Virchows Arch (2005) 446: 310–315
DOI 10.1007/s00428-004-1174-2

CASE REPORT

B. Bode-Lesniewska · J. Hodler · A. von Hochstetter · L. Guillou · U. Exner · R. Caduff

Late solitary bone metastasis of a primary pulmonary synovial sarcoma with SYT-SSX1 translocation type: case report with a long follow-up

Received: 5 September 2004 / Accepted: 12 November 2004 / Published online: 25 January 2005

Abstract Primary synovial sarcoma outside its classical presentation in para-articular soft tissue of young patients is rare but regularly reported. One of the rarest primary locations is the lung. We describe a 73-year-old female patient who presented with a solitary malignant bone tumor 8 years after the resection of a lung neoplasm. The bone tumor was classified as an osteosarcoma and the lung tumor as an atypical carcinoid tumor at their first respective diagnostic work-ups. The resection of the affected humerus with allograft and endoprosthesis implantation followed. Reevaluation of the tumor samples at the time of the local recurrence of the bone tumor 6 years following the initial symptoms of the bone tumor lead to the reclassification of both specimens as synovial sarcomas. Both neoplasms contained the SYT-SSX1 type of the diagnostic translocation t(X;18) as detected by the reverse-transcription polymerase chain reaction analysis. The patient died 14 years after the resection of the primary synovial sarcoma of the lung and 6 years following the occurrence of the bone metastasis. This prolonged clinical course is uncommon for the SYT-SSX1 translocation, which, in other locations, is usually associated with an unfavorable prognosis.

B. Bode-Lesniewska (✉) · A. von Hochstetter · R. Caduff
Department of Pathology, University Hospital Zurich,
8091 Zurich, Switzerland
e-mail: beata.bode@usz.ch
Tel.: +41-1-2554051
Fax: +41-1-2554551

J. Hodler
Department of Radiology, Balgrist Hospital,
University of Zurich,
Switzerland

L. Guillou
University Institute of Pathology,
Lausanne, Switzerland

U. Exner
Department of Orthopaedic Surgery, Balgrist Hospital,
University of Zurich,
Switzerland

Keywords Synovial sarcoma · Lung tumor · Bone metastasis · Gene translocation

Introduction

Synovial sarcomas, which account for approximately 10% of all malignant soft-tissue tumors, arise most commonly in the para-articular tissues in adolescents and young adults [13, 25]. It has become increasingly apparent, however, that synovial sarcomas may arise in a wide variety of other sites, including head and neck, mediastinum, heart, kidney, prostate, esophagus and vulva, and that they also occur in elderly patients [6]. There are four different morphological subtypes of synovial sarcoma: biphasic, monophasic spindle cell type, monophasic glandular type and poorly differentiated. While the histological diagnosis of a classical biphasic subtype is usually not difficult, the other types may be confounded with many other entities, especially when presenting in an unusual clinical context. The identification of the specific cytogenetic alteration in form of a balanced translocation t(X;18) with fusion product between SYT and SSX genes allows reliable diagnosis and/or confirmation of the diagnosis of a synovial sarcoma [13]. The correct diagnosis leads to the institution of the proper treatment and the estimation of prognostic factors. Although at present, surgery is still the mainstay of the treatment of synovial sarcomas and although there are no specific adjuvant methods (except for the notion of better response to some chemotherapy regimes), the situation may change in the future. The results of molecular studies on the oncogenic mechanism of the SYT-SSX fusion product [10, 11, 20] and on the expression profiles of synovial sarcomas [1, 21] may possibly allow the development of tumor-specific medications with the best candidate targeted at present being epidermal growth factor receptor.

Spindle cell tumors of the lung fall into several prognostically and pathogenetically different categories, such as sarcomatous carcinomas, malignant mesotheliomas and sarcomas. Primary sarcomas of the lung are exceedingly rare and constitute about 0.1% of malignant lung tumors.

Reports of primary synovial sarcomas of the lung and pleura began to appear with increasing frequency in recent years due to the potent diagnostic tools in the form of immunohistochemistry and molecular genetics [5, 12, 18].

