

Solitary fibrous tumor of the pleura: a review

H. Trihia¹, Ch. Valavanis¹, N. Baltayiannis²

Departments of ¹Pathology and ²Thoracic Surgery, Metaxa Cancer Hospital, Piraeus, Greece

Summary

Solitary fibrous tumor (SFT) of the pleura is a rare neoplasm that arises most commonly within the visceral pleura but may evolve from the parietal pleura of the chest, mediastinum or diaphragm.

These tumors are most commonly diagnosed in the 6th to 7th decade of life with equal rates of occurrence for both sexes.

In this review we discuss the clinical, radiographic and histological features, the diagnosis and differential diagnosis, prognostic factors and therapy of these rare tumors.

Key words: benign tumor of the pleura, diagnosis, localized fibrous tumor of the pleura, prognosis, solitary fibrous tumor of the pleura, treatment

Introduction

SFTs of the pleura are uncommon, slowly growing, primary neoplasms of the pleura, unrelated to asbestos exposure, thought to arise from submesothelial primitive mesenchymal cells (facultative fibroblasts) [1]. They represent less than 5% of all neoplasms involving the pleura [2]. The peak age of incidence is the 6th decade of life and 80% of these lesions arise in the visceral pleura. They occur as neoplasms in the sub-visceral-subpleural zone of the lung, within the pleural space, attached to the pleura (usually the visceral) by a small pedicle, or intrapulmonary [3].

The terms fibrous mesothelioma, benign mesothelioma, localised mesothelioma, subpleural mesothelioma and subpleural fibroma have also been used

for their characterisation, reflecting the controversies over their histogenesis, as both mesothelial and mesenchymal differentiation have been postulated over the years [4-12].

SFT of the pleura has been recognized as an entity for over half a century and during this time it has intrigued pathologists because of its distinctive microscopic appearance and controversial histogenesis [13].

New immunohistochemical markers, as well as the establishment of histologically similar tumors in extraserosal sites including the peritoneum, retroperitoneum, mediastinum, the orbit, the nasal cavity, paranasal sinuses, nasopharynx, liver, epiglottis as well as soft tissues, capsule of the kidney, thyroid gland, upper respiratory tract, salivary glands, mesentery and spinal cord, have contributed to a better understanding of the true nature of the tumor [14-24].

The histological diagnosis of a benign STF is straightforward in the appropriate clinical setting and in the presence of the typical "patternless" proliferation of spindle cells. SFT is often misdiagnosed, due to the variability of growth patterns, such as neurofibroma-like, leiomyoma-like and hemangiopericytic that complicate the diagnostic process. In addition, the rarity of SFT accounts for the difficulty of its diagnosis in extrapleural locations. The malignant SFTs are contrasted to sarcomatoid mesotheliomas and sarcomas [25].

Received 10-08-2003; Accepted 27-08-2003

Author and address for correspondence:

Nikolaos Baltayiannis, MD
14 Sokratous street
174 55 Alimos
Athens
Greece
Tel: +30 210 9885779
Fax: +30 210 9883740
E-mail: baltayiannis@yahoo.gr

Histogenesis

Although cases with morphologic similarities to SFT have been documented in earlier literature, it was the 1931 report of 5 cases by Klemperer and Rabin that focused attention on the lesion, and from that time on, it has been recognized as a distinct entity. These authors divided pleural neoplasms into diffuse and localized forms. They postulated that diffuse neoplasms arose from a multipotential mesothelial cell and the localized form from subpleural mesenchymal cells [10].

In 1942, Stout and Murray and later Sano et al. postulated a mesothelial origin for the localized form [26,27]. Although ultrastructural studies of SFT have demonstrated features of mesothelial differentiation, other investigations have shown only primitive mesenchymal fibroblastic cells, without evidence of mesothelial differentiation.

