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Single-center experience with intra-abdominal liposarcoma

Optimal minimum duration for postoperative remnant tumor screening

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Abstract

This study sought to identify factors related to the prognosis of intra-abdominal liposarcoma and to determine the optimal minimum duration for remnant tumor screening. Intra-abdominal liposarcoma is associated with high rates of incomplete resection and recurrence requiring a sophisticated follow-up strategy.

Patients who underwent surgery for intra-abdominal liposarcoma were included. Cox analyses were used to analyze factors related to recurrence and survival. To determine the optimal minimum duration for remnant tumor screening, patients with recurrence after surgery despite gross complete resection were grouped by a postoperative detection time of 1, 3, or 6 months. Their survivals were compared to the gross incomplete resection group.

A total of 168 patients were included. Kaplan–Meier 5-year disease-free survival was 35.9% and overall survival was 66.5%. Multiplicity (HR=2.528, CI=1.585–4.033, $P<.001$), organ invasion (HR=1.628, CI=1.020–2.598, $P=.041$), and FNCLCC grades (G2,HR=1.730, CI=1.000–2.994; G3, HR=3.812, CI=2.112–6.880, $P<.001$) were related to recurrence. Multiplicity (HR=2.131, CI=1.050–4.329, $P=.036$), organ resection ≥3 (HR=2.857, CI=1.322–6.174, $P=.008$), gross incomplete resection (HR=4.368, CI=1.890–10.097, $P=.001$), positive margin (HR=2.766, CI=1.367–5.600, $P=.005$), FNCLCC grade (G2,HR=2.044, CI=0.937–4.459; G3,HR=4.470, CI=1.893–10.557; $P=.003$), and RT (HR=0.322, CI=0.160–0.648, $P=.001$) were related to overall survival. Dividing patients into 1 month ($P=.097$) and 3 months ($P=0.063$) did not yield significant differences in univariate analyses, whereas 6 months showed significant difference ($P=.015$) compared to the gross incomplete resection group. Patients with tumors detected within 6 months showed similar survival to the gross incomplete resection group (HR=0.552, CI=0.241–1.260, $P=.158$), whereas patients with tumor detection after 6 months showed better survival (HR=0.325, CI=0.149–0.708, $P=.005$).

In conclusion, minimum duration of 6 months for remnant tumor screening using CT seems optimal.

Abbreviations: DDLPS = de-differentiated liposarcoma, FNCLCC = Fédération Nationale des Centres de Lutte Contre le Cancer, LPS = liposarcoma, RT = radiotherapy, WDLPS = well-differentiated liposarcoma.

Keywords: intra-abdominal liposarcoma, liposarcoma, retroperitoneal liposarcoma, retroperitoneal soft tissue sarcoma, sarcoma

1. Introduction

Liposarcoma (LPS) is a malignant tumor of mesenchymal origin that can occur wherever fat is present. Up to 40% of LPSs occur in the retroperitoneum, especially in perirenal fat.[1] Although rare, LPS can also occur in the mesentery or peritoneum.[2]

Currently, the most effective treatment for intra-abdominal LPS is complete surgical resection. However, intra-abdominal LPS, especially retroperitoneal LPS, is associated with a high local recurrence rate. Due to large tumor size and proximity to critical anatomical structures, complete resection cannot be achieved in all patients. In many cases, complete resection is not possible because of aggressive regrowth soon after operation by a hidden remnant tumor. Efforts to completely remove tumors are also related to high disease-related morbidity and mortality.[3–5] In addition to surgery, radiotherapy (RT) is traditionally used as an adjunctive therapy for locoregional control. Although the benefits of RT are controversial and failed to demonstrate survival benefits, some studies showed the effectiveness of RT.[6–8]

The purpose of this study was to summarize intra-abdominal LPS data from a high-volume single center. We summarized data on patterns of remnant tumor detection and analyzed the optimal minimum duration for postoperative remnant tumor screening. In this approach, we tested for the time point that would significantly divide regrowth of remnant tumors from recurrence. We hypothesized that patients within the time point would have similar survival to patients with evident remnant tumor after gross incomplete resection. In contrast, patients with tumors

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detected after that time point would have better survival than patients with gross incomplete resection. Factors related to locoregional control and overall survival were also analyzed.

