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Development and Treatment of Pulmonary Metastases in Adult Patients with Extremity Soft Tissue Sarcoma

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Objective
The authors reviewed a series of adult patients with extremity soft tissue sarcoma to determine the incidence of pulmonary metastases and outcome after treatment.

Methods
Of 716 patients admitted between January 1983 and December 1990, 135 (19%) had isolated pulmonary metastases as the initial site of distant recurrence. Fifty-eight percent (78 of 135) of the patients were treated surgically, and 83% of them had their tumors completely resected.

Results
The median survival after complete resection was 19 months; incomplete resection, 10 months; and no operation, 8 months ($p = 0.005$). The 3-year survival rate after complete resection was 23%, compared with a 2% rate (1 of 57) in those treated nonsurgically ($p < 0.001$). Factors associated with an increased risk of pulmonary metastases included high tumor grade, tumor size greater than 5 cm, lower extremity site, and histologic type (spindle cell, tendosynovial, and extraskeletal osteosarcoma). Factors associated with complete resectability were the histologic types of spindle cell and extraskeletal osteosarcoma.

Conclusions
Complete surgical resection remains the only possibility for cure from pulmonary metastases in soft tissue sarcoma; however, only 11% of the 19% of patients with an extremity sarcoma whose first distant recurrence is in the lung will be alive at 3 years, despite therapy. Complete resection and the development of more effective adjuvant treatments are imperative to improve outcome for this group of patients.

Soft tissue sarcomas can arise from any anatomic site; however, more than one half of all primary soft tissue tumors originate within an extremity.[1] Unfortunately, patients with extremity sarcomas are more likely to have distant metastatic disease as their initial site of recurrence; those with retroperitoneal and visceral sarcomas tend to have local recurrences.[2,3] Consequently, in patients with an extremity soft tissue sarcoma, pulmonary metastases tend to develop more frequently than in those with sarcomas at other sites.[2–4] The actual incidence of pulmonary metastases in an adult population of patients with extremity soft tissue sarcoma is not known however.

Surgical resection of pulmonary metastases from soft

tissue sarcomas is a well-accepted form of potentially curative therapy.[5,6] Three-year survival rates range from 30% to 42% in patients rendered disease-free by resection.[7-11] Despite surgical resection, the majority of these patients eventually die as a result of an early second recurrence within the lung.[4,12]

A number of prognostic variables have been examined to predict survival after surgical resection of pulmonary metastases. Those most frequently associated with a favorable effect on survival include prolonged disease-free interval (DFI),[7,8,11] longer tumor doubling time,[7,8,10] and three or less metastatic pulmonary nodules.[7,8,10] Factors that have generally been shown to have little effect on survival are patient age and sex, site or histopathologic findings of the primary tumor, and unilateral *versus* bilateral pulmonary disease.

The majority of studies examining the results of surgical resection for pulmonary metastases from soft tissue sarcoma have begun with a denominator that is represented by the number of patients who have undergone either exploration or resection. Such analysis therefore may suggest a more favorable outcome for these patients than is true for all patients with pulmonary metastases.

In an effort to determine the true incidence of pulmonary metastases from extremity soft tissue sarcomas, we reviewed a series of adult patients with such tumors admitted and entered into a prospective data base at the Memorial Sloan-Kettering Cancer Center (MSKCC) between January 1983 and December 1990. The data were analyzed using the following tumor-related variables: grade, size, site, and histopathologic findings to determine the rate of development of pulmonary metastases after primary tumor management. This series was also analyzed to determine the probability of complete pulmonary resection and survival based on treatment.

MATERIALS AND METHODS

Patient Population

From January 1983 to December 1990, 716 adult patients with a primary or locally recurrent extremity soft tissue sarcoma were admitted to MSKCC. Patients with desmoid tumors (n = 45) were excluded. Five hundred eighty-five (82%) patients presented with their original tumor intact or within 1 month after local excision. One hundred thirty-one (18%) patients presented with a local recurrence. The histopathologic findings, including subtype and grade (high or low), were confirmed at our institution in all patients. Tumor size (≤ 5 cm, > 5–10 cm, and > 10 cm) was available for 545 patients. The location (upper or lower extremity) and anatomic site were recorded for each patient. During the initial evaluation and follow-up, standard chest radiographs were obtained. After pulmonary metastases developed, the extent of overall disease was determined by physical examination, laboratory tests, and clinically directed studies.