In 1994, studies provided support for the idea that SFT is not derived from, or related to conventional mesothelium [1-3]. Nearly 80% of SFTs were shown to strongly express CD-34 and none keratin, in the published studies [28-30]. Vimentin was almost equally expressed in benign as well as in malignant SFTs. In contrast, 90% of mesotheliomas expressed vimentin and keratin, but none contained CD-34 -positive cells [30]. The expression of CD-34 to the same degree in SFTs in other sites served as an independent means of confirming the idea that similar tumors in diverse sites shared a sufficient number of morphologic similarities to consider them a common entity [29].

There seems to be an emerging consensus that the SFT arises from a submesothelial cell, that has been variably regarded by Bolen et al. as a primitive fibroblast or mesenchymal cell [31], or by Graighead as a primitive multipotential cell [32]. Other evidence that supports this postulate is the observation by Raftery that mesothelium may originate from submesothelial connective tissue after injury [33]. Skin and Firminger [34] postulated that both surface mesothelial cells and submesothelial connective tissue cells may have a role in the histogenesis of mesothelioma. The expression of CD-34 does not provide evidence as to the exact line of differentiation for the SFT because it does not appear to be lineage-specific. However, some investigators postulate that CD-34 may define cell populations able to serve as precursors or progenitors, independently of site or line of differentiation [35]. Although originally described as a hematopoietic progenitor cell antigen, the transmembrane glycoprotein has been localized to an increasing number of different tissues, including endothelium, peri-

follicular hair shaft cells and a subset of perineural cells [36]. A number of mesenchymal tumors, including dermatofibrosarcoma and some benign nerve sheath tumors also are immunoreactive with CD-34 [35]. CD-34 appears to be an empirically useful antigen to discriminate SFT from desmoplastic mesothelioma, two lesions that could cause diagnostic problems, especially in the context of limited biopsy material [30].

Clinical and radiological features

Localized pleural tumors present as circumscribed masses and often appear to follow a benign course. They are rare, the incidence being only 2.8 cases per 100,000 registrations at the Mayo Clinic [37]. The majority arise from visceral pleura and many project into the pleural cavity as pedunculated masses. A small number of tumors (approximately 3.5%) may be mainly, or entirely intrapulmonary [5,38].

The age range is 5 to 87 years, with peak incidence in the 6th and 7th decades of life [4,39].

The sexes are equally affected, with a slight female preponderance, irrespective of whether the tumor is benign or malignant.

As many as 50% of patients have been asymptomatic at the time of diagnosis, the tumors having been discovered on chest X-ray as incidental coin lesions (Figures 1-3) [4,40,41]. In symptomatic patients chronic cough, dyspnea and ipsilateral chest discomfort, osteoarthropathy and finger clubbing appear to be the most frequent complaints [42]. Ipsilateral pleural effusion, occasionally blood-stained, has been described in association with larger or malignant tumors



Figure 1. Chest radiograph shows mass in the left hemithorax (all of the following figures come from the same patient).



Figure 2. Chest CT scan shows 8 cm mass arising from the pleura.

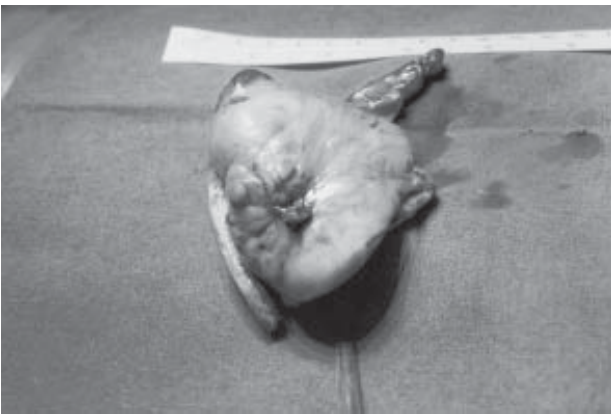


Figure 3. Operative specimen of solitary fibrous tumor of the pleura.

and compression of the inferior vena cava with ascites and leg edema have been mentioned in rare cases. Another interesting manifestation is hypoglycaemia, a complication that occurs in about 5% of patients, mostly in women in association with larger or malignant tumors, due to secretion of insulin-like growth factor II [43,44].