2. Materials and methods

2.1. Patients

Data on patients who underwent surgery for intra-abdominal LPS at Samsung Medical Center from January 1998 to December 2015 were retrospectively collected from our institution's prospectively maintained sarcoma database. Data on patients' first operation performed at Samsung Medical Center were used in the study. Patients who had abdominal metastasis of limb LPS or LPS located on the abdominal wall or inguinal canal were excluded. Patients who were operated by surgeons in the Department of Urology were also excluded.

2.2. Data collection

Demographic data and treatment history from other hospitals were collected via a chart review. Anatomical locations of tumors were determined by reviewing preoperative computed tomography (CT) scans and operation records. Laterality, location, and multiplicity were assessed. Surgical data collected included resected organs, completeness of resection based on operation record, margin status based on pathology report, and insertion of tissue expander. Data on tumor characteristics included histological differentiation, Fédération Nationale des Centres de Lutte Contre le Cancer (FNCLCC) grade, and presence of organ invasion, collected from pathology reports. Old histological reports were updated by review of a sarcoma pathology specialist. Whether patients underwent chemotherapy or RT was also reported.

Endpoints were recurrence and overall survival. Interval to recurrence was defined as time from initial surgery to time of tumor detection.

2.3. Data analysis

Kaplan–Meier survival analysis was performed to estimate 1-year, 5-year, and 10-year disease-free survival and 1-year, 5-year, and 10-year overall survival.

Cox proportional hazard ratios were used to analyze prognostic factors for disease-free survival and overall survival. Sex, age ($\leq$60 or $>$60 years), disease status (primary or recurrent), multiplicity, organ invasion based on pathology report, number of resected organs ($<$3 or $\geq$3), histological margin based on pathology report (unknown or positive), tumor differentiation (well-differentiated liposarcoma or other liposarcomas), FNCLCC grade (G1, G2, or G3), and radiotherapy were analyzed for disease-free survival. Analysis of prognostic factors for overall survival included all factors used in analysis for disease-free survival and surgical completeness (gross complete resection or gross incomplete resection).

Cox analysis was used to analyze optimal minimum duration for remnant tumor screening. To estimate the clinical importance of time to tumor detection, patients with recurrence who had gross complete resection (n=77) were divided by 1-month, 3-months, or 6-months. Using univariable Cox analyses, survival of groups were compared to patients who underwent gross incomplete resection confirmed via CT 1 week after operation (n=18). Multivariable Cox analysis included other prognostic factors for survival.

All statistical analyses used SPSS 18.0 (SPSS Inc., Chicago, IL). This study was approved by the Institutional Review Board of Samsung Medical Center (IRB No.2013-07-122).

3. Results

During the study period, 180 patients underwent 250 surgeries for abdominal LPS conducted by surgeons in the Department of Surgery. After excluding 4 abdominal wall LPSs, 5 inguinal canal LPSs, and 3 abdominal metastases from limb LPSs, 168 patients were included.

Demographic, clinical, and pathological characteristics of patients are presented in Table 1. Mean age was 55.8 years,

Table 1

Demographic, clinical, and pathological characteristics of patients who underwent surgery for intra-abdominal liposarcoma at Samsung Medical Center.