We present an unusual case of a late solitary bone metastasis—at first erroneously diagnosed as an osteosarcoma—occurring 8 years after a resection of a primary pulmonary synovial sarcoma—at first erroneously diagnosed as an atypical carcinoid tumor—with confirmatory molecular analysis of the SYT-SSX translocation. Thanks to this examination, both tumors proved to represent manifestations of the same disease (monophasic synovial sarcoma), despite differing diagnoses in the preceding biopsies.

Case report

A 73-year-old female patient presented in September 1995 with slowly progressive pain in her right shoulder and weight loss. Within few weeks, the intensity of the pain increased and was also present at night. Standard radiographs obtained in December 1996 demonstrated an extensive aggressive, osteolytic lesion in the proximal humerus (Fig. 1A). Scintigraphically, no other bone lesions were found. An incisional biopsy of the tumor was performed in January 1996. The histological diagnosis was consistent with small cell osteosarcoma. The thorough staging procedure revealed no other tumor manifestations, specifically no pulmonary or bone metastases. The patient rejected an amputation, and the transarticular resection of the proximal humerus with implantation of an allograft and endoprosthesis was performed in January 1996 without direct complications. The postoperative follow-up was uneventful, with satisfying healing and no metastases radiologically.

In March 1998, 2 years later, standard radiographs and computed tomography of the chest demonstrated small pulmonary nodules compatible with metastatic spread. The patient declined further diagnostic and therapeutic procedures, and radiological follow-up showed slow progression of the pulmonary findings. Local recurrence of the tumor in the right humerus in August 2000, 4 years after the resection of the proximal humerus, proved unresponsive to radiation therapy. An accelerated growth as well as development of exulcerated tumor necrosis prompted palliative resection in December 2001. The patient died within 1 week of postoperative cardiac complications, 14 years following the resection of the pulmonary primary tumor. The patient was a housewife, and her medical history was otherwise uneventful, except for a remote history of a cholecystectomy, high blood pressure and slight aortic valve stenosis. No autopsy was performed.

At review, the tumor tissue resected in December 2001 as well as the previous histological specimens from this location were strongly suggestive of a monophasic spindle cell synovial sarcoma. The careful study of the patient file revealed the history of an operation of a lung tumor 8 years prior to the current onset of symptoms in the right shoulder (Fig. 1B) with the histological diagnosis of an atypical carcinoid tumor. At the time of the lung resection, no other tumor manifestations were found clinically and radiologically. The slides and paraffin blocks of this tumor could be recovered from another institution. The comparison of the morphology, immunohistochemical properties and the status of the t(X;18) proved identical tumor cell types morphologically and immunohistochemically with the same SYT-SSX1 translocation specific for synovial sarcoma.

Materials and methods

Clinical information was obtained from the files of the medical facilities where the patient had been treated. The study was performed in accordance with the guidelines of the local ethics commission. Histological material from the lung and bone tumors was fixed in buffered 4% formalin

