infiltrated by advanced pSCC. The tumor had grown gradually over 2 years and originated from a penile mass, which was confirmed as well-differentiated squamous carcinoma by histopathology. The infiltration was from skin of right anterior superior iliac spine

Table 1

Detailed documentation of the patients.

Patient no.	Sex	Age, years	Cause of defects	Preoperative examination	Remote metastasis or deep invasion	Defect region	Size of skin defect, cm	Number of subunits	Flap design	Flap size, cm	Complications
1	F	65	Carcinoma of vulva	Abdominal and pelvic MRI	Inguinal glands metastasis	Perineal region	16 × 17	2	Bilateral anteromedial thigh flap	20 × 9;25 × 8	None
2	M	51	Dermatofibrosarcoma protuberans	Abdominal MRI	No	Abdomen	21 × 22	2	Bilateral superficial iliac artery flap	16 × 9;13 × 11	None
3	M	49	Dermatofibrosarcoma protuberans	Abdominal and thigh MRI	No	Right groin	13 × 17	2	Right anterolateral thigh flap, right deep iliac artery flap	8 × 18;10 × 15	None
4	F	47	Advanced breast cancer	Thoracic and abdominal CT	Pulmonary metastasis	Chest wall	21 × 18	2	Bilateral TRAM flap	18 × 10; 19 × 10	None
5	F	62	Advanced breast cancer	Thoracic and abdominal CT	No	Chest wall	20 × 17	2	Bilateral TRAM flap	18 × 9; 18 × 9	None
6	F	59	carcinoma of vulva	Abdominal and pelvic MRI	Inguinal glands metastasis	Perineal region	19 × 15	2	Bilateral anteromedial thigh flap	26 × 8;27 × 8	Fat liquefaction, Partial wound dehiscence
7	F	53	Advanced breast cancer	Thoracic and abdominal CT	No	Oxter-chest wall	29 × 18	3	Left TRAM flap, lateral thoracic advanced island flap and local rotational flap of proximal left upper arm	11 × 23; 30 × 8; 12 × 6	none
8	M	39	Local infiltration of advanced penile carcinoma	Abdominal and thigh MRI, whole-body PET/CT	Left pelvic lymph nodes metastasis and invasion of left femoral sheath	Lower abdomen-Perineum	36 × 23	3	Right anteromedial thigh flap, left deep iliac artery flap and left anteromedial thigh flap	30 × 17; 27 × 15; 22 × 10	None

CT = computerized tomographic scanning, MRI = magnetic resonance imaging, PET = positron emission tomography, TRAM flap = transverse rectus abdominis myocutaneous flap.

to left anterior superior iliac spine, going across lower abdominal. The infiltration also extended to the bilateral inguinal region, and reached 6 cm below the left groin. Almost the whole scrotum was involved. The magnetic resonance imaging (MRI) showed that there was extensive local infiltration, bilateral inguinal lymph nodes and left pelvic lymph nodes metastasis and invasion of left femoral sheath. Massive exudation was produced every day from the wound, and hemorrhage occurred when changing the dressing. The purpose of the surgery was to remove the ulcer and the infiltration of the soft tissue as much as possible for a better nursing care, reducing the pain of the patient and facilitating the next course of treatment.

After incision, there was a large skin defect in the lower abdomen, perineum, and inguinal region, which was about 36 × 23 cm. To reconstruct the defect in 1 stage, the whole defect area was divided into 3 sub-defects, defined by medioventral line, left arcus cruralis (root of the left thigh). A combined pedicled bilateral anteromedial thigh flaps and left deep circumflex iliac artery flap were prepared according to the location of the perforators identified by a Doppler examination before the operation. To our knowledge, it is the largest defect after aggressive palliative resection of pSCC in the literature so far, which was 36 × 23 cm. The giant abdominoperineal defect was reconstructed with bilateral AMT flaps and left DCIA flap, which is also the first reported (Fig. 5).