Factors	No. of patients	%
Sex male/female	91/77	54.2/45.8
Mean age, years	55.8 (26–81)	
Disease status		
Primary	117	69.6
Recurrent	51	30.4
Multiplicity		
Unifocal	130	77.4
Multifocal	38	22.6
Anatomy		
Retroperitoneal		
Right		
Suprarenal	2	1.2
Infrarenal	9	5.4
Perirenal	66	39.3
Pelvis	6	3.6
Left		
Suprarenal	2	1.2
Infrarenal	8	4.8
Perirenal	40	23.8
Pelvis	9	5.4
Intraperitoneal	26	15.5
Size, cm		
Median	22.5 (1–86)	
0–9.9	25	14.9
10.0–19.9	59	35.1
20.0–29.9	39	23.2
More than 30.0	45	26.8
Adjacent organ invasion		
No invasion	93	55.4
Invasion	59	35.1
Unresectable invasion	16	9.5
Differentiation		
Well-differentiated LPS	61	36.3
De-differentiated LPS	96	57.1
Myxoid/round cell LPS	7	4.2
Others	4	2.4
FNCLCC Grade		
1	67	42.7
2	61	38.9
3	29	18.5
Undetermined	11	
Recurrence	95	56.5
Recurrence type		
Local recur	88	92.6
Distant metastasis	7	7.4
Death	50	29.8

FNCLCC = Fédération Nationale des Centres de Lutte Contre le Cancer, LPS = liposarcoma.

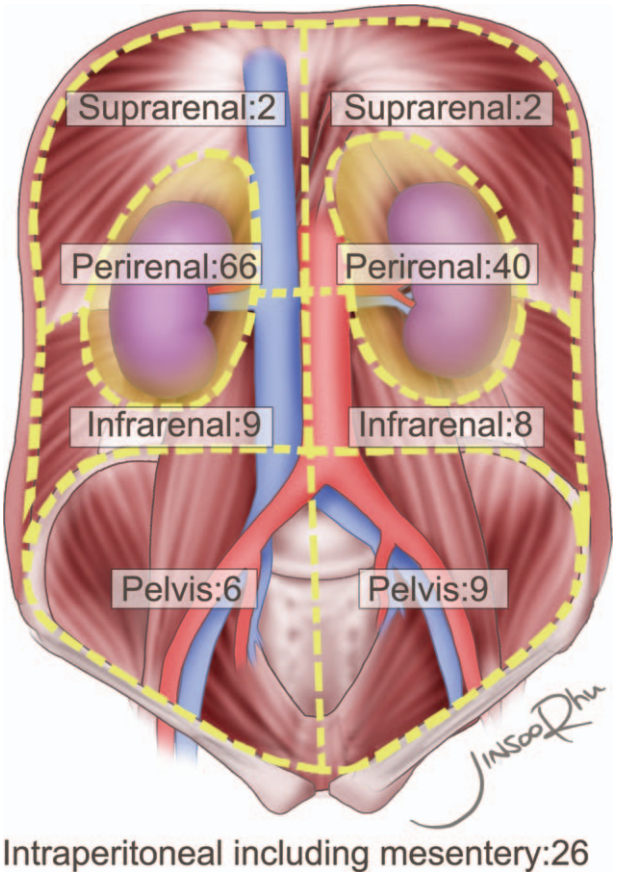

Figure 1. Anatomical location of intra-abdominal liposarcomas in patients who underwent surgery.

ranging from 26 to 81 years. The proportion of patients with primary tumors was 69.6%, whereas 30.4% of patients underwent their first operation in other hospitals. Nearly one-fourth of patients had multifocal tumors (n=38, 22.6%). Anatomical locations of tumors are presented in Fig. 1. Nearly two-thirds of patients had a tumor in the perirenal region (n=106, 63.1%); three-quarters had perirenal tumors when we considered only retroperitoneal LPS (74.6%). Median tumor size was 22.5 cm, ranging from 1 to 86 cm. A patient with an 86-cm mass actually had 3 separate masses of 39 cm, 30 cm, and 17 cm. A total of 44.6% of patients had adjacent organ invasion. Well-differentiated LPSs (WDLPS) were 36.3% (n=61) of all LPSs, and 57.1% of patients (n=96) had de-differentiated LPSs (DDLPS). FNCLCC tumor grading was grade 1 in 42.7% (n=67) of patients, grade 2 in 38.9% (n=61), and grade 3 in 18.5% (n=29). The FNCLCC grade was unclassifiable for tumors in 11 patients, even after review by our institution's sarcoma pathology specialist. Recurrence of remnant tumor was seen in 95 patients (56.5%), and 7 of the 95 had recurrence as distant metastases. Fifty patients expired during the study period.