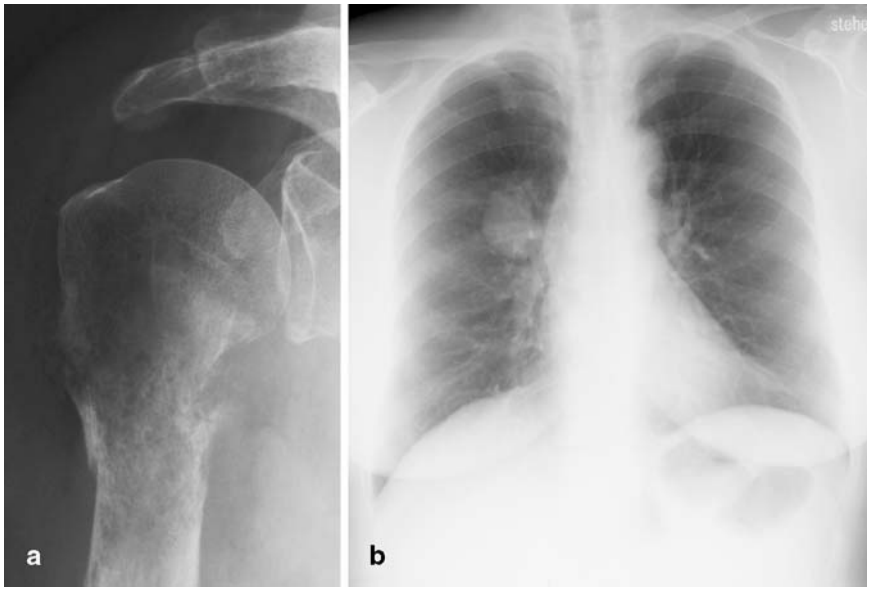

Fig. 1 **A** Extensive osteolytic tumor in the metaphysis of the proximal right humerus (standard radiograph). **B** Proximally located lung tumor resected 8 years prior to the presentation of the bone lesion (standard radiograph)

and embedded in paraffin according to standard procedures. Sections (1–2 μm) were cut for conventional histology and immunohistochemistry. The following antibodies were used: pan-cytokeratin (1:250; Biomedicals AG, Augst, Switzerland), early membrane antigen (EMA, 1:20; Dako, Glostrup, Denmark), S100 (1:3000; Dako), CD34 (1:50; Serotec Ltd., Oxford, UK), synaptophysin (1:30; Dako), chromogranin (1:50; Dako), alpha-smooth-muscle actin (SMA) (1:20,000; Sigma, St. Louis, USA), desmin (1:20; Dako). Immunohistochemistry was performed on deparaffinized sections using the Ventana NexES automated staining system with diaminobenzidine as substrate. For antigen retrieval, slides were either enzymatically predigested or heated in citrate buffer for 3 min using a pressure cooker. Slides were counterstained with hemalaum. The quality of the reactions was controlled on tissue slides with known reaction patterns stained in parallel with the examined probes.

Reverse-transcription polymerase chain reaction

RNA extraction and reverse-transcription polymerase chain reaction (RT-PCR) analysis were performed as previously described [14]. For subtyping SYT-SSX fusion transcripts, 3 μl of each PCR product was enzymatically hydrolyzed at 65°C for 1 h with 5 units of the restriction enzyme *Taq*I (Roche Diagnostics) in a final volume of 10 μl. The digestion patterns of the PCR products were analyzed on 2% agarose gels and visualized using ethidium bromide staining. The size of digested products were 65 bp and 32 bp for the SYT-SSX1 fusion gene transcripts, but remained at 97 bp for SYT-SSX2.

Subtyping was determined in parallel by single-strand conformation polymorphism (SSCP) analysis. Aliquots of 5 μl of PCR products were mixed with 5 μl of denaturing buffer (0.1 M NaOH and 2 mM ethylenediaminetetraacetate), heated at 50°C for 10 min. After addition of 1 μl of formamide dye, the samples were immediately loaded onto a 40% mutation detection enhancement (MDE) gel (FMC BioProducts, Rockland, Maine USA) and electrophoresed in 0.5×Tris–borate–EDTA (TBE) buffer at 20°C and 300 V (20 V/cm) for 5 h. The gels were stained with a SYBR Gold gel stain (Molecular Probes, Eugene, OR, USA) diluted 1:10,000 in 1×TBE buffer and visualized under ultraviolet light using a charge-coupled device camera.

Results

Pathological findings

Lung tumor (1987)

The resected right upper lobe contained a 3-cm whitish, well-circumscribed tumor mass in the vicinity of a proximal segmental bronchus without infiltration of the mucosa. Microscopically, the tumor consisted of plump, oval and spindle cells densely packed, partially infiltrating the outer bronchial wall (Fig. 2A). Focally, a trabecular pattern was found. The mitotic activity was 12 mitoses per 10 high power fields. No necrosis or lymph-node metastases were found.

