Original Article

Characteristics of Abdominal Soft Tissue Sarcoma and an Algorithm for Reconstruction after Tumor Resection

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ABSTRACT

Background: In the abdominal reconstruction of soft tissue sarcoma (STS), a consistent operative method has not been previously reported. This retrospective case-control study aimed to investigate the characteristics of abdominal STS compared to other areas and to create an algorithm for abdominal reconstruction after STS resection.

Methods: We reviewed the cases of 425 STS patients. Patients were stratified into two groups (abdominal area vs. other areas). We also investigated our reconstruction procedures.

Results: The resection of abdominal STS was performed in 43 cases (10.5%). The reconstruction rate in the abdominal area group was significantly higher than that in the other areas group (33 cases [76.7%] vs. 119 cases [31.2%], p < 0.001); similarly, the local or pedicled flap rate was higher in the abdominal area group than in the other areas group (27 cases [81.8%] vs. 48 cases [40.3%), p < 0.001). Our algorithm was as follows: Abdominal wall was reconstructed using fascia graft. In the groin region only, pedicled tensor fasciae latae flap (TFL) was performed. In the upper abdominal area, we first tried to perform pedicled rectus abdominis musculocutaneous flap (RAM). In the lower abdominal area, we first tried to perform pedicled muscle sparing transverse RAM and considered performing pedicled anterior lateral thigh + TFL in abdominal wall defect cases.

Conclusions: Since patients commonly need reconstruction of the abdominal wall, the reconstruction rate was high. In all cases, reconstruction could be performed using pedicled flaps and/or fascia graft.

Key words: abdominal reconstruction, pedicled flap, plastic surgery, soft tissue sarcoma

Introduction

In the abdominal wall reconstruction of soft tissue sarcoma (STS), it is important to determine the extent of the abdominal wall defect. Abdominal wall reconstruction is typically performed using mesh; however, the procedure can also be performed using a fascia graft from the thigh. In general, abdominal wall reconstruction can be performed using mesh graft, which is effective when there is no need to reconstruct skin and soft tissue. In abdominal wall defects with skin and soft tissue defects, reconstruction using flaps with fascia is usually performed. Since the abdominal wall is often exposed, reconstruction using flaps is performed more often than using skin graft. Therefore, there are many reports on reconstruction using flaps.

Since in most cases large flaps can be raised from areas adjacent to the abdomen (e.g., thigh and back), reconstruction can be done using pedicled flaps. However, some previous studies have reported abdominal reconstruction using free flaps. A consistent operative method has not been reported yet. This retrospective case-control study aimed to investigate the characteristics of abdominal STS compared to the other areas and to create an algorithm for abdominal reconstruction after STS resection. Because mesh grafts include risks of adhesion and infection, a fascia graft was preferred over mesh for the reconstruction of the abdominal wall. Therefore, we tried to create an algorithm for abdominal wall reconstruction using fascia grafts.
Materials and methods

In this retrospective case-control study, we reviewed the cases of 425 patients who underwent resection of a primary STS at the Chiba Cancer Center (Japan) between April 2006 and June 2018. Cases of recurrent or metastatic sarcoma, bone sarcoma (such as osteosarcoma and chondrosarcoma), desmoids, and atypical lipomatous tumors were excluded. Cases of recurrent or metastatic sarcoma, bone sarcoma (such as osteosarcoma and chondrosarcoma), the intra-abdominal STS without resection of both the abdominal wall and the skin, desmoid, and atypical lipomatous tumor were excluded.

Patients were stratified into two groups (abdominal area vs. other areas). The abdominal area STS group was compared to the other areas (chest, back, and upper and lower extremities) STS group. Age, body mass index, operative time, bleeding, reconstruction rates, adjuvant radiotherapy rates, and adjuvant chemotherapy rates were compared. The histological types of abdominal STS were examined. The intra-abdominal STS cases without resection of both the abdominal wall and the skin, desmoid, and atypical lipomatous tumor were excluded.

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Reconstruction was defined as repair of the skin and soft tissue, fascia, vessel, nerve, and vascularized bone by a plastic surgeon.