Disease-free survival curves and overall survival curves of patients estimated by the Kaplan-Meier method are presented in Fig. 2. One-year disease-free survival was 63.1%; 5-year, 35.9%; and 10-year, 21.2%. One-year overall survival was 94.1%; 5-year, 66.5%; and 10-year, 39.9%.

3.1. Prognostic factors for disease-free survival

Multivariable Cox analysis of prognostic factors for disease-free survival is presented in Table 2. Multiplicity (HR=2.528, CI=1.585–4.033, $P<.001$), organ invasion (HR=1.628, CI=1.020–2.598, $P=.041$), and FNCLCC grades (G2, HR=1.730, CI=1.000–2.994; G3, HR=3.812, CI=2.112–6.880; $P<.001$) were significant prognostic factors for disease-free survival. Disease status ($P=.123$), number of resected organs ($P=.565$), and histological differentiation ($P=.463$) were significant only in univariable analyses.

3.2. Prognostic factors for overall survival

Multivariable Cox analysis of potential prognostic factors for overall survival is presented in Table 2. Multiplicity (HR=2.131, CI=1.050–4.329, $P=.036$), 3 or more resected organs (HR=2.857, CI=1.322–6.174, $P=.008$), gross incomplete resection (HR=4.368, CI=1.890–10.097, $P=.001$), positive histological margin (HR=2.766, CI=1.367–5.600, $P=.005$), FNCLCC grade (G2, HR=2.044, CI=0.937–4.459; G3, HR=4.470, CI=1.893–10.557; $P=.003$), and RT (HR=0.322, CI=0.160–0.648, $P=.001$) were significant prognostic factors for

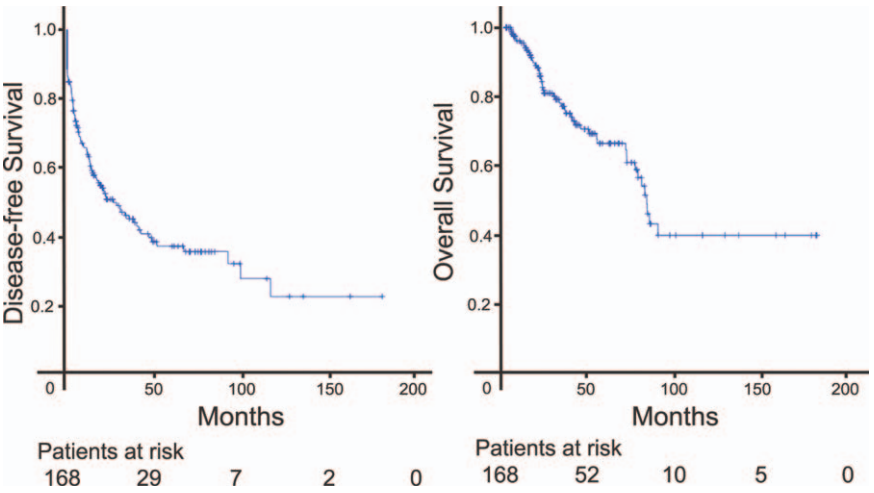

Figure 2. Kaplan–Meier survival curve and disease-free survival curves.

Table 2

Multivariable Cox proportional hazard models of potential prognostic factors for disease-free survival and overall survival.