Bone tumor (1996 and 2001)

The incisional biopsy contained hypercellular tumor tissue consisting of closely packed plump spindle and oval cells with scant cytoplasm, indistinct cell borders, arranged in irregularly intersecting fascicles or in a haphazard fashion. There were some variably ramifying and gaping, thin-walled vascular channels with a hemagiopericytoma-like appearance. Small foci of ossification (Fig. 3A) were present. Mitotic figures were easily found. The resected proximal humerus contained a large tumor mass with a longitudinal diameter of 8 cm, destroying the cortical bone

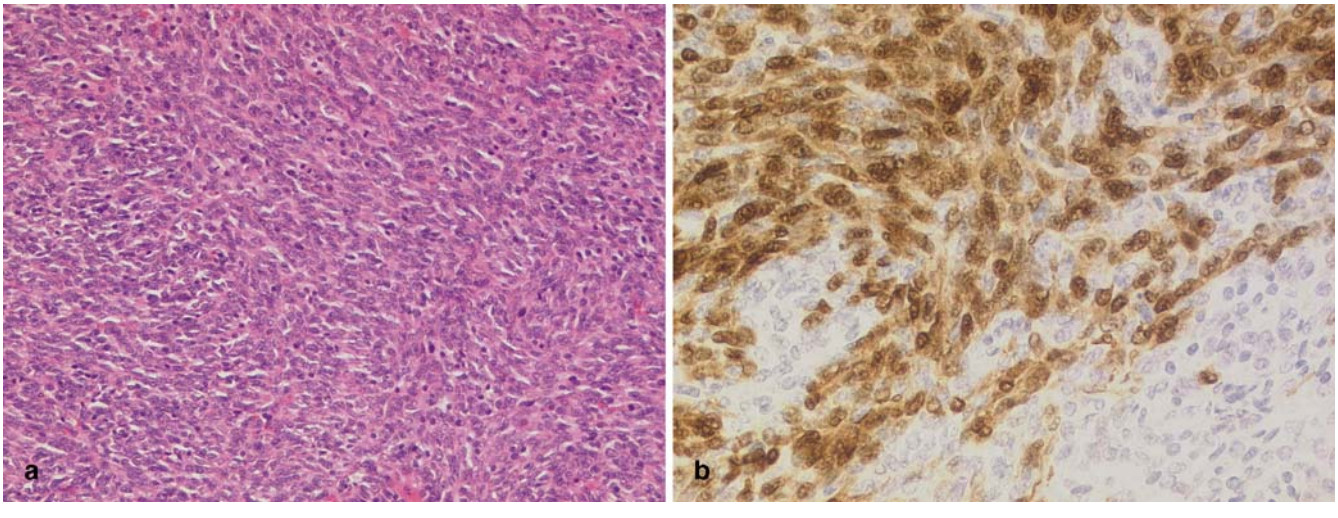

Fig. 2 Lung tumor. **A** Plump, relative monomorph spindle cells (hematoxylin and eosin ×10). **B** Intracytoplasmatic and nuclear expression of S100 protein (×20)

