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Reconstructive treatment following resection of high-grade soft-tissue sarcomas of the lower limb

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ABSTRACT

Purpose. To review the role of free tissue transfer in reconstructive surgery following resection of high-grade soft-tissue sarcomas of the lower limb.
Methods. Medical records of all consecutive patients with high-grade soft-tissue sarcomas of the lower limbs between August 1997 and September 2003 were reviewed.
Results. Of 8 patients (6 women and 2 men) aged between 19 and 65 years, 4 had malignant fibrous histiocytoma, one had malignant peripheral nerve sheath tumour, one had synovial sarcoma, one had recurrent liposarcoma, and one had epitheloid sarcoma. The tumour sizes ranged from 132 cm^2 to 483 cm^2. The soft-tissue defects following tumour extirpation ranged from 153 cm^2 to 896 cm^2. The flaps used were 3 free latissimus dorsi flaps, 2 free osteoseptocutaneous fibula flaps (one vascularised fibula flap and one 'double barrel' fibula flap), one free rectus abdominis flap, 2 free mini-transverse rectus abdominis flaps, and one pedicled rectus abdominis flap. Five patients did not have local recurrence and systemic metastases.
Conclusion. Tissue transfer allows early adjuvant therapy facilitating the multimodal approach for the high-grade soft-tissue sarcomas of the lower extremity.

Key words: *limb salvage; lower extremity; sarcomas; soft tissue neoplasms; surgical flaps*

INTRODUCTION

Soft-tissue sarcomas are primary mesenchymal tumours of anatomic sites excluding the bone, parenchymatous organs or hollow viscera, blood, and the reticuloendothelial system. Soft-tissue sarcomas remain a relatively uncommon neoplasm representing

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about 1% of all malignant neoplasm in adults. The lower extremity is the site most commonly affected (40%), with one in 4 of this type of neoplasm occurring below the knee.[1] These neoplasms often attain considerable size before being detected. Therefore, their management presents major challenges to both the patients and the surgeons. With the recent advances in multimodality treatments, the aims are to eradicate the local disease, to control the metastases, and to retain limb function.[2] This approach allows acceptable physical function and psychosocial benefits without any compromise to the survival.

The limb salvage surgery begins with preoperative assessment of the tumour using biopsy and radiography. After the assessment, the tumour is removed by a wide or radical surgical excision. This method has been the mainstay of the treatment for soft-tissue sarcomas of the lower limb. This surgery often results in large soft-tissue defects requiring either immediate or delayed soft-tissue coverage. Reconstruction of these composite defects of the lower extremities often depends on the anatomical sites and the patients' general condition. Local flaps are often technically possible in the proximal and middle lower extremity, but free flaps are the best choice in the distal third of the leg.[3] Both flaps allow the patient to undergo early uninterrupted adjuvant radiotherapy, chemotherapy, and rehabilitation.

MATERIALS AND METHODS

A retrospective study was performed on patients with high-grade soft-tissue sarcomas of the lower extremities, who underwent limb salvage surgery from August 1997 to September 2003 at the Hospital Universiti Sains Malaysia. All patients were assessed preoperatively by routine radiography, angiogram, computed tomographic (CT) scan, and magnetic resonance imaging (MRI). Preoperative biopsies were taken from all of these patients. The Enneking staging system for soft-tissue sarcomas was used to determine the extent of the tumour growth.[4] The tumour locations, sizes, soft-tissue defects, reconstructive techniques, hospital stay, adjuvant therapies, and their outcomes were reviewed.

RESULTS

At presentation, 8 patients (6 women and 2 men) had a mean age of 46.1 years (range, 19–65 years). The most common tumours were malignant fibrous histiocytomas (n=4, all at stage IIB), followed by malignant peripheral nerve sheath tumour (n=1, stage IIB), synovial sarcoma (n=1, stage IIB), recurrent liposarcoma (n=1, stage III), and epitheloid sarcoma (n=1, stage IIB).