In the abdominal reconstruction group, the types of reconstruction procedures as well as the complications (abdominal bulging and partial flap necrosis) were compared (skin graft only, local or pedicled flap, and free flap). Abdominal wall reconstruction was defined as reconstruction for the defects of abdominal muscles (rectus abdominis, external abdominal, internal abdominal, and transverse abdominal muscles) and abdominal fascia. However, abdominal reconstruction was defined as reconstruction due to abdominal skin and soft tissue defects with or without abdominal wall reconstruction. We investigated both reconstruction procedures and their results. According to these results, we created an algorithm for abdominal reconstruction after STS. Pedicled rectus abdominis musculocutaneous flap (p-RAM) included lower pedicled muscle sparing transverse RAM (p-MSTRAM) and upper p-RAM. P-thigh flap included anterior lateral thigh flap (ALT), tensor fasciae latae flap (TFL), and combined flap, consisting of both (ALT + TFL). Regarding complications, partial flap necrosis was defined as requiring additional surgery (primary closure or skin graft) for wound healing.

Statistical analysis

All data in this study were analyzed using IBM SPSS Statistics 22 (IBM-SPSS, Inc., Chicago, IL, USA). Mean and standard deviation (mean ± SD) were expressed. These data were compared using the Mann-Whitney U-test or Fisher’s exact test. Statistical significance was assumed at \( p < 0.05 \).

Results

Resections of primary abdominal STS were performed in 43 cases (10.5%). Reconstructions were performed in the abdominal area in 33 cases (76.7%) and in other areas in 119 cases (31.2%). The reconstruction rate was significantly higher in the abdominal group \(( p < 0.001)\), as well as the operative time (275 ± 153 min vs. 198 ± 141 min, \( p < 0.001 \)). Other characteristics (age, body mass index, bleeding, adjuvant chemotherapy and adjuvant radiotherapy rates) showed no significant differences (Table 1). The histological types of abdominal STS were: undifferentiated pleomorphic sarcoma (8 cases), malignant peripheral nerve sheath tumor (7 cases), myxofibrosarcoma (5 cases), dermatofibrosarcoma protuberans (3 cases), fibrosarcoma (3 cases), synovial sarcoma (3 cases), angiosarcoma (2 cases), myxoid liposarcoma (2 cases), Ewing sarcoma (2 cases), leiomyosarcoma (2 cases), and other STSs (6 cases).

In all of the reconstructed cases, local or pedicled flaps were used in 27 cases (81.8%) in the abdominal group, and in 48 cases (40.3%) in the other areas group. There were 33 skin
graft only reconstruction cases (27.7%) in the other areas group, and none in the abdominal area group. Furthermore, there were 27 free flap reconstruction cases (22.7%) in the other areas group and only one case (3.0%) in the abdominal area group.

The breakdown of cases in the abdominal reconstruction group was 14 lateral, 10 groin, 6 upper, and 3 lower, with large defects cases presenting overlapping areas. Reconstructive procedures included 4 fascia and 1 mesh graft in those with abdominal defects alone. From the 18 cases with either skin or soft tissue defects, 6 underwent p-RAM, 5 p-thigh, 1 p-latissimus dorsi (p-LD) flap, and 6 local flap reconstructions. From the 10 cases with both defects, 8 underwent p-thigh, 1 p-LD + fascia graft, and 1 free ALT reconstructions. We created an algorithm to guide the abdominal reconstruction after STS (Fig. 1). However, because the operating surgeons varied, some reconstructions were not performed according to the algorithm. In five cases, partial necrosis was reported (2 local flap, 1 p-TFL, 1 p-ALT, and 1 free ALT). In local flap, partial necrosis tended to occur frequently (33.3%). Three cases (1 p-RAM, 1 p-ALT + TFL, and 1 free ALT) were complicated by eventration.

Discussion

Soft tissue tumors can occur anywhere in the body; however, these tumors most commonly arise in the extremities. A previous study showed that abdominal STS account for 1–5% of all STSs. In the present study, because we restricted the cases to primary STS, the rate of abdominal STS was possibly higher than previously reported. As the reconstruction of the abdominal wall was frequently performed, the reconstruction rate in the abdominal area group was significantly higher than that in the other areas group. Therefore, operative time was also significantly longer in the abdominal area group.

In reconstructions using mesh grafts alone, if partial skin necrosis occurred, the mesh grafts could have been exposed. Other drawbacks to mesh grafts include the risks of adhesion and infection. Moreover, because all the cases involved the resection of STS, some cases required adjuvant radiotherapy and chemotherapy, which could have increased the risk of mesh exposure. Therefore, in the present study, especially in cases of skin, soft tissue, and abdominal wall defects, fascia grafts were preferred over meshes for the reconstruction of the abdominal wall. The components separation method, in which the abdominal wall is reconstructed by cutting the lateral oblique muscle fascia, is the standard method. This proved to be a good indication in cases derived from incisional hernia, but it was difficult to perform in cases with resections of the rectus abdominis muscle or external abdominal oblique muscle. Since all cases had a resection of the abdominal wall (not separation), it was difficult to perform this method.