Gross findings

Tumor weights range between 4 and 4,500 g and maximum diameters between 2.5 and 25.0 cm [45]. The tumors typically appear round or oval, well circumscribed, with a smooth covering of visceral pleura. Bosselation and prominent superficial blood vessels are sometimes noted. The cut surface shows a firm, well-circumscribed, white or gray, whorled appearance, reminiscent of leiomyoma (Figure 4). Tiny areas of hemorrhage, softening or cystic change are occasionally seen. Malignant tumors are grossly poorly circumscribed and have an infiltrative growth pattern [46].



Figure 4. Section from the periphery of the tumor. Note the smooth border of the tumor (H&E $\times 100$).

Microscopic findings

SFT is a spindle cell fibrous and myofibroblastic proliferation in which the cells are not arranged in consistent patterns. Histologically, there is a marked variation in the appearance of these tumors. Collagenized (Figure 5), hemangiopericytoma-like (Figure 6), and fibrocellular areas (Figures 7,8) are the main forms of growth pattern observed [28]. Many tumors show a mixture of two or more of these patterns. The fibrocellular areas consist of bland-looking spindle or oval-shaped cells with indistinct cytoplasm, arranged in short fascicles, non-descript, haphazard, loose or focal storiform or hemangiopericytomatous pattern. In collagenised areas, bundles of dense hyalinized collagen are disposed in whorls, basket weave and other complex patterns (Figure 2). The cellularity of the latter areas varies greatly and hypercellular areas alternate with paucicellular regions (Figure 9).

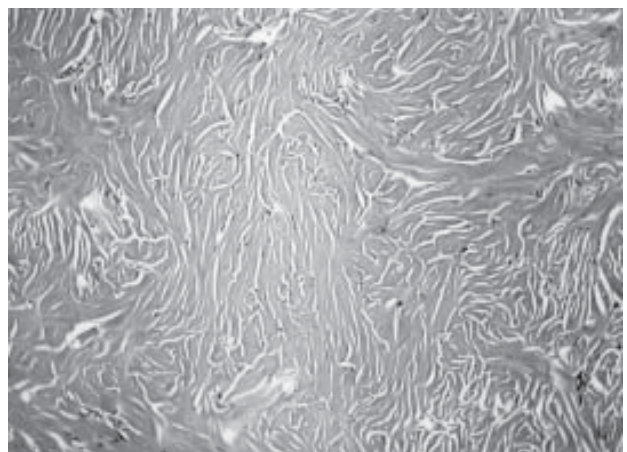


Figure 5. Bundles of dense hyalinized collagen are disposed in whorls (H&E $\times 200$).

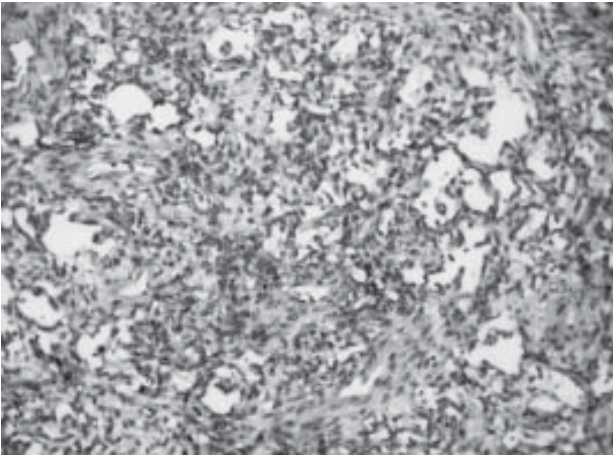


Figure 6. Hemangiopericytomatous area of the tumor (H&E $\times 200$).