The most common sites of occurrence of these tumours were the thighs (n=3), followed by the gluteal region (n=1), knees (n=1), popliteal fossa (n=1), middle third of the leg (n=1), and ankle (n=1). The size of the tumours ranged from 132 cm^2 (12x11 cm^2) to 483 cm^2 (23x21 cm^2), and the mean tumour size was 273.4 cm^2. All the tumours were excised with wide surgical margins of 5 cm or more depending on the anatomic sites. Hence, the resultant soft-tissue defects varied from 153 cm^2 (18x8.5 cm^2) to 896 cm^2 (32x28 cm^2), with a mean of 448.6 cm^2.

The tissue flaps used were 3 free latissimus dorsi myocutaneous flaps, 2 free vascularised osteoseptocutaneous fibula flaps (one vascularised fibula and one 'double barrel' fibula flap), one free rectus abdominis myocutaneous flap, 2 free mini-transverse rectus abdominis myocutaneous flaps, and one pedicle rectus abdominis flap (Table). Seven patients did not have any notable donor site morbidity. Recipient site morbidities occurred in 2 cases caused by an overt infection in the free fibula flap and by a zone IV necrosis of the free mini-transverse rectus abdominis myocutaneous flap. The mean duration of hospital stay for all the patients was 56.9 days (range, 25–90 days).

One patient received neoadjuvant radiotherapy for recurrent liposarcoma. Seven patients were started on early postoperative adjuvant radiotherapy, 5 of them received external beam radiotherapy, and 2 received postoperative brachytherapy. In addition, 4 patients received chemotherapy. One patient died one week after surgery from a myocardial infarction. Another patient succumbed to advanced pulmonary metastases at 5 months postoperatively.

The mean follow-up period was 7.1 months (range, 1.0–12.1 months). One patient had multiple pulmonary metastases and underwent chemotherapy. All the surviving patients underwent early postoperative rehabilitation and retained functioning lower limbs.

The management of soft-tissue sarcomas at the ankle region has been a great challenge for surgeons to obtain adequate tumour clearance without compromising the ankle function. Therefore, we report a patient from our series who underwent a resection of synovial sarcoma of the ankle and reconstruction using a free vascularised fibula osteoseptocutaneous flap.

A 50-year-old woman (patient 4) presented with a non-painful progressive swelling of the left ankle with restriction on the ankle joint movement, which she had

Table
Summary of the 8 cases of high-grade soft-tissue sarcomas of the lower limbs

Case no.	Age (years)	Tumour size (cm^2)	Soft-tissue defect (cm^2)	Histological type (subtype)	Type of flaps	Therapy
1	54	20x18 (360)	30x20 (600)	Malignant fibrous histiocytoma (myxofibrosarcoma type)	Pedicled rectus abdominis	Adjuvant radiotherapy
2	19	31x12.5 (387.5)	31x17 (527) and 19 cm of skeletal defect	Malignant peripheral nerve sheath tumour (rhabdomyoblastic differentiation: triton tumour)	Free rectus abdominis and free vascularised osteoseptocutaneous fibula ('double barrel' fibula)	Adjuvant radiotherapy and chemotherapy
3	34	12x11 (132)	21x18 (378)	Malignant fibrous histiocytoma (pleomorphic type)	Free latissimus dorsi	Adjuvant radiotherapy*
4	50	15x15 (225)	18x8.5 (153) and 20 cm of skeletal defect	Synovial sarcoma (malignant spindle cell type)	Free vascularised osteoseptocutaneous fibula	Adjuvant radiotherapy and chemotherapy
5	59	13x12 (156)	26x10 (260)	Recurrent liposarcoma (pleomorphic type)	Free latissimus dorsi	Neoadjuvant radiotherapy and chemotherapy
6	59	23x21 (483)	25x15 (375)	Malignant fibrous histiocytoma (pleomorphic type)	Free latissimus dorsi	None (early postoperative mortality)
7	65	12x12 (144)	25x16 (400)	Malignant fibrous histiocytoma (pleomorphic type)	Free mini-TRAM†	Adjuvant radiotherapy
8	29	20x15 (300)	32x28 (896)	Epitheloid sarcoma (distal type)	Free mini-TRAM	Adjuvant radiotherapy* and chemotherapy

* In the form of brachytherapy
† TRAM transverse rectus abdominis myocutaneous

for more than 2 years. The diagnosis of soft-tissue sarcoma was made by the district hospital surgeons. Below-knee amputation was suggested, but she refused. She sought a second opinion and was referred to our institution for limb salvage surgery.