In most cases where the abdominal wall defect was not present, p-MSTRAM was suitable because it offered the following three advantages. First, the donor site could be closed primarily even though the flap size was wide. Second, donor site closure contributed to the reduction of the defect. Third, donor site tissue was a good color match compared with the recipient site. In cases where reconstruction using p-
MSTRAM alone was difficult, we used a flap from the thigh, which could also provide a wide flap. However, most of our cases required skin grafts to the donor site, which was not cosmetically good. Therefore, p-MSTRAM was our procedure of choice whenever it was possible.

The MS0 flap, which included the removal of the entire width of the rectus abdominis muscle, was not technically difficult. However, it could not preserve the continuity of the rectus abdominis muscle. In cases where p-MS1TRAM was performed using medial side perforators, we maintained the continuity of the lateral side muscle by letting the flap through under the muscle and preserving the cranial and distal side of the intercostal nerves (Fig. 2). When the procedure was performed using lateral side perforators, it was not necessary to let the flap through under the muscle. Therefore, p-MS1TRAM using lateral side perforators is less invasive and technically easier. Because it needs to let the flap through under the muscle and may require additional cuts to the muscle, MS2, which could preserve both the lateral and the medial sides of the muscle, is more difficult. In this study, all the reconstructions of p-TRAM were performed using MS1. Pedicled deep inferior epigastric perforator flap (p-DIEP) could be performed in some cases. When the diameter and running layer of the perforator is excellent, p-DIEP is effective.

Particularly in the groin region, p-TRAM flap caused bulky reconstructions. Therefore, we opted to utilize p-thigh. When the defect was near the donor site and not too large, reconstruction could be performed using only a TFL flap. A previous study showed that TFL could be elevated safely up to 15 × 40 cm and 8–10 cm proximal to the knee joint. The range of TFL circulation varied among individuals and this flap has been known to be very unreliable. Therefore, partial necrosis of this flap has been frequently reported. The indication of TFL was restricted to the cases where the flap could be safely raised at the point of the flap circulation and where primary closure of the donor site could be performed. However, elevating TFL within the range could lead to partial necrosis. When the flap required more range, ALT + TFL was performed by including the descending branch of the lateral circumflex femoral artery and vein. The reconstruction of the cranial side of the abdominal wall and skin defect was difficult by p-ALT + TFL. However, we concluded that most cases could be reconstructed by a combination of fascia graft and p-flap (p-RAM, p-LD, or both, and perforator flap). We performed free ALT in one case. However, this case could have been reconstructed by p-RAM and fascia graft. We conclude that reconstruction could have been performed using pedicled flaps and/or fascia graft in all cases of this study.

Our algorithm in the abdominal reconstruction of STS was as follows (Fig. 1). The abdominal wall was typically reconstructed using fascia graft. In the skin defect of the groin region, p-TFL was performed. In the skin defect of the lower abdominal area, we tried to perform p-MSTRAM first and considered performing p-ALT + TFL in cases with abdominal wall defect. In the upper abdominal area, we tried to perform p-RAM first. Local flap and p-TFL were restricted only to the cases where the flap was safely raised at the point of the flap circulation. Free flap was generally not required.

Reconstruction using local flap was required for wide areas of the donor site closure, particularly in cases with large defects. In these cases, partial flap necrosis tended to occur frequently (Fig. 3). Since local flap did not require an invasive procedure on the abdominal wall, it had greater merit than p-RAM. However, in cases that required covering a wide area, the flap circulation was more uncertain than we expected, despite the wide flap pedicle. Therefore, we decided to restrict local flap only in cases in which the defect was small. Small defect was defined as cases that did not require undermining or skin grafts for the closure of the donor site.
The limitations of this study are as follows. Since the occurrence of abdominal STS was rare, the total number of cases was small, particularly for those repaired using local flaps. Because large STS typically caused both skin and abdominal wall defects, fascia grafts were generally used in small defects and demonstrated fewer complications. The p-flap and fascia graft methods required multiple donor sites and yielded poor cosmetic results.

Conclusions

We investigated the characteristics of abdominal STS compared to STS of other areas and we created an algorithm for abdominal reconstruction after the resection of STS. Because patients commonly need reconstruction of the abdominal wall, the reconstruction rate was found to be higher than in patients with other areas STS. Reconstruction could be performed using pedicled flaps and/or fascia graft in all cases of this study. It is important that abdominal wall reconstructions are carefully monitored to avoid partial necrosis, which can delay the start of radiotherapy and chemotherapy.

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None.

Conflicts of interest

None declared.

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