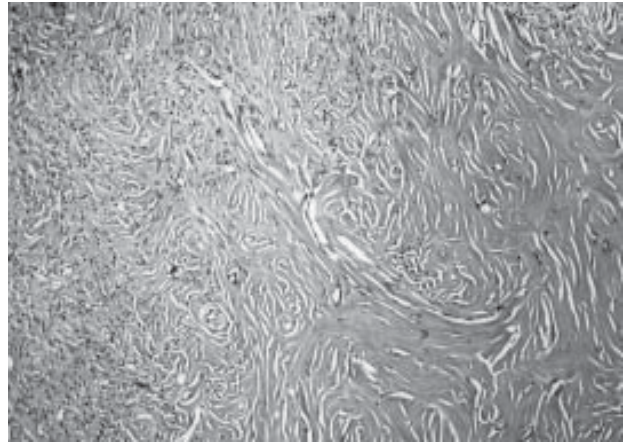


Figure 9. Bundles of dense hyalinized collagen are disposed in whorls. Note merging with fibrocellular area on the left (H&E $\times 200$).

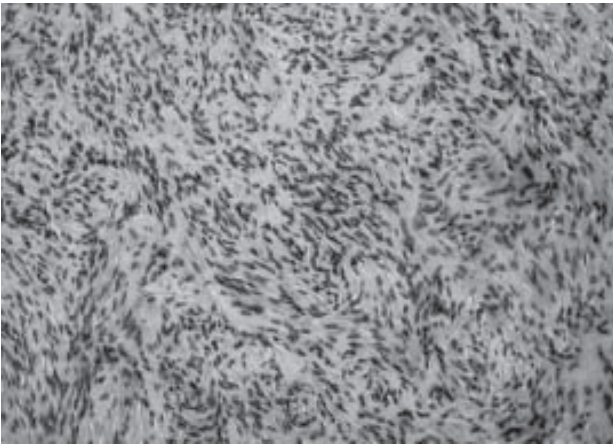


Figure 7. Storiform-hering-bone pattern in fibrocellular area of the tumor (H&E $\times 200$).

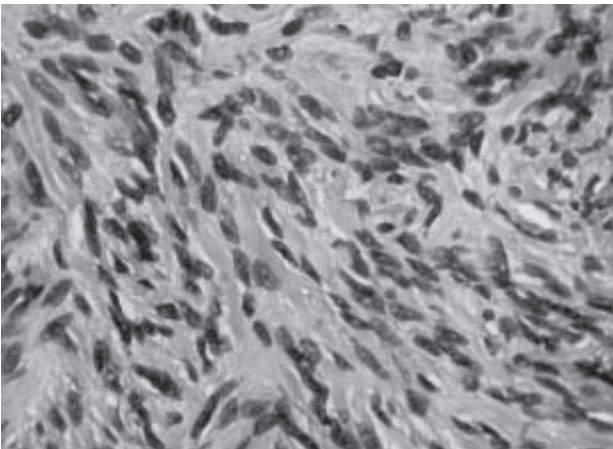


Figure 8. Higher magnification from fibrocellular area of the tumor. Note the presence of nuclear atypia but the absence of mitotic activity (H&E $\times 400$).

Often, thin bands of collagen are separated by fibroblastic nuclei (Figure 10). This distinctive pattern of collagen formation serves as a hallmark of the lesion.

Areas similar to those seen in hemangiopericytomas are composed of numerous rounded or branching vascular spaces with variable numbers of compact round or fusiform cells in the intervening tissue. Frequently, the vessels are encircled by a collar of loose, faintly staining tissue. The vessels may be hyalinized, plexiform, or pericytic, sometimes with a condensation of cells around gaping vessels. Vascular parts show a gradual merging into fibrous or cellular areas, but seldom the tumor appears to be entirely hemangiopericytomatous in character. Cytologic atypia and necrosis are typically absent and mitoses are rare (usually less than 4 per 10 hpf). Foci of degener-