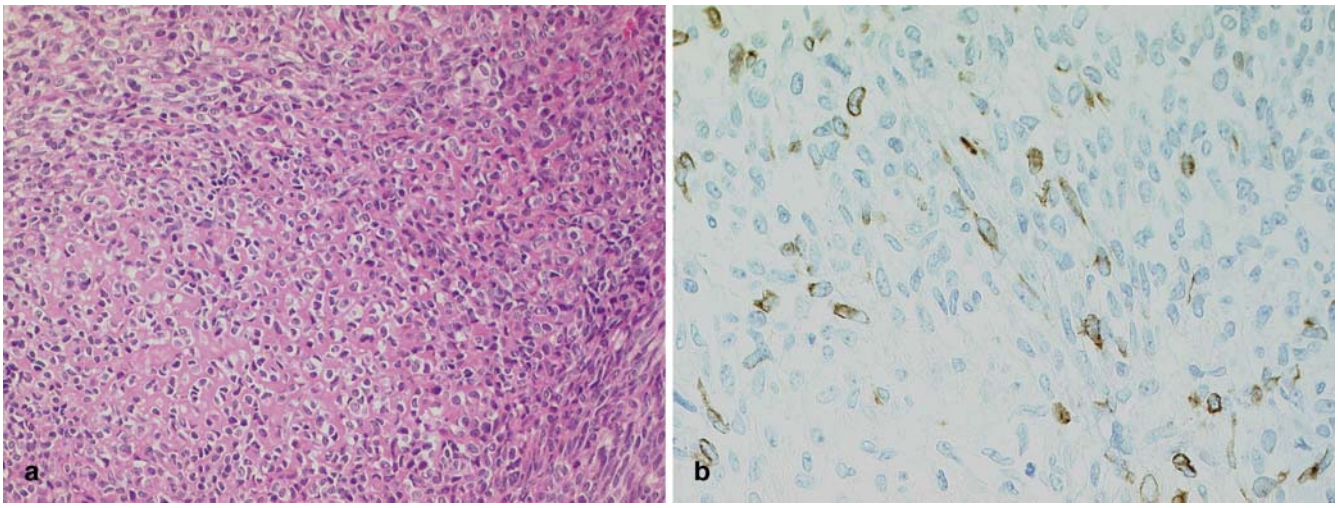

Fig. 3 Humerus tumor. **A** Spindle and oval tumor cells with focal osteoid production (hematoxylin and eosin ×200). **B** Expressin of cytokeratin by individual tumor cells (×400)

and minimally infiltrating the adjacent soft tissue. The tumor tissue was similar to the biopsy material, but areas with matrix hyalinization and slender spindle cells were more prominent. No tumor necrosis except for the biopsy site was noted. The recurrent tumor following radiotherapy was partially necrotic, showing high mitotic activity and somewhat stronger pleomorphism.

Immunohistochemistry

The lung tumor was negative for cytokeratin, EMA, synaptophysin, chromogranin and showed focal positivity for S100 (Fig. 2B). Contrary to the biopsy and resection material of the bone tumor, the recurrence showed focal positivity for cytokeratin and EMA. Focal positivity for S100 was present in all bone tumor specimen (Fig. 3B). Other markers remained negative.

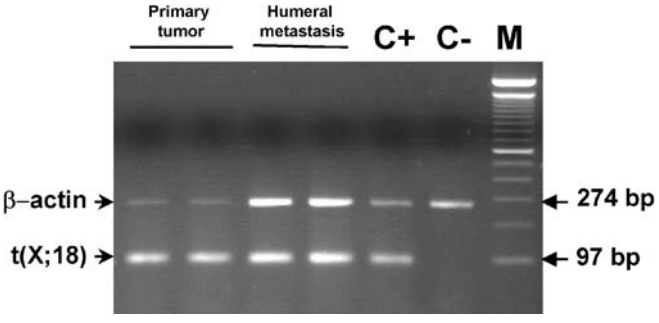

Fig. 4 Detection of the t(X;18) (SYT-SSX) translocation in the primary lung tumor (*lanes 1 and 2*), in the humeral metastasis (*lanes 3 and 4*), using reverse-transcription polymerase chain reaction (PCR). For each sample, two PCR amplifications were performed in parallel, both containing the primer set necessary for the amplification of SYT-SSX fusion gene transcripts and a set of primers for the ubiquitously expressed β-actin gene transcripts (positive control). A biphasic synovial sarcoma was used as a positive control (*lane 5*) for the t(X;18) detection. Negative control consisted of t (X;18)-negative desmoid tumor. *Lane 7* pGEM DNA size markers (Promega Madison, WI)

RT-PCR for SYT-SSX translocation

SYT-SSX fusion transcripts were detected in both primary lung tumor and humeral metastasis. Subtyping using SSCP showed that both were of SYT-SSX1 type (Fig. 4).