	Disease-free survival						Overall survival						
		Univariable			Multivariable			Univariable			Multivariable		
Factors	No.	HR	95% CI	P	HR	95% CI	P	HR	95% CI	P	HR	95% CI	P
Sex				.183						.077			
Male	91												
Female	77	0.758	0.504–1.139					0.590	0.329–1.060				
Age, years				.343						.054			
≤60	104												
>60	64	1.219	0.809–1.837					1.725	0.990–3.004				
Status				<.001			.123			.153			
Primary	117												
Recur	51	2.403	1.588–3.637		1.503	0.896–2.523		1.533	0.854–2.753				
Multiplicity	38	3.040	1.974–4.682	<.001	2.528	1.585–4.033	<.001	1.875	1.021–3.444	.043	2.131	1.050–4.329	.036
Organ invasion	75	2.408	1.591–3.643	<.001	1.628	1.020–2.598	.041	2.750	1.554–4.866	.001	1.498	0.685–3.276	.312
No. of resected organ				.008			.565			.001			.008
Less than 3	141												
3 or more	27	1.969	1.191–3.255		1.183	0.668–2.095		3.002	1.526–5.904		2.857	1.322–6.174	
Surgical completeness										<.001			.001
Gross complete	149												
Gross incomplete	19							3.554	1.772–7.128		4.368	1.890–10.097	
Histological margin				.090						.016			.005
Unknown	117												
Positive	51	1.444	0.944–2.210					2.009	1.140–3.542		2.766	1.367–5.600	
Differentiation				<.001			.463			.007			.552
WDPLS	61												
others	107	2.322	1.468–3.673		0.736	0.324–1.669		2.294	1.248–4.216		0.668	0.176–2.529	
FNCLCC Grade				<.001			<.001			.008			.003
1	67												
2	61	2.192	1.294–3.713	.004	1.730	1.000–2.994	.050	2.203	1.052–4.614	.036	2.044	0.937–4.459	.072
3	29	4.817	2.754–8.424	<.001	3.812	2.112–6.880	<.001	3.285	1.505–7.172	.003	4.470	1.893–10.557	.001
Undetermined	11												
Radiotherapy	80	0.770	0.510–1.162	.213				0.497	0.266–0.928	.028	0.322	0.160–0.648	.001

CI = confidence interval, FNCLCC = Fédération Nationale des Centres de Lutte Contre le Cancer, HR = hazard ratio, WDLPS = Well–differentiated liposarcoma.

overall survival. Organ invasion ($P=.312$) and differentiation ($P=.552$) were significant only in univariable analysis.

3.3. Subgroup analysis: 95 patients with recurrence

Numbers of patients with tumors detected during postoperative screening for remnant tumors on CT, categorized into 5 time intervals, are summarized in Table 3. Tumors were detected in 27 patients within 1 month after the operation. Among these, 18 were described as having undergone gross incomplete resection.

Table 3

Tumor detection during postoperative screening for remnant tumor based on computed tomography (CT).

Tumor detection during follow-up CT		No.	% (Cum)
Tumor detected on CT	Within 1 month*	27	28.4 (28.4)
	1–3 months	7	7.4 (35.8)
	3–6 months	14	14.7 (50.5)
	6–12 months	12	12.6 (63.2)
	After 12 months	35	36.8 (100.0)
	Total	95	
No recurrence		73	

CT = computed tomography.

* Of 19 cases described as gross incomplete resection in operation records, 18 were confirmed to have remnant tumors; 1 never showed recurrent tumor during follow-up.

Remnant tumors were detected on 1-week postoperative follow-up CT. During the postoperative period, 7 patients had tumors detected during months 1 to 3 and 14 patients during months 3 to 6. The number of patients with tumors detected within 6 months after operation was 48, or 50.5% of total recurrence. Tumors were detected in 12 patients during the 6- to 12-month period and 35 patients after 12 months. Unlike the recurrence pattern for other malignancies, intra-abdominal LPS showed a high recurrence rate in the early postoperative period, suggesting a high rate of remnant tumors after incomplete resection.