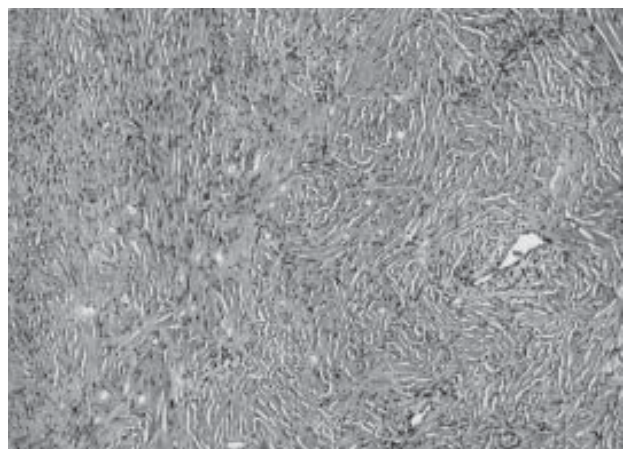


Figure 10. Neoplastic cells are scattered among bundles of collagen in hypocellular area of the tumor. Note numerous blood vessels present (H&E $\times 200$).

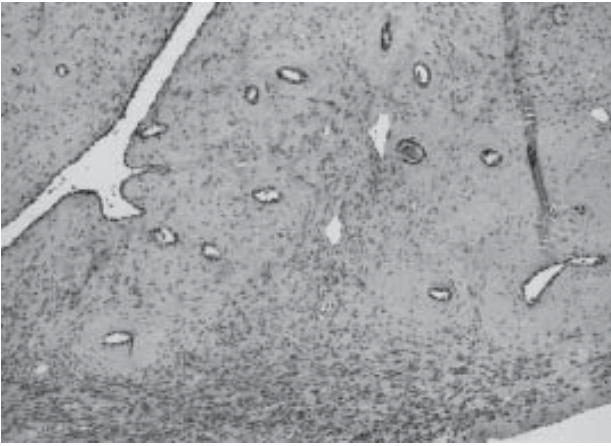


Figure 11. Cleft-like space on the left and tangentially cut tubular elements lined by cuboidal epithelium deep into the tumor substance at the periphery of the neoplasm (H&E $\times 100$).

ation and cystic change may be present, especially in larger lesions, as well as foci of calcification [38].

Irrespective of histological type, the pleura overlying or investing these tumors shows fibrous thickening. In those tumors related to visceral pleura, the boundary between the tumor and the lung substance is sharply demarcated but non-encapsulated. In many cases, some part of the pulmonary aspect of the tumor is covered by a single layer of cuboidal or low columnar epithelium and not infrequently irregular cleft-like spaces lined by the epithelium are seen to dip into the substance of the growth. Such ingrowths, cut transversely, seem to account for the finding of isolated tubular elements in the substance of the tumor close to the junction with the lung parenchyma (Figure 11). Occasionally, direct continuity between the epithelium lined clefts and adjacent bronchioloalveolar epithelium can be seen, which represents inclusions and not part of the neoplastic process [41].

Although most SFTs of the pleura are benign, they may recur (16% of the cases), or behave in a malignant fashion (12% of the cases) [4]. The best indicator of malignancy is the gross appearance suggesting infiltration into surrounding structures. It has been claimed that tumors arisen from the parietal pleura, fissure or mediastinum, or inverted into the lung tissue, are more likely to be malignant [4].

In malignant tumors, malignancy has been documented on synchronous liver metastases, invasion into the lung and chest wall. The malignant variants of SFTs show features of hemangiopericytoma, fibrosarcoma and malignant fibrous histiocytoma and the criteria followed are similar to their soft tissue counterparts [47]. Malignant tumors are characterised by high cellularity, extensive necrosis, increased mitotic

activity (equal or more than 4 mitoses per 10 hpf) and nuclear pleomorphism [12]. It has been claimed that histologic features of malignancy, such as nuclear pleomorphism and high mitotic activity, are not necessarily poor prognostic indicators. England et al. [12] found that the above mentioned features were significant, but the best prognostic indicator, regardless of the histologic features was the complete surgical resection of the tumor.

