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ARTICLE

Effect of unplanned excision of soft tissue sarcomas on skin defects and reconstructive procedures

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ABSTRACT

Unplanned excision (UE) is defined as a procedure wherein a surgeon operates a tumor resection without appropriate preoperative diagnostic modalities and without the intent to achieve tumor-free margins. Generally, the reconstruction rate after UE is higher than that after planned excision (PE). The present study aimed to investigate how the reconstructive procedure and size of skin defect could be influenced. We reviewed the cases of 442 patients who underwent the resection of soft tissue sarcoma. Patients were stratified into two groups (UE vs. PE). We compared the histologic grade, skin defect, reconstructive procedures, depth of the reconstruction layer. For superficial reconstructions, we also compared procedures involving skin graft-only or flap. 105 cases (23.8%) were UE. Histologic grade in PE was significantly higher ($p = .024$). The reconstruction rate and size of skin defect in UE was significantly higher (76.2% vs. 27.3%, $p < .001$) and larger (124.5 cm^2 vs. 65.7 cm^2, $p < .001$). The rate of deep layer reconstruction was significantly higher in PE (7.5% vs. 26.1%, $p = .001$). In superficial reconstructions, 18 (24.3%) skin graft-only procedures were performed in UE and 15 (22.1%) in PE, all other superficial reconstructive procedures involved flap, and there was no significant difference ($p = .45$). Skin defects were 1.9 times larger after UE than PE. UE did not affect the superficial reconstructive procedure.

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Introduction

Unplanned excision (UE) is defined as a procedure wherein a surgeon operates a tumor resection without appropriate preoperative diagnosis [1,2]. UE can be classified as total or partial. Total UE is the most common. In total UE, no preoperative diagnostic modalities are performed and there is no intention to achieve tumor-free margins. Tumors in total UE are generally superficial [3,4], misdiagnosed as benign tumors or nontumor (lipoma, lymph node, epidermal cyst and hematoma et al.) [4,5]. Partial UE is less common and occur in 11% to 34% of all UE [5,6]. Preoperative imaging and/or a biopsy are performed, but the results are inadequate or misinterpreted, leading to inappropriate excision.

Soft tissue sarcomas (STS) develop. from mesoderm and constitute less than 1% of all malignant tumors. Benign soft tissue tumors had 300 times the incidence of STS [7]. Therefore, the diagnosis of STS is difficult in a nonspecialized center. Although preoperative diagnostic modalities were performed, radiologist and pathologist often diagnosed inappropriately [8]. Therefore, UE often occurred.

In the diagnosis for a soft tissue mass of unknown origin, MRI enhancement was most effective for improving diagnostic accuracy [9]. Sonography was also effective [10]. MRI was useful in the assessment of size, tumor depth, and the relationship to neurovascular structures. Sonography was cost-effective and could identify features such as size, location, depth, and the presence of hyperemic chaotic vasculature on Doppler phase imaging [10]. CT was also effective not only for a soft tissue diagnosis but also for the evaluation of metastasis.

In UE case, a secondary re-excision is recommended. Tumor bed re-excision was an independent predictor of local control in multivariate analysis compared to the patients managed nonsurgically [11,12]. Most authors mentioned a surgical safety margin of 3 cm from enhanced area in CT or T2-weighted MRI [4,13]. Treatment by radiation alone yielded a high local control probability [14]. This treatment strategy was judged appropriate for those patients for whom re-excision was not favored due to functional or cosmetic consequences or for patients who were not operable for medical considerations. However, several authors had shown radiation therapy alone to be ineffective in preventing local recurrence following unplanned excision [3,15,16]. The preponderance of retrospective data recommended a combined strategy of radiation therapy and tumor bed re-excision in most patients with UE [17].

In general, the reconstruction rate after UE is significantly higher than that after planned excision (PE) [1,3,18]; however, most authors did not mention how UE affected the reconstruction procedure and size of skin defect. As information on this issue is still inconclusive, the present study aimed to investigate how the reconstructive procedure and size of skin defect following UE could be influenced.