One hundred thirty-five (19%) of 716 patients had pulmonary metastases as the initial and only site of distant recurrence. Excluded from the analysis were 13 of 716 patients who presented simultaneously with pulmonary and other distant sites of metastases.

Preoperative chest computed tomography was available for review in 80 (59%) of 135 patients and standard linear tomography, in 17 (13%). The remaining 38 studies were not available for review. Tumor doubling times were measured according to a published method.[13]

Treatment of Pulmonary Metastases

One hundred sixteen (86%) of 135 patients with pulmonary metastases were treated either surgically or nonsurgically. Detailed nonsurgical treatment information was not available in 13 patients, and 6 either refused treatment or, because of associated medical problems, received no treatment. Indications for pulmonary resection included the following criteria: (1) absence of, or a removable, simultaneous recurrence of the primary lesion; (2) absence of simultaneous distant metastases; (3) pulmonary metastases anatomically located to allow complete removal; and (4) sufficient pulmonary function to tolerate resection. Surgical candidates were treated with either a unilateral thoracotomy, bilateral thoracotomies, or median sternotomy. Wedge resection was performed routinely. Nodules not amenable to wedge or segmental resection were removed by pulmonary lobectomy. Chest wall resection or radioactive isotope implantation was performed when metastatic disease extended beyond the pulmonary parenchyma. The number of resected metastatic nodules and the size of the largest nodule were obtained from the pathologist's report. Preoperative chemotherapy or immunotherapy was administered to 24 patients. Postoperative chemotherapy or chemotherapy alone was used in 60 patients.

Follow-Up

The dates of the original diagnosis, presentation to MSKCC, occurrence of pulmonary metastases, pulmonary resection, recurrence after a complete resection, and last follow-up were recorded. The median follow-up for the 135 patients with pulmonary metastases was 12

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months, 11 months for those who died of disease, and 30 months for those patients alive at last follow-up.

Statistics

Survival and DFI curves were calculated based on the method of Kaplan and Meier.[14] Chi square and Fisher's exact test were used to compare values. Univariate analysis of predictive variables was performed using the log-rank test.[15]

RESULTS

Patient Characteristics

In 135 (19%) of 716 patients, isolated pulmonary metastases developed as the initial site of distant disease. At the initial presentation, 112 (83%) of 135 patients were admitted for primary tumor management and 23 (17%) of 135, for locally resectable recurrent disease. Fourteen of these 112 patients were treated for a local recurrence before the development of pulmonary metastases. Thirty-five (31%) of 112 patients presented with synchronous pulmonary metastases, and in 77 (69%) of 112 patients, metachronous pulmonary metastases developed during the follow-up period. Overall, there were 82 male and 53 female patients (age range, 17 to 85 years; median, 55 years).

DFI

The median DFI between the treatment of the primary tumor and the development of metachronous pulmonary metastases was 14 months (range, 1 to 152 months). Of those patients who had metachronous pulmonary metastases, 72% occurred within the initial 2 years after treatment of the primary tumor, 20% between years 2 and 5, and 6% between years 5 and 10. In only one patient, did pulmonary metastases develop more than 10 years after primary tumor management. There were no significant differences in DFI based on the histopathologic findings, grade, size, and location of the primary tumor.

Tumor Doubling Time

Tumor doubling times were calculated in 29 instances in which the chest radiographs were available for review. The doubling time was less than 20 days in 9 patients, 20 to 40 days in 5 patients, and greater than 40 days in 15 patients. No conclusions were drawn because of the small number of patients in these subgroups.