Special studies

100% of SFTs of the pleura express vimentin and are uniformly negative for keratin. About 75-80% express CD-34 (Figures 12,13), a slightly greater percentage express the anti-apoptotic protein bcl-2 [48] and at least half are CD-99-positive [29,40,46,49]. SFTs do not stain for keratin or epithelial membrane

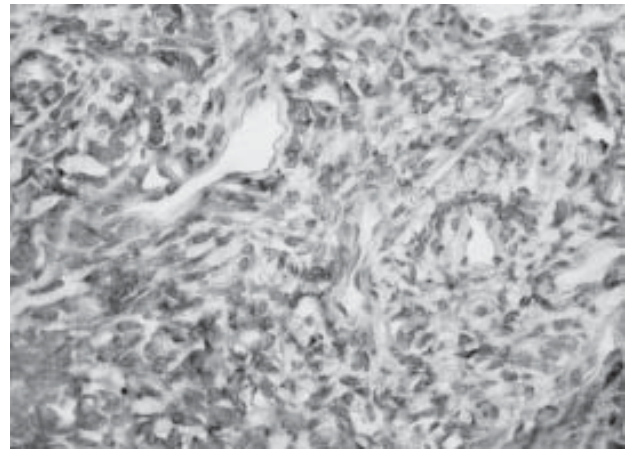


Figure 12. Hemangiopericytomatous area of the tumor stained positively for CD-34 (IHC $\times 200$).

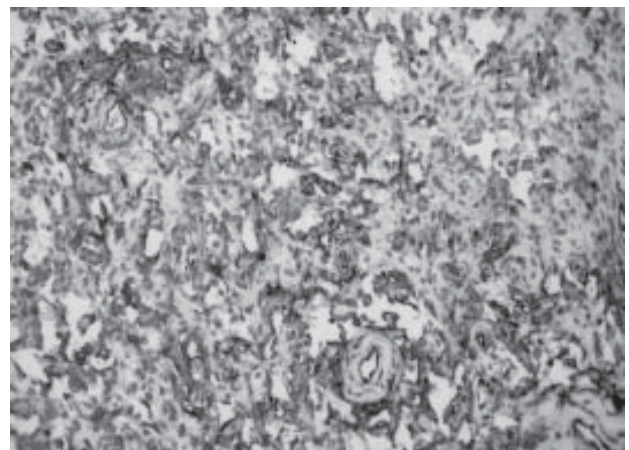


Figure 13. Hemangiopericytomatous area of the tumor. Note the presence of the CD-34 positive endothelial cells (IHC $\times 200$).

antigen, and are usually actin and desmin- negative. SFTs have not been found to express S-100 protein but a few cases of extrapleural cases have been reported to be positively expressed.

Benign forms of the tumor show low Ki-67 expression, in contrast with the malignant forms that show a mean score of 30% [50].

p53 is also expressed in malignant forms of SFTs of the pleura [51].

Ultrastructurally, the cells have features of myofibroblasts.

Cytological features

As with other tumors, fine needle aspiration biopsy (FNAB) can be helpful in the evaluation of SFT. Features of SFT can be detected and have been described in FNAB specimens [52,53]. Well circumscribed tumors of the pleura yielding smears composed of spindle cells, vessels and small clusters of epithelioid cells should raise the suspicion of SFT. The presence of transitional forms between epithelioid and spindle cells is a feature useful for diagnosis. CD-34 staining of the smears can be of help in confirming the suspected diagnosis, although should be interpreted with caution because of its positive expression in a variety of soft tissue neoplasms.

Differential diagnosis

When SFT of the pleura forms a polypoid mass protruding from the serosal surface into the pleural cavity, diagnostic evaluation can be reached, or at least suggested by FNAB, with the concomitant use of cell blocks [54].

