Surgical outcomes of vascular reconstruction in soft tissue sarcomas of the lower extremities

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Background: **Limb-sparing procedures are currently considered the standard treatment for lower limb soft tissue sarcoma (STS). Surgical excision combined with vascular resection may be necessary to provide an adequate safety margin and to improve the oncologic outcomes. In this scenario, vascular reconstruction is required to preserve limb function. We evaluated the long-term patency and survival outcomes of arterial and venous reconstruction after resecting lower limb STS in the largest single-center case series to date.**

Methods: **Between November 1995 and July 2014, 25 patients with lower limb STS and vascular invasion underwent surgical resection followed by arterial or venous reconstruction. Patients were followed up at regular outpatient visits, at which clinical examinations and duplex ultrasound mapping were performed to assess graft patency.**

Results: **A total of 44 revascularization procedures were performed. The median follow-up time for the arterial and venous groups combined was 25.2 months (range, 0.26-225.6 months). The 5-year survival probability was 42.1%. The graft occlusion rate was significantly higher after reconstruction with synthetic grafts than after reconstruction with saphenous vein substitutes ($P = .02$). The occlusion rate was not significantly different between arterial reconstruction and venous reconstruction ($P > .05$).**

Conclusions: **Arterial and venous reconstruction is feasible after surgical resection of lower limb STS. Vascular reconstruction provides favorable long-term patency outcomes and low complication rates, allowing limb preservation and disease control in a select group of patients. Vascular reconstruction using venous grafts had a significantly higher patency rate than reconstruction with artificial venous substitutes. (J Vasc Surg 2015;62:143-9.)**

Soft tissue sarcomas (STSs), a diverse group of neoplasms that arise from mesenchymal tissue, differentiate heterogeneously. Historically, amputation was the only reasonable treatment option for tumors close to the vascular bundle. However, improvements in the surgical techniques for osseous and vascular reconstruction as well as combined radiotherapy and chemotherapy offer local disease control with limb preservation and provide good functional and quality of life outcomes.[1]

Limb-sparing procedures are currently considered the standard treatment for lower limb STS.[2,3] Surgical en bloc resection combined with multimodality therapy offers good oncologic outcomes together with preservation of limb function in patients with vessel or nerve involvement, assuming the safety margin is adequate.[4]

Arterial reconstruction is always indicated after limb-sparing surgery because of the high risk of limb ischemia after arterial ligation. However, despite the benefits of venous reconstruction for preventing long-term post-thrombotic syndrome,[5,6] the need for venous reconstruction is debated because the ligatures do not directly interfere with limb preservation, and the patency rates are sometimes unsatisfactory.

There are few recent studies in this area, and to the best of our knowledge, this is the largest case series of lower limb STS resection with the greatest number of vascular reconstructions performed by a vascular surgical team at a single center. We evaluated the following long-term outcomes: primary arterial and venous patency rates, vascular and nonvascular complications, limb salvage rates, tumor recurrence rate, and overall patient survival.

METHODS

This study was approved by our hospital's Ethics Committee. Patient consent was not required for this study because of its retrospective design. Between November 1995 and July 2014, 33 patients with lower limb malignant tumors presenting with vascular invasion were scheduled for surgical resection followed by arterial or venous reconstruction. Eight patients were excluded from our study because their malignant disease was not classified as STS. Therefore, 25 patients were analyzed in this study. The excluded cases included two patients with melanoma, two with spinocellular carcinoma, three with osteosarcoma, and one who underwent resection of a colorectal adenocarcinoma metastasis in the lower limb.

A total of 44 reconstruction procedures (21 arterial and 23 venous) were performed in the 25 patients with STS.

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Nineteen patients underwent both arterial and venous reconstruction, whereas six underwent revascularization of just one vessel; four patients underwent venous reconstruction, and two underwent arterial reconstruction.

The overall outcomes of this study were based on a detailed retrospective review of the patients' medical records. Since starting data collection, we have used a strict protocol for data retrieval for all patients, which remained unchanged throughout the study. This has allowed us to carry out the present research with minimal data loss, despite the retrospective design.