Discussion

The definition of synovial sarcoma has strikingly changed since its initial description in the beginning of the 20th century. Due to its commonly para-articular location, the tumor was initially falsely considered to originate from the synovial lining of joints. The most recent definition of synovial sarcoma includes the occurrence of a specific genetic abnormality [13]. After observation of the translocation between chromosome X and 18 in synovial sarcomas in 1986 [11], the fusion products of SYT-SSX with its variants -SSX1, -SSX2 and -SSX4 were described, depending on the SSX gene involved. The oncogenic potential of this gene is currently a subject of many studies [1, 10, 20, 21, 25]. The abnormalities mentioned above are specific to synovial sarcoma and are found in more than 95% of this tumor type with isolated reports on related cytogenetic abnormalities [23]. There are, at present, no convincing reports of its occurrence in other tumor types [4, 8, 14]. Thanks to the progress in molecular techniques, the detection of the fusion product is currently possible on standard pathological paraffin-embedded archive material [2, 4]. According to several reports, synovial sarcomas in unusual locations or in unusual clinical contexts have been previously diagnosed under various names, such as “classical” soft tissue fibrosarcoma for cases of monophasic fibrous synovial sarcoma [25] or embryonal sarcoma of the kidney for renal monophasic synovial sarcomas [3]. In our patient, the difficulty in classifying the lung neoplasia resulted in the diagnosis of an atypical carcinoid tumor.

We present a case where a synovial sarcoma was not considered as a diagnostic possibility either during the primary presentation in the lung or during the work-up of the solitary bone metastasis 8 years later. The examination of the local recurrence of the bone metastasis with review of all the slides and the molecular analysis of the SYT-SSX fusion product allowed the diagnosis of a primary lung synovial sarcoma. This tumor type is very rare, as the primary in the lung. Only about 50–60 cases (most of them monophasic spindle cell type and only two of the biphasic type) have been recorded in the English-language literature [5, 12, 16, 18, 22, 24]. This probably underestimates the prevalence of the disease, due to the diagnostic difficulties in differentiating among various spindle cell tumors of the lung. Many entities must be considered, namely sarcomatous carcinoma, malignant mesothelioma, spindle cell thymoma invading the lung, metastatic melanoma or—in women—metastatic malignant mixed Müllerian tumor and, of particular importance, metastatic sarcoma. Other primary sarcoma types also occurring in the lung must be taken into account, such as leiomyosarcoma, malignant peripheral nerve sheath tumor, solitary fibrous tumor, fibrosarcoma and mesenchymal chondrosarcoma. The eventual diagnosis of a spindle cell tumor of the lung depends in many cases on the results of the immunohistochemical reactions and—if the synovial sarcoma is a morphological consideration—on the molecular analysis.

Due to the small number of the described synovial sarcomas of the lung, the course of the disease is not yet fully known. There are only few reports with specific reference to the SYT-SSX translocation type [5, 16, 22, 24]. Patients with the SYT-SSX2 translocation, generally considered to have a relatively favorable outcome [17, 19], fared poorly and died within months. Most patients (including the patient described in the current study) with the SYT-SSX1 fusion product demonstrated a prolonged disease course with survival of up to 14 years, but a few died as early as at 12 months [16, 22, 24].

Synovial sarcoma in elderly patients is uncommon. Less than 10% of synovial sarcomas occur in patients over 60 years. Chan et al. [6] analyzed 32 patients older than 60 years with synovial sarcoma. They concluded that the tumors in this age group occur more often in unusual locations and have more often poorly differentiated morphology. Four of their cases were primaries of the lung, with none being metastatic at 36–48 months of follow-up.

The possibility of a primary bone synovial sarcoma presenting metachronously as lung tumor may theoretically be considered in our patient. However, the long time lag between both tumor presentations as well as the lacking clinical skeletal symptoms at the time of the lung resection make this possibility unlikely. Synovial sarcoma metastasizes predominantly hematogenously, most commonly to the lung (90–100% of the patients with metastases), followed by lymph nodes (<10%) and, in rare cases, by bone marrow [25]. At least two cases of a primary pulmonary sarcoma have been reported as metastatic to bone [16, 22]. A primary synovial sarcoma of bone is practically unknown. Hiraga [15] describes a radius tumor with morphological properties of a synovial sarcoma and the t(X;18) translocation, but there is no mention of the past medical history of the patient, and the possibility of a late metastasis (as in our case) is not excluded. The tendency of the synovial sarcoma for late metastases is well known and is mirrored in marked differences between short- and long-term survival [25]. The case of Cohen [7] probably represents a classical presentation of a synovial sarcoma in the para-articular soft tissue of the knee of a 22-year-old man with secondary infiltration of the tibia. Because no radiological or pathological documentation is included, the topography of the tumor cannot be definitively estimated.

