**Original
Article**

Effective Utilization of Chest X-ray for Follow-up of Metastatic Lung Tumor due to Soft Tissue Sarcoma

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Computed tomography (CT) is widely used for follow-up of lung metastasis in patients due to soft tissue sarcoma (STS), the frequency of chest X-ray (CXR) is obviously reduced. This study verified the current status of diagnostic measures and the efficacy of CXR.

A retrospective analysis of 18 patients that underwent surgery for lung metastasis due to STS was performed. The investigation compared the follow-up interval using CT after STS surgery, time from STS surgery to lung metastasis, tumor size of lung metastasis, detection rate with CXR, time from detection to surgery for lung metastasis, number of CT scans and follow-up interval using CT after detection of lung metastasis.

The follow-up interval when using CT after STS surgery was 3.5 months (m). Time from STS surgery to lung metastasis was 34.3m. Tumor size of lung metastasis was 15 mm, and the detection rate by CXR was 66.7%. The time from detection to surgery for lung metastasis was 4.8m, the number of CT scans was 3.1, and the interval was markedly shortened to 1.6m.

Follow-up should be performed by CXR if the tumor is detected by CXR. CT evaluation is required when the tumor size has increased, and prior to surgery for lung metastasis.

Keywords: soft tissue sarcoma, lung metastasis, follow-up

Introduction

Soft tissue sarcomas (STS) are rare tumors in adulthood, and STSs are a heterogeneous group of malignant tumors with more than 50 histological subtypes.¹⁾ The pattern of spread to the lungs is commonly haematogenous.²⁾ In metastatic STS, the lung is the most frequent organ affected and is seen 20% of patients, which is less than that in osteosarcoma.³⁾ Prognostic indicators for recurrence include age at diagnosis, tumor depth, tumor

size, histological type and grade, and positive surgical margins.^{4–8)} Imaging of the chest by computed tomography (CT) and chest X-ray (CXR) is recommended regularly for detecting the presence of pulmonary metastasis after curative resection for STS.

Computed tomography is widely used for follow-up of lung metastasis in patients with STS. On the other hand, the frequency of CXR is obviously reduced. The effective radiation dose from CXR is estimated to be between 0.02 mSv and 0.1 mSv, which is equivalent to between 2.4 days and 10 days of background radiation. Obviously, the overall radiation dose of CXR is smaller than that of CT. Furthermore, CT may give false positive results in the presence of small lung nodules (<5 mm).⁹⁾

Although CXR is a valid and feasible way, CT is performed without CXR.

The aim of this study is to elucidate the current status of diagnostic measures for the follow-up of lung metastasis due to STS and the efficacy of CXR.

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Table 1 Analysis results of all patients

Follow-up interval using CT after STS surgery	3.5m (1–24)
Time from STS surgery to lung metastasis	34.3m (1–132)
Tumor size of lung metastasis at surgery	15 mm (6–41)
Detection rate of CXR	66.7% (12/18)
Time from detection to surgery for lung metastasis	4.8m (1–23)
Number CT scans after detection	3.1 (1–15)
Follow-up interval using CT after detection	1.6m (1–4.0)

STS: soft tissue sarcoma; CXR: chest X-ray

Table 2 Results based on CXR availability

Factor	Detectable by CXR (n = 12)	Undetectable by CXR (n = 6)	p-value
Follow-up interval	3.7m (1–24)	3.1m (2–6)	N.S.
Time from STS to lung meta	30.8m (1–108)	39.8m (2–132)	N.S.
Tumor size at surgery	15 mm (6–41)	8 mm (6–10)	p <0.05
Time from detection to surgery	5.0m (1–23)	4.1m (1–18)	N.S.
Number CT scans	3.5 (1–15)	2.0 (1–5)	N.S.
Follow-up interval using CT	1.4m (1–2.2)	2.1m (1–4.0)	N.S.

STS: soft tissue sarcoma; CXR: chest X-ray

Patients and methods

A retrospective analysis of consecutive 18 patients (synovial sarcoma, 6; liposarcoma, 3; malignant peripheral nerve sheath tumor, 2; leiomyosarcoma, 2; malignant fibrous histiocytoma, 2; alveolar rhabdomyosarcoma, 2; ewing sarcoma,¹⁾ that underwent surgery for lung metastasis due to STS during a 4-year period was performed between August 2006 and October 2010. The subjects included 9 males and 9 females with a mean age of 42.6 ± 8.6 (12 to 67) years. The study compared the follow-up interval when using CT after STS surgery, time from STS surgery to lung metastasis, tumor size of lung metastasis during surgery, detection rate with CXR, time from detection to surgery for lung metastasis, number of CT scans after detection of lung metastasis, and follow-up interval using CT after detection of lung metastasis. Informed consent was received from each patient in this study. Statistical analysis was examined using Mann-Whitney U tests.

Results

The results of the analysis of all patients are shown in **Table 1**. The follow-up interval using CT after STS surgery was 3.5 months (m; 1–24m). The time from STS surgery to lung metastasis was 34.3 m (1–132m). The median tumor size of the maximal lung metastasis was

15 mm (6–41 mm), and the detection rate by CXR was 66.7% (12/18). The time from detection to surgery for lung metastasis was 4.8 m (1–23), number of CT scans after detection of lung metastasis to surgery was 3.1 (1–15), and the interval was markedly shortened to 1.6m (1–4.0m).