Complementary imaging findings, including computed tomography and magnetic resonance, were used for preoperative analysis of tumor invasion and assessment of the potential for resection. All patients were initially evaluated by the surgical oncology team and were referred to the vascular service for further surgical planning if imaging demonstrated vascular invasion or the lack of a cleavage plane between the tumor mass and the vascular bundle.

En bloc resection of the tumor mass was indicated by the surgical oncology team and was performed if the surgical findings revealed agglomeration and adherence of the tumor mass to vascular structures. However, the feasibility of complete resection was assessed after considering oncologic principles and whether an adequate margin could be achieved.

Clamping and sectioning of the vessels were performed in the last stage of en bloc resection, after selection of the vascular substitute to be used for reconstruction. If the saphenous vein was used as a replacement graft, it was excised and prepared before tumor resection to reduce the duration of tissue ischemia and to avoid venous congestion of the limb. In all patients, the contralateral saphenous vein was used to avoid edema in the limb already undergoing extensive manipulation of the lymphatic and deep venous systems. All of the patients received 5 units of intravenous heparin before clamping as well as prophylactic antibiotics during the induction of anesthesia.

The patients were constantly followed up at regular outpatient visits, at which they underwent extensive clinical examinations and duplex ultrasound mapping to determine the patency of the arterial and venous grafts. The oncology team monitored the follow-up assessments and any patients with recurrence who required further interventions.

Statistical analysis. Categorical variables are presented as frequencies; continuous variables are presented using measures of central tendency and variability. Associations between categorical variables were examined by Fisher exact test. The Kaplan-Meier method was used to estimate overall survival probabilities as well as the rates of arterial, venous, or arterial-venous patency. A 5% significance level was used for all statistical tests. The follow-up time was defined as the time from the surgical event until death or the last registered outcome. The patency rate was calculated on the basis of the time from surgery to the first observed vascular complication (occlusion or rupture).

Table I. Site of tumors, histologic type of sarcoma, tumor grade, and previous oncologic treatment strategy

Site of tumor	*No. of patients (N = 25), No. (%)*
Thigh	20 (80)
Inguinal region	4 (16)
Infrageniculate region	1 (4)
Histologic type of sarcoma	*No. of patients*
Synovial sarcoma	8
Liposarcoma	3
Fibrosarcoma	2
Pleomorphic sarcoma	2
Leiomyosarcoma	2
Fibromyxoid tumor	1
Fibrohistiocytoma	1
Myxofibrosarcoma	1
Malignant peripheral nerve sheath tumor	1
Chondrosarcoma	1
Hemangiopericytoma	1
High-grade fusocellular sarcoma	1
Ewing sarcoma	1
Tumor grade	*No. of patients (N = 25), No. (%)*
High grade	17 (68)
Low grade	5 (20)
Unclassified	3 (12)
Previous oncologic treatment	*No. of patients (N = 25), No. (%)*
Surgery + RT + CT	7 (28)
CT	6 (24)
CT + RT	5 (20)
Surgery + CT	3 (12)
Surgery	1 (4)
Surgery + RT	1 (4)
No treatment	2 (8)

CT, Chemotherapy; *RT,* radiotherapy.

RESULTS

The study included 13 female patients (52.0%) and 12 male patients (48.0%). The age ranged from 15 to 76 years (median, 38.0 years).

Table I lists the sites of the tumors, the histologic types of the sarcomas, the tumor grade, and the previous oncologic treatment strategies used. The thigh was the most frequently involved site, accounting for 80% of all sarcomas. Twelve patients (48%) had recurrent tumors at the time of the vascular resection. We considered recurrent all cases with previous resection performed more than 3 months before the vascular resection. Incisional biopsies were not considered in this group as previous surgery. Even among the patients with nonrecurrent tumors, the majority of them had received some kind of neoadjuvant treatment. Only two patients (8%) did not receive prior oncologic treatment. Eleven patients (44%) received only chemotherapy or radiotherapy. Twelve patients (48%) required repeated surgery.

Among patients with nonrecurrent tumors, 62% were submitted to computed tomography-guided core biopsy,