6. Discussion

In reconstructive surgery and surgical oncology, the flap technique is very important when closing the wound followed resection. All flap surgeries are "robs Peter to pay Paul." How to balance the defect reconstruction and donor-site morbidity is critical for the recovery and following treatment. For covering the large wound or defect, a large area flap was designed leaving the donor sites closed under great tension. As a result, great tension tends to lead wound dehiscence, local malformation, hypertrophic scar, limitation of movement, and so on. If the donor-site morbidities were frequent or serious, the primary flaps probably should be designed more reasonable initially. On the other hand, when applying a skin graft in regions of body that demand mobility, shear forces tend to result in graft slippage and incomplete graft take, which requires long-term postoperative immobilisation with increased inconvenience. To solve this problem, different surgeons have different ways. Visconti and Salgarello [13] used V-Y anteromedial thigh perforator flaps for the defect closing after harvesting anterolateral thigh free flap. Similarly and more comprehensively, Liu et al[14,15] designed a conception named "buddy flap," which was used to repair the donor-site defect. Marsh and Chana[16] describe a split-skin paddle ALT flap, which is a novel variation on the standard ALT flap design, to provide customized wound cover for very large defects whilst maintaining direct closure of the donor site. But some defect still could not be covered by a single flap; multiple pedicled flaps followed partition concept were necessary.

Reconstruction of large defects following resection of malignant tumors with multiple pedicled flaps has some advantages. First, the defects could be covered by 1 surgical operation and the risk of reoperation due to complications was lower than skin graft or skin substitute graft. It has a wide indication, not only for the defects originated from oncologic excision, but also for other kinds of defect. Second, operation difficulty and operation risk are reduced. The primary defect was divided into several subunits; therefore, the areas to be repaired became relatively

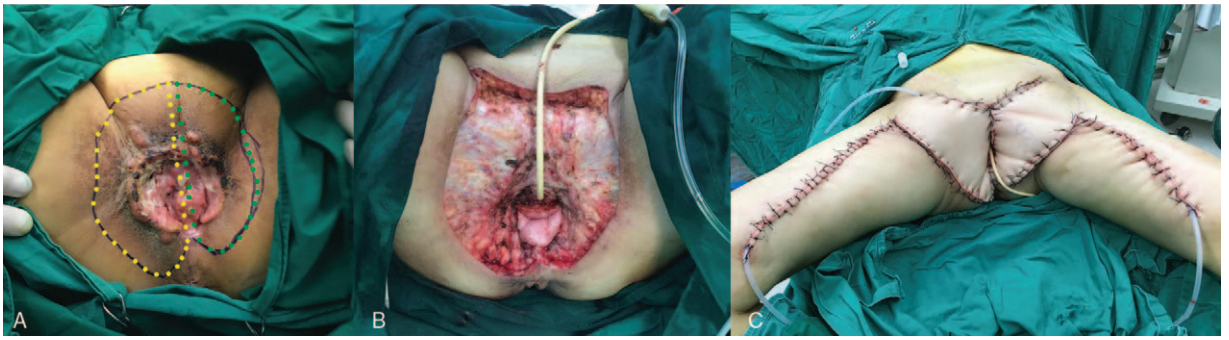

Figure 1. (A) Preoperative view with different colors defining defective subunits. (B) Operative view. (C) Postoperative view.

small, which also ensured the operability. Meanwhile, the blood circulation disturbance in a certain 1 area single flap could be prevented. Furthermore, the multiple pedicled flaps, transferred without vascular anastomosis, outclass free flap in terms of postoperative complications, which includes complete flap failure,[17] pseudoaneurysms,[18] and vascular embolization.[19] Third, with smaller donor site wound, the secondary defect can be closed easily. Any risk of incapable of closing the secondary defect goes against the original intention of the partition concept. The donor-site morbidity is reduced.

Though we think the multiple pedicled flaps cover for large defects following resection of malignant tumors with partition concept could be applied widely in wound therapy, it is not an all-round method in large defect repair. In some parts of the body where subject to poor blood supply and lack loose adjacent skin,[20] taking lower leg for instance,[21] large skin defects may not be suitable for multiple pedicled flap repair, and the principle thereof.