Table 1. SOFT TISSUE EXTREMITY SARCOMAS: HISTOLOGIC TYPE IN 716 ADULT PATIENTS (MEMORIAL SLOAN-KETTERING CANCER CENTER 1982–1990) AND 135 PATIENTS WITH PULMONARY METASTASES

Histologic Type	Overall	With Pulmonary Metastases	p Value
Liposarcoma	213 (30)	25 (18)	0.002
Malignant fibrous histiocytoma	184 (26)	36 (27)	0.86
Tendosynovial sarcoma	103 (14)	30 (22)	0.006
Leiomyosarcoma	53 (7)	7 (5)	0.36
Malignant peripheral nerve tumor	44 (6)	7 (5)	0.75
Rhabdomyosarcoma	30 (4)	9 (5)	0.18
Extraskeletal chondrosarcoma	23 (3)	3 (2)	0.18
Fibrosarcoma	20 (3)	1 (1)	0.07
Angiosarcoma	16 (2)	4 (3)	0.19
Spindle cell sarcoma	14 (2)	9 (7)	<0.001
Extraskeletal osteosarcoma	8 (1)	4 (3)	0.04
Hemangiopericytoma	4 (1)	0	0.43
Alveolar soft part	4 (1)	0	0.43

Values are no. (%).

Development of Pulmonary Metastases

The primary histologic types are shown in Table 1 for all patients with extremity soft tissue sarcoma and those with pulmonary metastases. The most common histologic types of extremity sarcomas were liposarcoma (30%), malignant fibrous histiocytoma (26%), and tendosynovial sarcoma (14%). Those patients with spindle cell sarcoma were the most likely to have pulmonary metastases ($p < 0.001$), followed by tendosynovial sarcoma ($p = 0.006$), and extraskeletal osteosarcoma ($p = 0.04$). The high-grade histologic subtypes of biphasic and clear cell tendosynovial sarcomas were more often associated with pulmonary metastatic disease than were the monophasic or epithelioid subtypes ($p < 0.02$). Those patients with liposarcoma were the least likely to have pulmonary metastases ($p = 0.002$). However, the pleomorphic and lipoblastic subtypes of those with liposarcoma were more often associated with the development of pulmonary metastases than with myxoid, fibroblastic, or well-differentiated types ($p < 0.04$), as previously reported.[16]

The primary tumor locations and anatomic sites are shown in Table 2 for all patients and those with pulmonary metastases. Overall, there were 2.3-fold as many lower extremity as upper extremity tumors ($p < 0.001$).

Table 2. SOFT TISSUE EXTREMITY SARCOMAS: PRIMARY TUMOR SITES IN 716 ADULT PATIENTS AND 135 PATIENTS WITH PULMONARY METASTASES

Lower Extremity	Overall	With Pulmonary Metastases	Upper Extremity	Overall	With Pulmonary Metastases
Thigh	326 (46)	75 (56)	Upper arm	56 (8)	8 (6)
Lower leg	71 (10)	11 (8)	Shoulder	46 (6)	8 (6)
Groin	33 (5)	6 (4)	Forearm	49 (7)	2 (1.5)
Foot	23 (3)	6 (4)	Axilla	24 (3)	3 (2)
Knee	28 (4)	7 (5)	Elbow	14 (2)	1 (1.5)
Other	19 (2)	4 (3)	Hand	14 (2)	1 (1)
			Scapula	7 (1)	1 (1)
			Other	6 (1)	1 (1)

Values are no. (%).

The most common lower extremity sites included the thigh, lower leg, and groin. The most common upper extremity sites included the upper arm, forearm, and shoulder. One hundred nine (22%) of 500 patients with a lower extremity tumor had pulmonary metastases compared with 25 (12%) of 216 patients with an upper extremity tumor ($p = 0.002$).