Examination revealed a large irregular hard mass on the left ankle, which was non-mobile and non-tender, measuring about 15x15 cm. The left ankle joint movement was restricted and showed evidence of foot drop (Fig. 1). The regional lymph nodes were not palpable. An open biopsy confirmed the diagnosis of synovial sarcoma (stage IIB). The patient underwent wide excision of the tumour, reconstruction of the distal end of tibia using a free vascularised osteoseptocutaneous fibula flap, and left ankle arthodesis (Fig. 2). Postoperatively, the patient had early adjuvant radiotherapy and chemotherapy. There was no notable donor or recipient site morbidity (Fig. 3). At the 4-month follow-up, the patient was ambulating well with a sensate foot. The patient was free of local recurring and systemic metastases.

DISCUSSION

Management of extremity soft-tissue sarcomas has been controversial. Previously, the prognosis for patients with soft-tissue sarcomas was poor, with high incidence of local recurrence and systemic metastases. High incidence of local recurrence (20%–50%) after excision has been reported in cases of amputation surgery.[5,6] The survival rate was poor with more than 50% of the patients dying of the disease.[7,8]

The current trend in the management of high-grade soft-tissue sarcomas of the lower extremity is to use a multimodality treatment approach. The aim is to eradicate local disease, control metastases, and salvage the limb without compromising the patients' survival. Amputation offers no survival advantage over wide excision and adjuvant therapy, particularly when the sarcomas have histopathological features of high-grade malignancy.[9] Such tumours are frequently associated with the presence of occult metastases which may manifest at a later date. Hence, limb salvage

Figure 1 Synovial sarcoma of the left ankle of patient 4.

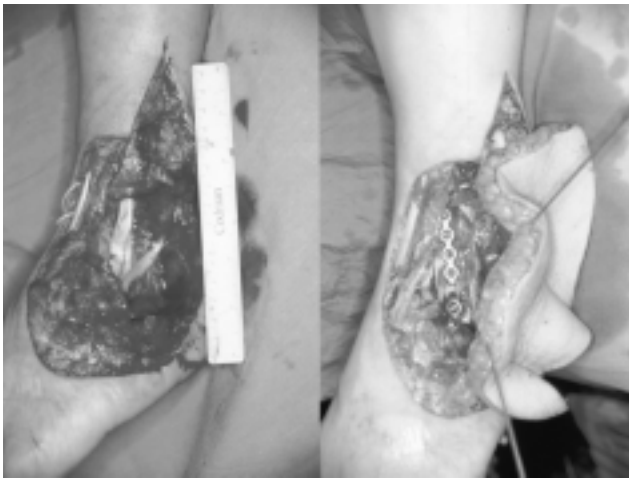

Figure 2 Free vascularised osteoseptocutaneous fibula flap covering the soft tissue and bone defects of the ankle.

has become the standard of care and can now be accomplished in 95% of cases.[9] However, there is always a premium to pay for limb salvage surgery, and the fear is the incomplete tumour clearance at the tumour margin. Recent advances include preoperative assessment using highly sensitive and specific imaging modalities, such as MRI and CT scan, better histopathological analysis to study the tumour behaviour, as well as adjuvant radiotherapy and chemotherapy. All these methods have contributed to the low incidence of local recurrence and systemic metastases.

On the other hand, the management of these high-grade sarcomas often presents many challenges in terms of soft-tissue coverage for the large composite defects following oncological resection. The use of tissue transfer for soft-tissue coverage has influenced the outcome of the management of these tumours, because the method allows adequate resection of tumour, and there is less tumour recurrence with good reconstructive recovery. Selection of the flap donor site depends primarily on the extent and location of the defect, and the types of tissue needed for reconstruction. Clinically, it has been shown that the use of local flaps are feasible when the defect is in the middle and proximal lower limb, but free flaps are the best choice for defects in the distal third of the leg.