Materials and methods

In this retrospective case-control study, we reviewed the cases of 442 patients who underwent the resection of a primary STS, excluding recurrent or metastatic sarcomas and atypical lipomatous tumors, at the Chiba Cancer Center between April 2006 and December 2018. Patients were stratified into two groups—UE vs.

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Table 1. Characteristics of the patients in unplanned (UE) and planned excisions (PE).

	UE	PE	*p* Value
Number of cases	105 cases	337 cases	
Age	62.1 ± 17.1	56.7 ± 19.0	.33
Body mass index (kg/m^2)	23.3 ± 3.8	23.3 ± 6.2	.38
Operative time (min)	226.0 ± 144.0	201.6 ± 142.9	.18
Intraoperative bleeding (ml)	134.3 ± 188.7	383.8 ± 829.4	.004
Skin defect (cm^2)	124.5 ± 103.3	65.7 ± 89.8	<.001
Gender			.10
Male	64 (61.0%)	179 (53.1%)	
Female	41	158	
Histologic grade			.024
Low	27 (25.7%)	70 (20.8%)	
High	51 (48.6%)	238 (70.6%)	
Unknown	26	29	
Reconstruction	80 (76.2%)	92 (27.3%)	<.001
Adjuvant chemotherapy	19 (18.1%)	95 (28.2%)	.024
Adjuvant radiotherapy	17 (16.2%)	91 (27.0%)	.015

Upper row: mean ± SD (Mann–Whitney U Test). Lower row: case number (Fisher's exact test).

PE—which were then compared by age, body mass index, operative time, intraoperative bleeding, the size of skin defect, gender, histologic grade [low (∼G1) or high (G2,G3), Federation Nationale des Centres de Lutte le Cancer Grading System], reconstruction rates, adjuvant radiotherapy rates, and adjuvant chemotherapy rates (Table 1). The PE group included previous operative procedures of needle and incisional biopsies, whereas the UE group included excisions and excisional biopsies with insufficient margins. We also investigated the histological types of UE cases.

In all of UE cases, primary excisions were performed in other hospital and secondary re-excisions were performed in our hospital. The patients without secondary re-excisions after UE were not included in both groups. Secondary re-excision was performed by orthopedic oncologist with surgical margin of 3 cm from enhanced area in T2-weighted MRI. The size of skin defect was measured by pathological specimens at the time of primary excision in PE group or secondary re-excision in UE group. In UE cases, adjuvant radiotherapy was performed when the pathological diagnosis suggested the possibility of insufficient margin.

With regard to reconstructive procedures, we identified two patterns related to the depth of the reconstruction layer (Table 2): superficial reconstructions were defined as a skin graft or flap (both pedicle and free) or flap + skin graft, which resulted in defects of the skin and soft tissue only; deep reconstructions were defined as sural nerve grafts, great saphenous vein grafts for revascularization, fascia grafts for abdominal wall reconstruction, and vascularized bone grafts. We categorized those cases in which both superficial and deep reconstruction were performed as deep reconstructions. All reconstructions were performed by plastic surgeons; therefore, prosthetic reconstructions or no vascularized bone grafts performed by orthopedic surgeons only were excluded. For superficial reconstructions, we also compared procedures involving skin graft-only and flap procedures. In this study, reconstruction rate meant the rate of superficial or deep reconstruction performed by plastic surgeons.

Statistical analysis

All data in this study were analyzed using IBM SPSS Statistics 22 (IBM SPSS, Inc., Chicago, IL, USA). The mean and standard deviation (mean ± SD) were calculated and then compared using the Mann–Whitney U test or Fisher's exact test. Statistical significance was assumed to be $p < .05$ (Tables 1 and 2).

Table 2. The depth of reconstruction layer.

	UE	PE	*p* Value
Number of reconstruction cases	80 cases	92 cases	
Deep reconstruction	6 (7.5%)	24 (26.1%)	.001
Superficial reconstruction	74 (92.5%)	68 (73.9%)	

Case number (Fisher's exact test). Superficial reconstruction: skin graft or flap (both pedicled and free). Deep reconstruction: nerve graft, vein graft, fascia graft, vascularized bone graft. The cases both superficial and deep reconstructions performed were included deep reconstructions.