The original tumor sizes were available in 545 (76%) of the patients, and these are shown in Table 3 with the tumor grade. Overall, 134 (26%) of 523 patients with a high-grade sarcoma and 1 (0.5%) of 193 patients with a low-grade sarcoma (myxoid extraskeletal osteosarcoma) had pulmonary metastases ($p < 0.001$). Eighteen (11%) of 169 patients with a high-grade primary tumor that was 5 cm or less had pulmonary metastases compared with 29 (29%) patients with high-grade tumors that were between 5 and 10 cm ($p < 0.001$) and 39 (33%) with high-grade tumors that were 10 cm and larger ($p < 0.001$). The effect of size and grade on the development of pulmonary metastases was similar when analyzed only in those patients who presented initially for primary management ($n = 472$). In this subgroup, 17 (11%) of 149 patients with a high-grade, 5-cm or less tumor and none of 64 patients with a low-grade, 5-cm or less tumor had pulmonary metastases ($p = 0.001$).

Table 3. SOFT TISSUE SARCOMAS: RANGE OF TUMOR SIZES IN 545 ADULT PATIENTS AND 94 PATIENTS WITH PULMONARY METASTASES*

Tumor Size (cm)	Overall		High Grade With Pulmonary Metastases
	High Grade	Low Grade	
≤5	169	87	18 (11)
>5–10	101	26	29 (29)
>10	118	44	39 (33)

Values are no. (%).
* Tumor size unknown in 171 patients overall.

Treatment

Seventy-eight of the 135 (58%) patients in whom pulmonary metastases developed were treated surgically and 38 (28%), nonsurgically; 19 (14%) received no treatment. There were 41 unilateral thoracotomies, 17 bilateral thoracotomies, and 20 median sternotomies performed on 78 patients. Sixty-five (83%) of the 78 patients undergoing a thoracic surgical procedure had completely resectable disease. Wedge resection alone was performed in 70 patients, a combined lobectomy with wedge resection in 3, a combined chest wall and wedge resection in 3, and biopsy alone in 2. One patient had a radioactive implant placed because of the presence of residual disease after resection. Fifty-six patients were not considered candidates for surgical treatment, and one patient refused surgery.

Resectability

The predictability of complete resection for pulmonary metastases from extremity soft tissue sarcomas was related to the histopathologic findings of the primary tumor (Table 4). Patients with primary lesions of the following histologic types—spindle cell sarcoma and extraskeletal osteosarcoma—were more likely to have completely resectable lesions than were those with other histologic subtypes. Those patients with liposarcoma were less likely to have completely resectable tumors ($p = 0.001$).

The resectability rate was not affected by the patient's age or sex, DFI, presentation status, size or grade of the

Table 4. COMPLETE RESECTABILITY RATE FOR PULMONARY METASTASES FROM EXTREMITY SOFT TISSUE SARCOMAS BASED ON HISTOLOGY

Histologic Type	No. With Pulmonary Metastasis	Resection		p Value	Median Survival (mo)	
		Complete	Incomplete		Complete	Incomplete
Extraskeletal osteosarcoma	4	4		0.05	11	
Spindle cell	9	7		0.05	16	
Rhabdomyosarcoma	11	7		0.14	39	
Tendosynovial	31	14	5	0.15	14	10
Malignant fibrous histiocytoma	36	18	5	0.15	20	10
Malignant peripheral nerve	8	4		0.28	14.5	
Liposarcoma	30	7	3	0.001	22	8
Leiomyosarcoma	9	2		0.08	20	
Angiosarcoma	5	1		0.17	20	
Chondrosarcoma	3	1		0.39	108	

original tumor, or pattern of the metastatic pulmonary disease. Eleven (58%) of 19 patients with tumors of 5 cm or less, 17 (53%) of 32 patients with lesions between 5 and 10 cm, and 16 (40%) of 40 patients with lesions larger than 10 cm had completely resectable pulmonary disease. Those with unilateral disease who had their tumors measured by preoperative radiographic studies had completely resectable lesions in 26 (60%) of 43 cases and those with bilateral disease, in 39 (42%) of 92 cases ($p = 0.08$).

Survival After Resection

The overall median survival for the 135 patients with pulmonary metastases was 12 months with a 7% 3-year survival rate. Of the 65 patients whose tumors were completely resected, the median survival time was 19 months compared with 10 months after incomplete resection and 8 months with nonsurgical treatment ($p = 0.005$, Fig. 1). The 3-year survival rate after a complete resection was 23%. Preoperative chemotherapy or immunotherapy was associated with a median survival time of 25.5 months compared with 18 months in patients who underwent complete resection without preoperative therapy. This difference was not significant.