Defects of a large surface area, which require only soft-tissue replacement, generally can be covered with a latissimus dorsi flap. In our series, this flap was used for the majority of the thigh and knee soft-tissue defects. The latissimus dorsi is a reliable and versatile large muscle that is particularly useful in providing well-vascularised coverage for neurovascular structures, bone devoid of periosteum, allografts, or prosthesis.[10] The flap is consistently large and the long vascular pedicle allows easy anastomosis to the recipient vessels. The size of the flap can vary greatly to cover much larger defects. Furthermore, transfer of the latissimus dorsi results in minimal functional or aesthetic problems at the donor site.[11]

In this series, 4 rectus abdominis flaps were used to reconstruct the lower limb, of them one pedicle and one free rectus abdominis myocutaneous were used to cover the defects in the thighs. Reconstruction of a huge soft-tissue defect in the thigh requires a flap that can obliterate the dead space with muscle bulk, and provide contour to the thigh. This rectus abdominis flap has a long, narrow, and flat muscle that allows excellent contour of the soft-tissue defects, eliminates the dead space, and can be easily raised. The rectus abdominis flap's long vascular pedicle, with a wide lumen, offers similar advantages to the latissimus dorsi flap.[12,13]

Alternatively, when presented with a huge contour defect that requires minimal filling of the muscular space, reconstruction using free mini-transverse rectus abdominis myocutaneous can be used. This

Figure 3 Postoperative photograph of the left ankle after limb salvage surgery.

modification involves removing only a small cuff of the rectus abdominis muscle together with a flap. Hence, this will reduce considerably the donor site morbidity.[14] In our series, 2 free mini-transverse rectus abdominis myocutaneous flaps were used to reconstruct the defects at the popliteal fossa in one case and the middle third of the leg in the other. We found this flap an excellent way to restore huge defects in the lower limb, especially in patients with previous deliveries, where a large flap from the abdominal region can be harvested without leaving considerable morbidity.

A free vascularised fibula flap is probably the most suitable option for the repair of a large defect in a long bone following tumour ablation, because of the flap's length, geometrical shape, and mechanical strength.[15] If the composite defect of the bone and soft tissue were encountered, the free fibula flap could be harvested as an osteoseptocutaneous flap. In situations following tumour extirpation where the dead space is to be obliterated, the free vascularised osteoseptocutaneous fibula flap is incorporated together with another flap, such as the myocutaneous flap. In this study, the free vascularised osteoseptocutaneous fibula flaps were used in 2 cases. In one of these cases, a large composite defect in the proximal femur was encountered following the extirpation of malignant peripheral nerve sheath tumour. The fibula flap was osteotomised and inserted as a 'double-barrel' fibula flap to provide the maximum strength to the deficient femur. This technique provides twice the cross-sectional area of a single fibula transfer, thus allows improved biomechanical strength in the flap.[16] This flap was combined with a free rectus abdominis flap to obliterate the dead space and cover the large residual composite soft-tissue defect.

In the patient with synovial sarcoma of the distal end of tibia, the free vascularised osteoseptocutaneous fibula flap was used to reconstruct the huge composite defect following the wide excision of the tumour. The ankle arthodesis was performed simultaneously to provide union and stability to the ankle joint.

Unfortunately, one patient in our series suffered overt infection of the lower limb and underwent above-knee amputation 16 days postoperatively. Surgeons should offer available options of surgery after weighing up the risks. The choice of surgical procedure, in this case, was decided by the patient and family. The patient preferred the limb salvage surgery because it had far-reaching psychological and physical benefits, positively affecting the patient's quality of life.

The importance of adjuvant radiotherapy in the management of high-grade soft-tissue sarcomas should not be overlooked. The local management of large sarcomas may be enhanced by preoperative external radiotherapy. The recurrence rate of sarcomas after limb salvage surgery and treatment with postoperative external beam radiotherapy is less than 15%.[17] Moreover, brachytherapy can be used to deliver higher doses of radiation and is safer than external beam techniques because this method spares much of the surrounding soft tissue. The local recurrence rate of 6% at 50 months has been reported when limb salvage surgery was used in conjunction with adjuvant brachytherapy for the treatment of high-grade resectable tumours.[18] In our series, 4 patients also received postoperative adjuvant chemotherapy because of the high histological grading of the tumours, which have propensity to metastasise. The role of chemotherapy is less clear, although it appears to be of some benefit for high-grade tumours.[19] Free tissue transfer allows initiation of early uninterrupted postoperative external beam radiotherapy and/or brachytherapy and chemotherapy.