Reconstruction of large defects following resection of malignant tumors with multiple pedicled flaps was similar with some techniques. The concept of subunits has a long history and is well established in facial reconstruction as the "aesthetic subunit" principle.[22,23] Also, some nonfacial wound reconstruction given expression to partition concept. Zhang et al[24] used the reverse bipaddle posterior interosseous artery perforator flap to cover large defects of the hand. In their cases, the type A chain-like variant was used to cover defects involving 2 different units of the hand, and the type B "kiss" pattern was required to resurface a large, single unit defect of the hand. Some other reports, such as "double-helix flap to close a massive circular soft-tissue defect,"[25] "multiple V-Y advancement and rotation flaps for a large cheek defect"[26] and "double pedicled perforator flap to close flank defects"[27] embody obvious elements of partition concept. What is more, some literature[28] had reported reconstruction of large defects with multiple pedicled flaps, but only case report, in which skin grafting also be used.

Conceptually, some theories were similar with partition concept introduced in our cases. These theories contained "components separation technique" proposed for repairing large abdominal wall hernias,[29] "serial laser excision method" developed for melanocytic nevi larger than 5 mm,[30] "compartmentalization of massive vascular malformations" in which a massive vascular malformation is divided into multiple compartments by changing the direction of the suturing,[31] and "diamond concept" in fracture healing.[32] All these techniques, methods and concepts contained similarities, in which a big issue could be solved by decomposing it into small ones. When decomposed, the small ones could be solved easily and better.

In conclusion, we think the partition concept of closing large defects after skin malignant tumors resection with multiple pedicled flaps proposed an important guideline in our cases. It provided a way of surgical design, as a supplement or an alternative option for the selection of flap for covering large defects after skin malignant tumors resection.

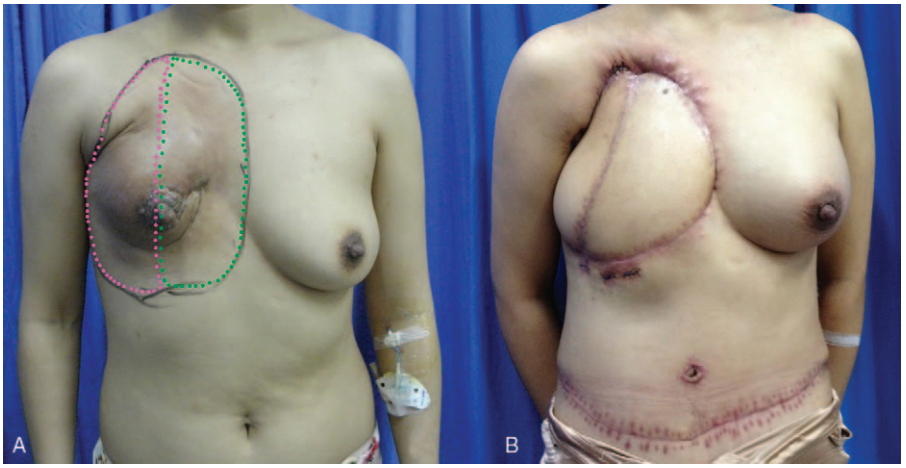

Figure 2. (A) Preoperative view. The pink dashed line and green dashed line represented subunits of defect. (B) Four months postoperative.

Figure 3. (A) Preoperative view. (B) Operative view. (C) Postoperative view. (D) Seven months later.