To estimate the clinical importance of the time to tumor detection, Cox analyses of overall survival were performed by dividing patients into 3 groups by tumor detection timing (Table 4). Significant factors in univariable analysis were patients divided by time of tumor detection of 6 months ($P=.043$) compared to the gross incomplete resection group, tumor differentiation ($P=0.037$), and RT ($P=.016$). A time to tumor detection of 1 month ($P=.097$) or 3 months ($P=.063$) was not significant in univariable analyses when compared to the gross incomplete resection group. In multivariable analysis, patients divided by time to tumor detection of 6 months (within 6 months, HR = 0.552, CI = 0.241–1.260; after 6 months, HR = 0.325, CI = 0.149–0.708; $P=.015$) compared to the gross incomplete resection group, tumor differentiation other than WDLPS (HR = 2.114, CI = 1.078–4.146, $P=.029$) and RT (HR = 0.438, CI = 0.229–0.840, $P=.013$) were all significant factors predicting overall survival. Survival curves for patients were divided into 3

Table 4

Multivariable Cox proportional hazard model of prognostic factors for overall survival in patients with recurrence after operation.

		Univariable			Multivariable		
Factors	**No.**	**HR**	**95% CI**	***P***	**HR**	**95%CI**	***P***
Sex				.544			
Male	54						
Female	41	0.829	0.453–1.518				
Age, years				.111			
≤60	56						
>60	39	1.594	0.898–2.828				
Status				.895			
Primary	55						
Recur	40	0.961	0.531–1.738				
Multiplicity	32	1.115	0.603–2.063	.728			
Organ invasion	53	1.657	0.922–2.979	.091			
3 or more resected organs	20	1.856	0.921–3.742	.084			
Histological margin				.077			
Unknown	62						
Positive	33	1.693	0.944–3.036				
Differentiation				.037			.029
WDPLS	26						
Others	69	1.986	1.041–3.790		2.114	1.078–4.146	
FNCLCC Grade				.088			
1	25						
2	34	2.327	1.027–5.274	.043			
3	27	2.222	0.954–5.174	.064			
Radiotherapy	40	0.454	0.239–0.863	.016	0.438	0.229–0.840	.013
Time of tumor detection				.097			
Gross incomplete resection	18						
Within 1 month	9	0.371	0.080–1.709	.203			
After 1 month	68	0.472	0.233–0.955	.037			
Time of tumor detection				.063			
Gross incomplete resection	18						
Within 3 months	16	0.679	0.256–1.800	.436			
After 3 months	61	0.433	0.211–0.889	.022			
Time of tumor detection				.043			.015
Gross incomplete resection	18						
Within 6 months	30	0.659	0.294–1.473	.309	0.552	0.241–1.260	.158
After 6 months	47	0.388	0.183–0.821	.013	0.325	0.149–0.708	.005

CI = confidence interval, FNCLCC = Fédération Nationale des Centres de Lutte Contre le Cancer, HR = hazard ratio, WDLPS = Well–differentiated liposarcoma.

groups and presented in Fig. 3: gross incomplete resection, tumors detected within 6 months, and tumor detected after 6 months.

4. Discussion

This study summarizes the experience of a high-volume center with 168 patients with intra-abdominal LPS. Similar to other challenging retroperitoneal soft tissue sarcomas, the first treatment of choice was to remove the intra-abdominal LPS completely. For adjuvant RT, tissue expander insertion (n=44, 26.2%) was performed when deemed necessary for safety. Patients who underwent intra-abdominal LPS resection were discussed in multidisciplinary meetings to decide further treatment strategies. Patients who did not have a tumor detected during early follow-up underwent RT (n=80, 47.6%). Chemotherapy was performed in patients (n=29, 17.3%) who underwent gross incomplete resection or in whom a growing tumor was detected early after operation. We investigated the optimal screening duration for remnant tumors. Tumors detected early after operation might require early, aggressive treatment. In tumors detected past a certain period, RT after precise planning and sufficient surgical recovery may be sufficient. The observed 5-year disease-free survival of 35.9% and 5-year overall survival