The necessity of molecular testing in every case of a synovial sarcoma has been discussed in the recent paper of Coindre [9]. The authors conclude that this examination is not required in every case. Diagnosing synovial sarcoma in its classical biphasic form and/or classical clinical presentation does not cause any difficulty. It is, however, more problematic in its more common, monophasic spindle cell variant or poorly differentiated type. Because, in many cases, the immunohistochemistry is not sufficient, the option of molecular testing represents a helpful alternative.

In conclusion, the presented case demonstrates that for the proper understanding of the natural course of some of the rare mesenchymal tumors, very long follow-ups must be taken into account. The possibility of molecular testing for the presence and type of the t(X;18) translocation is valuable in the differential diagnosis of spindle cell malignant tumors and allows precise classification of some of them. Its role for the prognosis of the primary pulmonary synovial sarcoma remains to be established.

References

1. Allander SV, Illei PB, Chen Y, Antonescu CR, Bittner M, Ladanyi M, Meltzer PS (2002) Expression profiling of synovial sarcoma by cDNA microarrays: association of ERBB2, IGFBP2, and ELF3 with epithelial differentiation. Am J Pathol 161:1587–1595
2. Argani P, Zakowski MF, Klimstra DS, Rosai J, Ladanyi M (1998) Detection of the SYT-SSX chimeric RNA of synovial sarcoma in paraffin-embedded tissue and its application in problematic cases. Mod Pathol 11:65–71
3. Argani P, Faria PA, Epstein JI, Reuter VE, Perlman EJ, Beckwith JB, Ladanyi M (2000) Primary renal synovial sarcoma: molecular and morphologic delineation of an entity previously included among embryonal sarcomas of the kidney. Am J Surg Pathol 24:1087–1096
4. Bijwaard KE, Fetsch JF, Przygodzki R, Taubenberger JK, Lichy JH (2002) Detection of SYT-SSX fusion transcripts in archival synovial sarcomas by real-time reverse transcriptase-polymerase chain reaction. J Mol Diagn 4:59–64
5. Boroumand N, Raja V, Jones DV, Haque AK (2003) SYT-SSX2 variant of primary pulmonary synovial sarcoma with focal expression of CD117 (c-Kit) protein and a poor clinical outcome. Arch Pathol Lab Med 127:201–204
6. Chan JA, McMenamin ME, Fletcher CD (2003) Synovial sarcoma in older patients: clinicopathological analysis of 32 cases with emphasis on unusual histological features. Histopathology 43:72–83
7. Cohen IJ, Issakov J, Avigad S, Stark B, Meller I, Zaizov R, Bar-Am I (1997) Synovial sarcoma of bone delineated by spectral karyotyping. Lancet 350:1679–1680