Results of the analysis based on CXR availability is shown in **Table 2**. There was no statistical difference of background disease between the two groups (detectable in CXR group: synovial sarcoma, 4; liposarcoma, 2; malignant peripheral nerve sheath tumor, 1; leiomyosarcoma, 1; malignant fibrous histiocytoma, 2; alveolar rhabdomyosarcoma, 1; ewing sarcoma, 1; undetectable in CXR group: synovial sarcoma, 2; liposarcoma, 1; malignant peripheral nerve sheath tumor, 1; leiomyosarcoma, 1; alveolar rhabdomyosarcoma.¹⁾ The follow-up interval when using CT after STS surgery of cases detectable by CXR was 3.7 m (1–24 m), and that in cases undetectable by CXR cases was 3.1m (2–6 m). The time from STS surgery to lung metastasis of cases detectable by CXR was 30.8m (1–108 m), and time in cases undetectable by CXR was 39.8m (2–132m). Median tumor size of the maximal lung metastasis of cases detectable by CXR was 15 mm (6–41 mm), and tumor size in cases undetectable by CXR was 8 mm (6–10mm; p <0.05). The time from detection to surgery of lung metastasis in cases detectable by CXR was 5.0m (1–23m), and time in cases undetectable by CXR was 4.1m (1–18m), respectively. The number of CT scans from detection of lung metastasis to surgery cases,

detectable by CXR was 3.5 (1–15m), and the number in cases undetectable by CXR was 2.0m (1–5m), respectively. Those intervals were markedly shortened to 1.4m (1–4.0m), 2.1 m (1–4.0), respectively. Although these results were based on a retrospective analysis, lung nodules that were detectable by CXR were observed by follow-up with CT within a short period of time prior to surgery to lung metastasis.

Because this study had a small sample size and was performed during a recent 5 year period, the survival rate could not be accurately analyzed. The median survival time detectable in the CXR group was 18 months, and undetectable in the CXR group, was 16 months.

Discussion

Soft tissue sarcoma is a rare disease, a heterogeneous group of solid tumors, and arises primarily from embryonic mesoderm. Soft tissue sarcoma occurs in about 2 patients per million, in Japan. The 5-year survival for STS of all stages is between 50% and 60%.¹⁰⁾ Several studies on pulmonary metastectomy for STS have been published, and the 5-year survival ranges from 25% to 57%.^{11–14)} All these studies have shown that complete surgical resection of pulmonary metastasis is a significant prognostic factor of STS. Surgical treatment of metastatic pulmonary STS is the best procedure for cure.

Currently the most common measure for screening lung metastasis is CT. However, although CT is more accurate, the difference in accuracy is not great. The accuracy of CXR is 96.9%, in comparison to 99.6% with CT. Furthermore, CT will detect indeterminate nodules. Chalmers reported that pulmonary nodules that were not seen on a CXR detected on CT in 13% of 146 patients with extra thoracic malignancy, but 80% of these nodules were benign.¹⁵⁾ Computed tomography is by no means infallible, and it could be argued that the detection of indeterminate nodules may lead to unnecessary investigation. The usefulness of a routine CXR to diagnose lung metastasis in STS has been less well documented. Kane summarized that CT is associated with a lack of cost effectiveness, increased regular clinic visits and clinical examinations.¹⁶⁾ Change AE et al. suggested that the low cumulative dose of radiation received from 6 monthly CXRs makes this a safe, simple, and appropriate first tool.¹⁷⁾ Chest X-radiography will pick up these large lung lesions, and CT of the chest is not always needed. Lung lesions below 5 mm in diameter will be missed on CXR and will only be identified on CT. The vast majority of

Fig. 1 Flow diagram of follow-up for lung metastasis.

Follow-up for lung metastasis with CXR or CT was performed as ever. CXR is examined if lung metastasis is detected on CT. When the tumor is detected by CXR, a follow-up is performed by CXR. When the tumor has obviously grown, it is evaluated by CT prior to surgery for lung metastasis.

CXR: chest X-ray

these patients is completely asymptomatic and will be offered radical surgery.

A recent study proposed that all patients with STS have a CXR, and only those patients with an abnormality on CXR or with a high/intermediate grade, such as deep tumors greater than 5 cm (stage 2b/3) in size, specific histological subtypes of STS, where the incidence of lung metastases at diagnosis is known to be high, for example, extra skeletal ewing sarcoma and malignant peripheral nerve sheath tumor, should undergo a CT routinely.¹⁸⁾

The goal of this study was to evaluate the current status of diagnostic measures to follow-up of lung metastasis due to STS and the efficacy of CXR. Most patients in this study were followed by routine CT only, but not by CXR. The results revealed that metastatic pulmonary nodules were detectable by CXR (66.7%), nodules undetectable by CXR were smaller than 10 mm. The time from detection to surgery was 4.8 m. The mean number of follow-up CT scans during this period was 3.1, and this interval was markedly short (1.6m).

This study confirmed that CT has been extensively used in the follow-up examination of lung metastasis due to STS. Orthopedists employ follow-up using CT regularly, since they feel insecure in follow-up only by CXR. We suggest the method of follow-up examination in **Fig. 1**.

A pulmonary nodule that cannot be detected by CXR requires the use of CT scans during the follow-up examination. However, pulmonary nodules that can be detected by CXR should be followed with the combined use of CXR and CT until the resection.

This study is a limited, small number study, but STS is a heterogeneous malignant subtype group. Furthermore, we will validate the effectiveness of CXR for follow-up of various metastatic lung tumors. In the present study, we showed that CXR provided much information for follow-up of metastatic lung tumor due to soft tissue sarcoma. In conclusion, it is important for clinicians to utilize CXR effectively while understanding the limit and characteristic of the modality, enough.

Disclosure Statement

No author has any conflict of interest

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