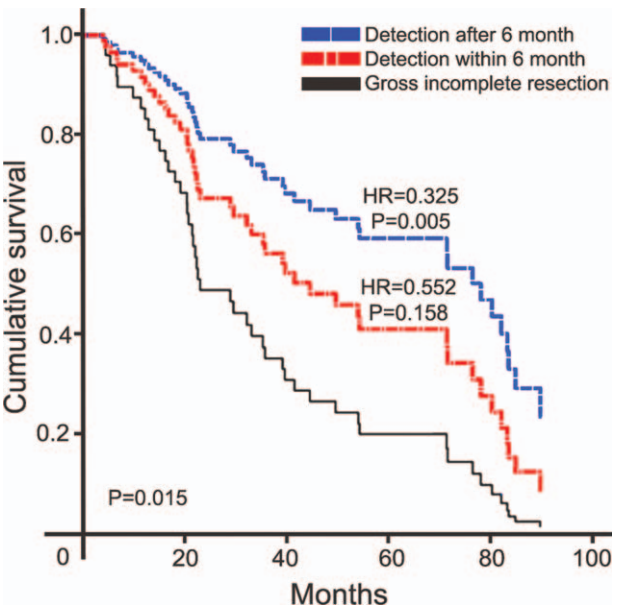

Figure 3. Overall survival of patients with recurrence after surgery for intra-abdominal liposarcoma, by time of tumor detection during follow-up.

of 66.5% in this study were comparable to published results for other high-volume centers.[9,10]

For 10 years, clinicians from high-volume centers have published studies on retroperitoneal soft tissue sarcomas.[3,9–11] Many studies showed the survival benefits of complete surgical resection, whereas adjuvant therapies did not have benefits.[6,10,11] The radical excision technique such as compartmental resection was performed in high-volume centers in Europe. [3] These radical approaches were mainly used to achieve complete resection with negative free margins.

Many studies analyzed factors predictive for recurrence and survival.[3,9–12] Factors related to quality of surgery such as complete resection and margin status are significant predictive factors.[3,9,12,13] Our center performed radical resection of tumors, resecting adjacent organs invaded by tumors. However, despite our experience with giant soft tissue sarcomas, completely removing tumors with a negative free margin was difficult. Even after removal, assessing every margin under the microscope was impossible.[14] These difficulties frustrated us when assessing prognosis and planning treatment. Retroperitoneal LPS is related to high recurrence and rapid tumor growth.[15] The aggressive nature of soft tissue sarcomas led to an early and frequent CT follow-up protocol. Our protocol involved follow-up CT scans at 1 week, 3 months, and 6 months after operation. Patients who underwent adjuvant RT had additional CT scans for RT planning and follow-up.

We sought to determine the optimal minimum duration for remnant tumor screening based on the need for a better index for predicting the patient prognosis, because information on complete resection and histological margins inevitably lacks reliability. The reason we divided patients into 3 groups based on time to tumor detection was to identify the clinical implications of this factor. In univariable analysis, no significant differences were found when patients were divided based on detection at 1 or 3 months. However, when patients were divided based on detection 6 months before or after operation, Cox analysis showed clinically significant differences even in multivariable analysis. These results meant that patients with tumors detected within 6 months after operation showed similar overall survival to patients who underwent gross incomplete resection. Patients with tumors detected 6 months after operation had better survival than patients who underwent gross incomplete resection. This result can be interpreted as indicating that patients with tumors detected within 6 months of operation tended to have similar characteristics to patients with evident remnant tumor. Therefore, we suggest 6 months as the optimal minimum duration for remnant tumor screening.