Diagnostic problems are invariably raised in cases of a sessile tumor, intrapulmonary or chest wall location, in the presence of atypia, or due to the variability of histological patterns observed in benign and malignant forms of the tumor [55].

First of all, when the histological sections include sparse cells within a collagenous stroma, an inflammatory process, such as inflammatory pseudotumor and pulmonary hyalinizing granuloma should be ruled out. The former are true especially in intrapulmonary location of the tumor. Likewise, hamartomas should be excluded in cases of intrapulmonary location.

Extensive tissue sampling is mandatory, because inflammatory and reactive fibroblasts are invariably present, dominating the histologic picture and obscuring the neoplastic nature of the lesion. The stratifica-

tion, generally seen in pleuritis, does not rule out the coexistence of a tumor, but the reactive fibroblasts do not show significant atypia.

Furthermore, size and cellularity are the best guide to the behavior of localised tumors. Because of the variation in cellularity and mitotic activity observed in different parts of these tumors, the importance of adequate sampling in relation to the assessment of the malignant potential should be emphasized [38].

In cases of a benign SFT of the pleura, the differential diagnosis includes a variety of benign tumors, such as hemangiopericytoma, leiomyoma, schwannoma and neurofibroma [53].

Hemangiopericytoma is not only CD-34- but also CD-31-positive, whereas SFT is CD-31-negative in the spindle cell component. In fact, hemangiopericytoma and SFT are related, either in the same tumor or in different parts of the same tumor spectrum, and distinction between the two is probably not important. What is important is to realize that the same histologic features predict malignant potential in both tumors.

Leiomyoma, schwannoma and neurofibroma can be ruled out by the presence of desmin intermediate filaments in the former and S-100 protein in the latter ones. In contrast to smooth muscle tumors, the staining for smooth muscle actin and desmin, when it occurs in SFT of the pleura, is invariably focal and limited to a few cells.

In cases of malignant forms of the tumor a great number of different neoplasms enter the differential diagnosis, including sarcomatous mesothelioma, monophasic synovial sarcoma, fibrosarcoma, malignant fibrous histiocytoma (MFH), malignant hemangiopericytoma, angiosarcoma and Kaposi's sarcoma [53]. In cases of sarcomatous mesotheliomas, the neoplasms can be distinguished on the basis of their reactivity for keratin and vimentin and negative staining for CD-34 and bcl-2. Spindle cells in synovial sarcoma have a poorly defined cytoplasm, plumper nuclei and usually more of a fascicular pattern than those of a SFT, but these are minor and inconsistent differences and even ultrastructurally the two tumors may be indistinguishable. Immunohistochemical studies can be of more help, as synovial sarcomas stain positively for cytokeratin and epithelial membrane antigen, whereas SFT is only CD-34 positive. Molecular genetic analysis is the best method in distinguishing synovial sarcomas from SFTs. Synovial sarcoma is characterized by the presence of the SYT-SSX1 fusion gene due to the chromosomal translocation t(x; 18)(p11.2-q11.2), easily identified by FISH, PCR or RT-PCR. This fusion gene is not present in SFTs [56,57].

The last 3 entities are usually positive for CD-

34, but unlike in SFT, CD-31 is also positive. Fibrosarcoma and MFH are negative for CD-34.

A peripheral lung carcinoma can closely simulate a pleural tumor. The remote possibility of metastasis from a distant site, such as a sarcomatoid renal cell carcinoma involving the peripheral lung or chest wall should also be kept in mind.

Treatment and prognosis

SFT of the pleura is usually a benign tumor. Nevertheless, a histologically bland-looking tumor can recur [58], so thus resectability remains the single most important prognostic factor determining the clinical outcome. Complete resection of the tumor is the treatment of choice and when the tumor is sessile, wide resection of the involved lung or chest wall adjacent to the tumor is desirable. Some benign tumors may require a segmental resection, or even lobectomy. More radical surgery is necessary for infiltrating malignant tumors, where there is a significant incidence of recurrence and metastasis [59].