Results

Of the STS cases, 105 (23.8%) were UE and 337 (76.2%) were PE; we compared the UE and PE groups. The reconstruction rate in UE cases was significantly high (76.2% vs. 27.3%, $p < .001$). On the other hand, intraoperative bleeding (134.3 ± 188.7 ml vs. 383.8 ± 829.4 ml, $p = .004$), histologic grade (48.6% vs. 70.6%, $p = .024$, high grade rate), and adjuvant chemotherapy (18.1% vs. 28.2%, $p = .024$) and radiotherapy (16.2% vs. 27.0%, $p = .015$) rates in PE cases were significantly higher than those in UE cases. In fact, the number of cases experiencing >1000 ml of intraoperative bleeding was only one (0.95%) in UE, but 17 (5.0%) in PE. The size of skin defect in UE cases was significantly large (124.5 ± 103.3 cm^2 vs. 65.7 ± 89.8 cm^2, $p < .001$), almost twice that in PE cases (Table 1). The histological types of UE were 32 Undifferentiated pleomorphic sarcoma, 16 Myxofibrosarcoma, 12 Dermatofibrosarcoma protuberans, 12 Malignant peripheral nerve sheath tumor, 7 Myxoid liposarcoma, 4 Leiomyosarcoma, 4 Synovial sarcoma, and 18 Other STS.

Examining the reconstruction layer, the rate of deep reconstruction was significantly higher in PE cases than in UE cases (7.5% vs. 26.1%, $p = .001$) (Table 2). In superficial reconstructions, 18 (24.3%) skin graft-only procedures were performed in the UE group and 15 (22.1%) in the PE group. All other superficial reconstructive procedures involved flap (+skin graft). There was no significant difference ($p = .45$).

Discussion

The influence of UE on local recurrence, distant metastases, and patient survival rate is still controversial [3,19–21]: UE may cause wider malignant cell contamination, requiring wider re-excision to achieve a negative surgical margin. Some authors have reported that a sufficiently wide excision in UE cases could reduce the risk of local recurrence and improve the patient survival rate equal to PE cases [20,22–24]. However, the survival rates in UE cases are quite good because the primary tumors tend to be small and more superficial [18,22,25]. Traub et al. [21] reported that UE of stage III STS lead to an unfavorable clinical course and necessitates more extensive surgery, however, as a result of aggressive re-excision and multidisciplinary treatment, a negative effect on oncologic outcomes couldn't be confirmed. However, most authors have concluded that UE should be avoided due to the need for additional excision and soft tissue reconstruction [1,3,18,21]. Because all cases of small and superficial sarcoma could not be diagnosed in specialized centers primary, UE could not be diminished entirely. It was important if UE occurred, the patient was consulted to a specialized center as soon as possible. UE should not be made on purpose.

Some authors reported that about 30% of all STS were located in the subcutaneous and superficial regions [26,27]. And superficial STS were often smaller and of a lower malignancy grade than deep STS and had a better prognosis both regarding local recurrence and survival [26,28,29]. Excision of large, rapidly growing tumors involving vessels/nerves was obviously avoided in the absence of preoperative imaging or biopsy. These practices were also adopted in our study. This explained why the histologic grade was significantly lower in UE cases than in PE cases, although the grade was unknown in some cases, and adjuvant chemotherapy and radiotherapy rates higher in the PE cases.

First, because of the high reconstruction rate in UE cases, we considered operative time was significantly longer in UE cases than in PE cases. However, there was no significant difference, which could be because although reconstruction takes a long time, the larger size and depth of STS in PE cases meant resection takes a similar length of time. Furthermore, whereas little intraoperative bleeding usually occurs during reconstruction, that from high-grade sarcoma was sometimes considerable; therefore, although there was no difference in operative time, intraoperative bleeding differed significantly.

Cases probably needing deep reconstruction were usually performed only after preoperative imaging or biopsy, explaining why such cases appeared more often in the PE group than in the UE group. Although bone sarcomas such as osteosarcoma and chondrosarcoma occurred in a deeper layer, some authors reported UE cases in which bone sarcomas were resected [30–35]. At our hospital, reconstructions involving vascularized bone grafts were used to resect osteosarcoma, but not in UE cases. Therefore, especially as they could affect the rate of deep reconstructions, we excluded these cases from our study.