In addition to the optimal minimum duration for screening, our study analyzed prognostic factors potentially related to disease-free survival and overall survival. Multiplicity ($P < .001$), organ invasion ($P = .041$), and FNCLCC grade ($P < .001$) were significantly related to disease-free survival. Multiplicity ($P = .036$), 3 or more resected organs ($P = .008$), gross incomplete resection ($P = .001$), positive histological margin ($P = .005$), FNCLCC grade ($P = .003$), and RT ($P = .001$) were significant factors related to overall survival. These results were similar to previous studies.[3,9–11] RT improved overall survival, as suggested by other studies.[10,13] Favorable outcomes related to RT have also been described in another study from our center.[8] Although 1 study suggested that recurrent disease status is a negative factor for overall survival compared to primary tumors,[16] our data showed that disease status was not a significant prognostic factor for survival. This finding indicated the importance of performing radical and curative resection, even for recurrent cases.

Our study was retrospective in nature. Inevitably, there may be some innate limitations of our study design, such as missing data. Although a long study period of 17 years allowed the study to include many patients, this also causes potential heterogeneity in clinical practice and outcomes. Including both primary and recurrent LPS may be another shortcoming. However, disease status was not a significant factor in disease-free survival or overall survival, even in univariable analysis. In our study, the FNCLCC grade was not initially determined in 11 patients (6.5%). However, grades were re-examined by a specialist sarcoma pathologist for this study. Histologic margin status was impossible to determine in many cases. Fifty-one patients (30.3%) who were mentioned to have a positive margin showed significantly poor overall survival compared to 117 patients (69.7%) who had no mention of margin status. Since margin evaluation is practically impossible in many cases, the statistical accuracy of this is questionable, however. Incomplete data on organ invasion bare similar limitations. However, pathological reports of other organ invasion showed the increased risk of recurrence compared to cases with no mention of histological invasion. Despite these limitations, we presented comprehensive results on the risk factors of intra-abdominal LPS. The aggressive nature of intra-abdominal LPS limits the clinicians to work on a well-designed prospective study. Compared to previous studies that usually include all retroperitoneal soft tissue sarcomas, our study included only LPSs, which eliminated heterogeneity.

Soft tissue sarcoma is recommended to be managed in a high volume center. Therefore, the finding from this study may not be practical for community hospitals. However, community hospitals can have benefit by setting the 6-month postoperative period for extensive screening.

Our inference that 6 months is the optimal minimum duration for postoperative screening was obtained using an indirect approach and is not based on objective markers such as tumor markers or tumor-specific imaging studies. Our approach was to divide patients using a time point that was predictive of prognosis. Patients who have early recurrence will have a poorer prognosis than patients with late recurrence. However, 1-month and 3-month did not show statistically meaningful results. A 12-month time point may yield significant differences, but lacks clinical implications. The 6-month time point fulfilled both statistical and clinical implications. Furthermore, our suggestion that re-growing tumors detected within 6 months are likely to be remnant tumors will be useful to oncologists planning follow-up and treatment strategies. During this period, the patients should be monitored extensively. Nearly half of patients (50.5%) had a recurrent tumor detected within 6 months. Therefore, it is recommendable for sarcoma oncologists to screen for remnant tumor at least for 6 month. Furthermore, 6 postoperative months can be a reference point for assessing the efficiency of new treatment modalities. It is important to control for baseline characteristics in a clinical trial. Oncologists investigating the impact of chemotherapy and RT on clinical outcomes of LPS should set 6 month-clearance after the operation as their inclusion criteria.

Despite the low prevalence of soft tissue sarcomas including LPS, many patients around the world require treatment by sarcoma specialists. Many oncologists struggle to find the best way to treat soft tissue sarcomas. To date, complete resection remains the best option. However, the challenge of complete removal necessitates other strategies in postoperative patient management. As an option, we suggest close follow-up with a remnant tumor screening

protocol using CT. Well-designed prospective studies on remnant tumor screening are needed to improve management strategies for soft tissue sarcomas including LPS.

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