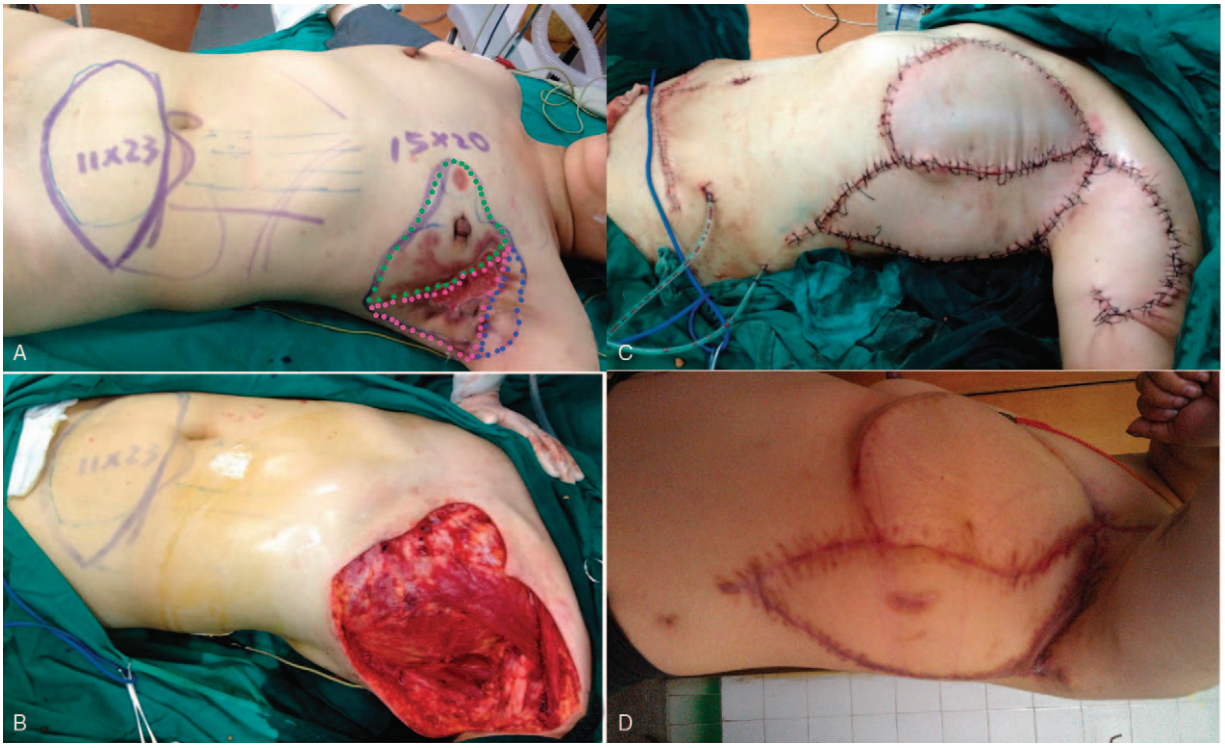

Figure 4. (A) Preoperative view with different colors defining defective subunits. (B) Operative view. (C) Postoperative view. (D) Four months postoperative view.

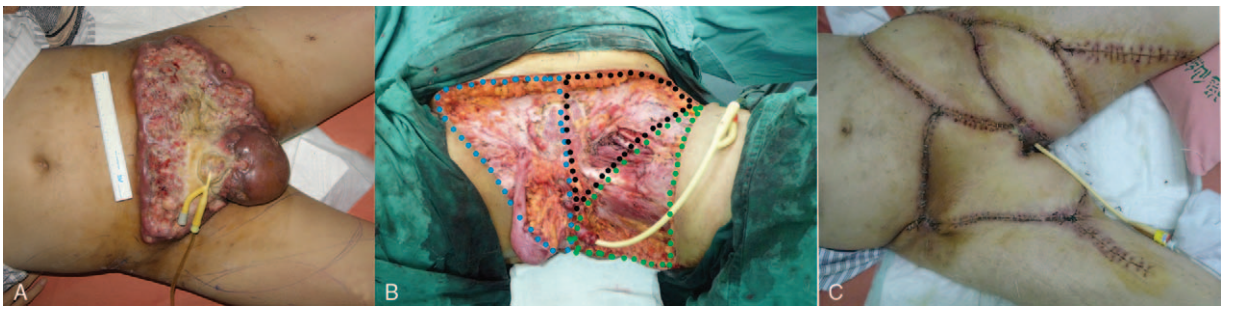

Figure 5. (A) Preoperative view. (B) Operative view with different colors defining defective subunits. (C) Three weeks postoperative view.

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