Although it was possible to detect microscopic residual disease with MRI enhancement, even in the absence of discrete nodular enhancement [36], most orthopedic oncologists performed additional excisions according to enhanced MRI. As UE rarely affected the deep areas revealed by MRI enhancement, our findings on deep reconstruction rates were understandable. On the other hand, MRI could greatly affect superficial reconstructions. Excisions in the PE group were included within the skin excisional margin from the biopsy scar, but proved to be much smaller than that from MRI enhancement in the UE group. Therefore, although this biopsy margin was included in this study, it influenced the skin defect results very little.

In this study, resection of STS tended to result in deep defects requiring reconstruction, leading to reconstructions involving flap being performed more frequently than skin graft only. The superficial reconstructive procedures in UE and PE cases were not significantly different. Nakamura et al. reported that reconstruction of STS was performed more often in distal (e.g. forearm and lower leg) than proximal parts of limbs, as well as the trunk [18]. This tendency was also evident, except for the resection of STS. Generally, skin graft-only procedures were performed in the cases of skin defect without the exposures of bone, vessels, tendon, nerve and internal organs. Moreover, we tended to use flaps in the cases overlapped joints. Because the resection of STS tended to be large skin defect, the reconstruction of local flap only was restricted. The reconstructions of proximal upper limbs (elbow-brachium) were usually performed by pedicled latissimus dorsi flaps (p-LD) [37–40], proximal lower limbs (thigh) by pedicled rectus abdominis musculocutaneous flaps (p-RAM) [41,42], trunk (chest, abdomen, back) by p-LD [40,43,44], p-RAM [45,46] or pedicled tensor fasciae latae (+ anterior lateral thigh) flap [44,47]. The reconstructions of distal limbs (hand-forearm, foot-lower leg) were usually performed by free flaps [48–50]. Therefore, similar to other standard reconstructions, tumor site was an important factor for using flap (pedicled or free) in reconstructions.

The contribution of this study lies in providing a specific value for skin defects. Along with reporting the reconstruction rate following UE, like many earlier studies, we also reported that skin defects were 1.9 times larger after UE than PE. As we focused on reconstruction, we compared the skin defect rather than the primary tumor size, enabling us to investigate the exact value for skin defects. Moreover, UE tended to be avoided for cases requiring deep reconstruction, while few cases that did require it were affected by previous UE. Therefore, UE greatly affected skin defects but not reconstructive procedures.

Our findings influenced the clinical practice for plastic surgeons as follows. Due to UE, reconstruction was often required when performing secondary re-excision in patients who did not originally require reconstruction during the primary surgery. Here while a comparison of the same degree of malignancy could not be performed, the skin defect was significantly larger at 1.9 times despite the significantly low-grade in UE. For this reason, the magnitude of skin defects resulting from UE was assumed to be at least twofold larger when compared to the same STS in the actual clinical settings. It was difficult to conclude the magnitude of skin graft and/or flap need 1.9 times larger for performing UE, as there were many PE patients in whom primary sutures were feasible even with the onset of skin defects. However, in patients originally indicated for reconstruction even in the primary surgery, UE was expected to be performed requiring a larger skin graft and/or flap for the secondary re-excision. Since UE could not affect the extent of deep resection, UE rarely induced to require a flap in the cases of primary surgery indicated for the skin graft only.

There were some limitations to our investigation of skin defects. As tumor sizes tended to be smaller and of a lower grade in UE than PE cases, the health status of patients with a tumor were different, to compare the groups. Nevertheless, skin defects were revealed to be significantly larger in UE than PE cases, strongly suggesting the need for superficial reconstruction in UE cases. Moreover, Alamanda et al. reported that the cost of unplanned primary surgery nearly doubled the financial burden [51]. Therefore, we conclude that UE is a misuse of treatment for the patients.

Conclusions

We investigated reconstruction following UE and found that the reconstruction rate and size of skin defects were significantly higher in UE cases than in PE cases. Skin defects were 1.9 times larger after UE than PE. Although UE did not affect the reconstructive procedure in this study, it should be avoided where possible.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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