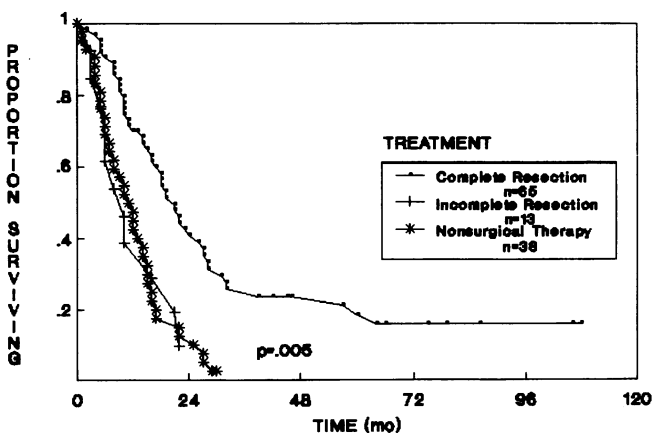

Figure 1. Survival based on the treatment of the pulmonary metastases from extremity soft tissue sarcomas.

The survival time after the resection of the pulmonary metastases based on the histologic tumor types is shown in Table 4. Patients with metastatic adult rhabdomyosarcomas had a median survival of 39 months after complete resection ($p = 0.001$) compared with 11 months in patients with extraskeletal osteosarcoma ($p = 0.03$).

Survival was not affected by the number or size of the metastases removed, the thoracic surgical approach, or the intraoperative technique. The average number of positive nodules resected was 2 (range, 1 to 20). Twenty-five (32%) patients had a solitary metastases, 13 (17%) had two, 12 (15%) had three, and 28 (36%) had more than 3.

Recurrence After Complete Resection

Forty-five of 65 patients (69%) with completely resectable pulmonary metastases had a second pulmonary recurrence as their first site of metastatic disease after thoracotomy. The median DFI was 4 months (range, 0.8 to 32.8 months). Twenty-four of 45 patients underwent a second thoracic surgical procedure. Fifteen of 24 patients underwent complete resections and had a median survival time of 17 months. Eleven of these 15 patients had recurrences in the lungs a third time, and 3 of 11 underwent a third thoracic procedure. Two of three underwent complete resections and survived 12 and 19 months.

DISCUSSION

To our knowledge, the incidence of pulmonary metastases in adult patients with extremity soft tissue sarcomas

has not been previously reported. In the current sequential series of 716 adult patients with extremity soft tissue sarcomas, 135 (19%) patients presented with or had pulmonary metastases as the only site of distant disease during the follow-up period. The predilection for pulmonary metastases in patients with extremity soft tissue sarcomas has been shown by others.[4,17–19] In a review of 211 patients with high-grade extremity soft tissue sarcomas, a recurrence rate of 31% was reported, including both local and distant sites.[4] Pulmonary metastases alone represented 70% of these sites, with an incidence of 21% in those patients with high-grade soft tissue extremity sarcomas followed for 7 years. In our series, 427 of 716 patients presented for primary management with a high-grade lesion, and within this subgroup, in 26%, pulmonary metastases developed.

The majority of patients that have recurrences after primary management of a soft tissue sarcoma do so within the initial 2 years after surgery.[3,4,17–19] The remaining 15% to 25% of patients generally have recurrences within the next 2 to 5 years. Our data were consistent with this pattern because 72% of those patients who had recurrences did so within the first 2 years after treatment of the primary tumor and 92%, within 5 years.