8. Coindre JM, Hostein I, Benhattar J, Lussan C, Rivel J, Guillou L (2002) Malignant peripheral nerve sheath tumors are t(X;18)-negative sarcomas. Molecular analysis of 25 cases occurring in neurofibromatosis type 1 patients, using two different RT-PCR-based methods of detection. Mod Pathol 15:589–592
9. Coindre JM, Pelmus M, Hostein I, Lussan C, Bui BN, Guillou L (2003) Should molecular testing be required for diagnosing synovial sarcoma? A prospective study of 204 cases. Cancer 98:2700–2707
10. de Bruijn DR, dos Santos NR, Kater-Baats E, Thijssen J, van den Berk L, Stap J, Balemans M, Schepens M, Merkx G, van Kessel AG (2002) The cancer-related protein SSX2 interacts with the human homologue of a Ras-like GTPase interactor, RAB3IP, and a novel nuclear protein, SSX2IP. Genes Chromosomes Cancer 34:285–298
11. dos Santos NR, de Bruijn DR, van Kessel AG (2001) Molecular mechanisms underlying human synovial sarcoma development. Genes Chromosomes Cancer 30:1–14
12. Essary LR, Vargas SO, Fletcher CD (2002) Primary pleuro-pulmonary synovial sarcoma: reappraisal of a recently described anatomic subset. Cancer 94:459–469
13. Fisher C, de Bruijn DRH, Geurts van Kessel A (2002) Synovial sarcoma. In: Fletcher CDM, Unni KK, Mertens F (eds) WHO pathology and genetics. Tumours of soft tissue and bone. IARC Press, Lyon, pp 200–204
14. Guillou L, Coindre J, Gallagher G, Terrier P, Gebhard S, de Saint Aubain Somerhausen N, Michels J, Jundt G, Vince DR, Collin F, Trassard M, Le Doussal V, Benhattar J (2001) Detection of the synovial sarcoma translocation t(X;18) (SYT-SSX) in paraffin-embedded tissues using reverse transcriptase-polymerase chain reaction: a reliable and powerful diagnostic tool for pathologists. A molecular analysis of 221 mesenchymal tumors fixed in different fixatives. Hum Pathol 32:105–112
15. Hiraga H, Nojima T, Isu K, Yamashiro K, Yamawaki S, Nagashima K (1999) Histological and molecular evidence of synovial sarcoma of bone. A case report. J Bone Joint Surg Am 81:558–563
16. Hisaoka M, Hashimoto H, Iwamasa T, Ishikawa K, Aoki T (1999) Primary synovial sarcoma of the lung: report of two cases confirmed by molecular detection of SYT-SSX fusion gene transcripts. Histopathology 34:205–210
17. Kawai A, Woodruff J, Healey JH, Brennan MF, Antonescu CR, Ladanyi M (1998) SYT-SSX gene fusion as a determinant of morphology and prognosis in synovial sarcoma. N Engl J Med 338:153–160
18. Kuhnen C, Mentzel T, Haas V (1999) [Primary synovial sarcoma of the lung.] Pathologe 20:130–134
19. Ladanyi M, Antonescu CR, Leung DH, Woodruff JM, Kawai A, Healey JH, Brennan MF, Bridge JA, Neff JR, Barr FG, Goldsmith JD, Brooks JS, Goldblum JR, Ali SZ, Shipley J, Cooper CS, Fisher C, Skytting B, Larsson O (2002) Impact of SYT-SSX fusion type on the clinical behavior of synovial sarcoma: a multi-institutional retrospective study of 243 patients. Cancer Res 62:135–140
20. Morimoto Y, Ouchida M, Ozaki T, Kawai A, Ito T, Yoshida A, Inoue H, Shimizu K (2003) Splicing isoform of SYT-SSX fusion protein accelerates transcriptional activity and cell proliferation. Cancer Lett 199:35–43
21. Nielsen TO, Hsu FD, O'Connell JX, Gilks CB, Sorensen PH, Linn S, West RB, Liu CL, Botstein D, Brown PO, van de Rijn M (2003) Tissue microarray validation of epidermal growth factor receptor and SALL2 in synovial sarcoma with comparison to tumors of similar histology. Am J Pathol 163:1449–1456
22. Okamoto S, Hisaoka M, Daa T, Hatakeyama K, Iwamasa T, Hashimoto H (2004) Primary pulmonary synovial sarcoma: a clinicopathologic, immunohistochemical, and molecular study of 11 cases. Hum Pathol 35:850–856
23. Storlazzi CT, Mertens F, Mandahl N, Gisselsson D, Isaksson M, Gustafson P, Domanski HA, Panagopoulos I (2003) A novel fusion gene, SS18L1/SSX1, in synovial sarcoma. Genes Chromosomes Cancer 37:195–200
24. Terasaki H, Niki T, Hasegawa T, Yamada T, Suzuki K, Kusumoto M, Fujimoto K, Hayabuchi N, Matsuno Y, Shimoda T (2001) Primary synovial sarcoma of the lung: a case report confirmed by molecular detection of SYT-SSX fusion gene transcripts. Jpn J Clin Oncol 31:212–216
25. Weiss SW, Goldblum JR (2001) Malignant soft tissue tumors of uncertain type. In: Enzinger and Weiss's soft tissue tumors, 4th edn. Mosby, St. Louis, pp 1483–1571