These combined treatments facilitate early rehabilitation following limb salvage surgery, which is essential to restore the functional integrity of the

lower limb, and thus improve the patients' quality of life. In our study, all the surviving patients retained functioning lower limbs. However, this aspect was not adequately assessed, because the long-term results are not available. Our observations have shown that limb amputation does not offer better psychological and physical benefits than limb salvage surgery in those patients with limited life span.

In conclusion, limb salvage surgery is an effective option for managing high-grade soft-tissue sarcomas of the lower limbs, which has beneficial treatment outcomes.

REFERENCES

1. Collin C, Hadju SI, Godbold J, Shiu MH, Hilaris BI, Brennan MF. Localized, operable soft tissue sarcoma of the lower extremity. Arch Surg 1986;121:1425–33.
2. Rosenthal HG, Terek RM, Lane JM. Management of extremity soft-tissue sarcomas. Clin Orthop 1993;289:66–72.
3. Hidalgo DA, Carrasquillo IM. The treatment of lower extremity sarcomas with wide excision, radiotherapy, and free-flap reconstruction. Plast Reconstr Surg 1992;89:96–102.
4. Enneking WF, Spanier SS, Goodman MA. Current concepts review. The surgical staging of musculoskeletal sarcoma. J Bone Joint Surg Am 1980;62:1027–30.
5. Cantin J, McNeer GP, Chu FC, Booher RJ. The problem of local recurrence after treatment of soft tissue sarcoma. Ann Surg 1968;168:47–53.
6. Shiu MH, Hajdu SI. Management of soft tissue sarcoma of the extremity. Semin Oncol 1981;8:172–9.
7. Gerner RE, Moore GE, Pickren JW. Soft tissue sarcomas. Ann Surg 1975;181:803–8.
8. Rantakokko V, Ekfors TO. Sarcomas of the soft tissues in the extremities and limb girdles. Analysis of 240 cases diagnosed in Finland in 1960-1969. Acta Chir Scand 1979;145:384–94.
9. Pisters PW. Combined modality treatment of extremity soft tissue sarcomas. Ann Surg Oncol 1998;5:464–72.
10. Cordeiro PG, Neves RI, Hidalgo DA. The role of free tissue transfer following oncologic resection in the lower extremity. Ann Plast Surg 1994;33:9–16.
11. Stern PJ, Neale HW, Gregory RO, McDonough JJ. Functional reconstruction of an extremity by free tissue transfer of the latissimus dorsi. J Bone Joint Surg Am 1983;65:729–37.
12. Hidalgo DA. Rectus abdominis free flaps. In: Shaw WW, Hidalgo DA, editors. Microsurgery in trauma. New York: Futura; 1987:293–302.
13. Bunkis J, Walton RL, Mathes SJ. The rectus abdominis free flap for lower extremity reconstruction. Ann Plast Surg 1983;11: 373–80.
14. Galli A, Adami M, Berrino P, Leone S, Santi P. Long-term evaluation of the abdominal wall competence after total and selective harvesting of the rectus abdominis muscle. Ann Plast Surg 1992;28:409–13.
15. Hsu RW, Wood MB, Sim FH, Chao EY. Free vascularised fibular grafting for reconstruction after tumour resection. J Bone Joint Surg Br 1997;79:36–42.
16. Jones NF, Swartz WM, Mears DC, Jupiter JB, Grossman A. The "double barrel" free vascularized fibular bone graft. Plast Reconstr Surg 1988;81:378–85.
17. Torosian MH, Friedrich C, Godbold J, Hajdu SI, Brennan MF. Soft-tissue sarcoma: initial characteristics and prognostic factors in patients with and without metastatic disease. Semin Surg Oncol 1988;4:13–9.
18. Brennan MF. Management of extremity soft-tissue sarcoma. Am J Surg 1989;158:71–8.
19. Chang AE, Kinsella T, Glatstein E, Baker AR, Sindelar WF, Lotze MT, et al. Adjuvant chemotherapy for patients with high-grade soft-tissue sarcomas of the extremity. J Clin Oncol 1988;6:1491–500.