The probability of pulmonary metastases developing from an extremity soft tissue sarcoma was influenced by the histopathologic findings and the grade, size, and location of the primary tumor. Patients with an extremity spindle cell sarcoma, extraskeletal osteosarcoma, or tendosynovial sarcoma were more likely to have pulmonary metastases develop than were those with other histologic types. Patients with liposarcoma were the least likely to have pulmonary metastases. In another series, of 242 patients with recurrent soft tissue sarcomas from a variety of primary sites, patients with tendosynovial sarcoma also demonstrated an increased incidence of pulmonary metastases; those with liposarcoma and fibrosarcoma had a decreased incidence.[3] This may be accounted for by the observation that virtually all tendosynovial sarcomas are high grade; the histologic subtypes of liposarcoma and fibrosarcoma strongly influence the tumor grade and outcome.[7,16,20] In a series of 91 patients with extremity soft tissue sarcoma that was analyzed similarly, it was found that patients with malignant fibrous histiocytoma and malignant schwannoma had an increased incidence of pulmonary metastases; those with fibrosarcoma, liposarcoma, and myxofibrosarcoma were at lower risk.[18]

Additional characteristics of the original tumor that affected the development of pulmonary metastases included the grade, size, and site. These variables have repeatedly been shown to affect the outcome in patients with soft tissue sarcoma because of the increased risk of local and distant recurrence.[18,21–23] The majority of patients in our series in whom pulmonary metastases developed had a high-grade, 5-cm or larger primary tumor that was located on a lower extremity. A recent analysis from MSKCC considered the management of only those patients with small tumors, 5 cm or less, who presented for primary management.[24] In this study, distant disease occurred in 8 (7%) of 114 patients with high-grade tumors and in no patients with low-grade tumors ($p = 0.03$). When we examined the relationship between grade and a size of 5 cm or less, we found that 17 (11%) of 149 patients with a high-grade small tumor had pulmonary metastases compared with 61 (22%) of 278 patients with tumors larger than 5 cm ($p = 0.01$). The difference between 7% and 11% was not significant and probably reflects the larger number of patients analyzed in the current series.

Surgical treatment of pulmonary metastases is a well-accepted form of a potentially curative therapy. In our series, 53% of patients with pulmonary metastases were treated surgically. Forty-four per cent of the entire series or 83% of those patients who underwent a thoracic exploration had completely resectable tumors. There is variability within the literature as to the complete resectability rate for pulmonary metastases. In one review, 40 (71%) of 56 patients with high-grade sarcomas had completely resectable lesions.[4] Others, alternatively, resected only 29% of patients who presented with pulmonary metastases from a variety of histologic types of soft tissue sarcomas.[3] An explanation for these differences in resectability is not ascertainable without further details of the indications for resection or patient inclusion.

The specific surgical approach did not affect survival in our series. However, median sternotomy has been advocated by some as the surgical treatment of choice for pulmonary metastases from sarcomas because of its low morbidity, the high incidence of bilateral disease despite unilateral disease on preoperative imaging, and the elimination of a second thoracotomy.[25,26] The issue of survival was addressed based on the thoracic approach in a group of 68 patients.[26] The median survival after 42 lateral thoracotomies was 19.8 months and 14.8 months after 42 median sternotomies. The actuarial survival was not significantly affected by the treatment. From these data, it appears that either (1) the overall survival is so poor in these patients that occult bilateral disease frequently never becomes clinically evident or (2) we are having an impact on the natural history of the disease too late to effect a cure by surgical therapy alone.

The survival rate after a complete resection of pulmonary metastases was significantly improved compared with nonsurgical treatment and incomplete resection. The 1-, 2-, 3-, and 4-year survival rates for those patients who underwent complete resections were 71%, 38%, 23%, and 17%, respectively. The 1- and 2-year survival

Table 5. REPORTS OF SURVIVAL AFTER COMPLETE RESECTION OF PULMONARY METASTASES FROM ADULT SOFT TISSUE SARCOMA

Reference (yr)	No. of Patients	No. of Extremity Sites	No. With Pulmonary Metastasis	No. With Surgical Treatment	No. With Complete Resection	Median Survival (mo)	3-Year Survival (%)
Creagan (1950–1976)[27]	112	NS	112	112	64 (57)	18*	0*
Putnam/Roth (1974–1982)[7,8]	487	52	93	68	51 (75)	23	32
Casson (1981–1985)[10]	68	45	68	68	58 (85)	25	42
Jablons (1982–1987)[9]	74	58	57	57	49 (86)	27	35
Verazin (1970–1986)[11]	78	51	78		61 (78)	21	21.5†
MSKCC (1983–1990)	716	716	135	78	65 (83)	19	23

Values in parentheses are percentages. NS = not stated in text.
* Overall.
† Five-year survival.

rates for those patients treated nonsurgically were 37% and 9%, respectively. Although a median survival of 19 months after complete resection was consistent with those previously reported, the 3-year survival rate in these patients was much less than the generally reported rates of 30% to 42% (Table 5).[7–11,27] The criteria for surgical resection and the surgical techniques used were similar, but the patient population evaluated in our series included all patients who presented with pulmonary metastases. Most of the literature on pulmonary resection for metastatic soft tissue sarcomas includes an analysis of preselected patients with primary tumors arising from a variety of locations. In addition, we did not select patients for surgery based on the results of the tumor doubling time. There currently is little in the way of specific guidelines in regard to resectability, which have not changed during the last 30 years. Essentially, any patient in whom all known disease can be completely removed should be considered for surgical treatment as previously outlined.[11,28] Consistent with this approach is our inability to identify predictors for resectability.

Several variables that have previously been shown to affect survival after resection were not important in the current series. The number of pulmonary nodules resected had been shown to affect survival in two studies from the National Cancer Institute.[7,8] In their analysis, patients with three or less nodules (observed by linear tomography) experienced prolonged survival after thoracotomy. However, in agreement with our findings, their latest series and another revealed that, in patients in whom all disease could be resected, the number of nodules had no effect on long-term survival.[9,11] From a review of 234 patients with pulmonary metastases from a variety of tumors, it was reported that the median survival in those patients with a solitary lesion was 27.3 months compared with 17 months in patients with two or more nodules ($p < 0.01$).[29,30] On the contrary, it was found that the median survival was greater in those patients who had eight or more lesions compared with those with five to eight. The interpretation of these data is not clear enough to exclude any patient from resection based on the number of radiographic nodules alone.

Survival after resection was also not affected by the DFI, size, or grade of the primary tumor, patient's age or sex, multicentricity of the nodules, or the thoracic surgical approach. There was however a trend toward improved survival in those patients who received preoperative chemotherapy and had completely resectable lesions. Generally, the use of pretreatment or postoperative chemotherapy has not been shown to have an effect on early recurrence or survival in controlled trials.[5,22,31] When the outcome was reviewed of 26 patients with pulmonary metastases from soft tissue sarcoma who received preoperative chemotherapy followed by resection, no survival benefit was associated with the chemotherapy.[22] Alternatively, when others reviewed the outcome of 43 patients with a variety of bone and soft tissue sarcomas after resection of pulmonary metastases, 15 of 21 patients who received preoperative chemotherapy demonstrated a clinical response, and 7 (45%) of 15 remained disease-free at 27.5 months.[31]

Despite complete resection and the frequent use of adjuvant therapy, the DFI between subsequent pulmonary recurrences continues to shorten. In our series, 69% of patients who had completely resectable pulmonary metastases had a second pulmonary recurrence that developed within a median DFI of 4 months. The problem of early recurrence after "curative" resection has been repeatedly reported in the literature.[7–9,17,27] In a series of 112 patients with soft tissue sarcomas, 39 (61%) of 64 patients who underwent resection of their pulmonary metastases had a second pulmonary recurrence at a median DFI of 6 months.[27] Similarly, it was reported that

36 (55%) of 66 patients who underwent resections had recurrences with a median DFI of 7 months.[4]

The fact remains that 57% of patients in the current study were found to have advanced pulmonary disease before or during surgery that precluded a complete resection. It is clear that, to have an impact on survival, a complete resection is imperative. There will never be a trial comparing surgery with medical therapy unless better chemotherapeutic agents are developed. Alternatively, the surgical treatment of pulmonary metastases from sarcoma is inadequate, and the results are unsatisfactory. Our aims should be directed at improving overall disease control at the time of primary management and developing more effective adjuvant treatments that can be used in conjunction with surgical resection.

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