Postoperative radiotherapy, chemotherapy, or both have sporadically been used, but the benefits remain unproven [60].

Because local recurrence, after apparent complete resection, has been reported as late as 17 years from the time of surgery, long term follow-up with annual chest roentgenograms is advisable [59,60].

Conclusion

The term mesothelioma should be excluded in describing SFTs, as to avoid misinterpretation in relation to epidemiological and therapeutic considerations.

Over 80% of the tumors are benign and more than 50% are asymptomatic.

The knowledge of the entity, its clinical presentation and morphology can allow its preoperative recognition, at least in its typical form. Otherwise, thoracotomy is necessary for the final diagnosis. Thoracoscopy may be sufficient for small lesions.

Well defined immunohistochemical markers can be used for its final diagnosis.

Histologically malignant tumors, broad-based or locally invasive bear a high risk of recurrence, even after a complete resection.

Long-term follow-up is mandatory in benign and malignant forms of the tumor.

The role of adjuvant therapy remains to be defined.

References

1. Ferretti GR, Chilew C, Choplin RH, Coulomb M. Localized benign fibrous tumors of the pleura. *AJR* 1997; 169: 683-686.
2. Theros EG, Feigin DS. Pleural tumors and pulmonary tumors: differential diagnosis. *Semin Roentgenol* 1997; 12: 239-247.
3. Moran C, Suster S, Koss M. The spectrum of histologic growth patterns in benign and malignant fibrous tumors of the pleura. *Semin Diagn Pathol* 1992; 9: 169-180.
4. Briselli M, Mark EJ, Dickersin R. Solitary fibrous tumors of the pleura: Eight new cases and review of 360 cases in the literature. *Cancer* 1981; 47: 2678-2689.
5. Stout AP, Murray MR. Localised pleural mesothelioma. *Arch Pathol* 1942; 34: 951-964.
6. Foster EA, Ackerman LV. Localised mesotheliomas of the pleura: The pathologic evaluation of 18 cases. *Am J Clin Pathol* 1960; 34: 349-364.
7. Osamura RY. Ultrastructure of localised fibrous mesothelioma of the pleura: report of a case with histogenetic considerations. *Cancer* 1977; 39: 139-142.
8. Bolen JW, Thorning D. Mesotheliomas. A light and electron microscopical study concerning histogenetic relationships between the epithelial and mesenchymal variants. *Am J Surg Pathol* 1980; 4: 451-464.
9. Hernandez FJ, Fernandez BB. Localised fibrous tumors of the pleura: a light and electron microscopic study. *Cancer* 1974; 34: 1667-1674.
10. Klemperer P, Rabin CB. Primary neoplasms of the pleura: A report of five cases. *Arch Pathol* 1931; 111: 385-412.
11. Kawai TK, Mikata A, Toricata C et al. Solitary (localised) pleural mesothelioma. *Am J Surg Pathol* 1978; 2: 365-375.
12. England D, Hochholzer L, McCathy M. Localized benign and malignant fibrous tumors of the pleura. A clinicopathological review of 223 cases. *Am J Surg Pathol* 1989; 13: 47-50.
13. Qua JC, Rao UN, Takita H. Malignant pleural mesothelioma: a clinicopathological study. *J Surg Oncol* 1993; 54 : 47-50.
14. Truong M, Munden RF, Kemp BL. Localized fibrous tumor of the pleura. *AJR* 2000; 174 : 42-43.
15. Safneck JR, Alguacil-Garcia A, Dort JC et al. Solitary fibrous tumour: report of two new locations in the upper respiratory tract. *J Laryngol Otolaryngol* 1993; 107: 252-256.
16. Witkin GB, Rosai J. Solitary fibrous tumor of the upper respiratory tract. *Am J Surg Pathol* 1991; 15: 842-848.
17. Kim H, Damjanov I. Localized fibrous mesothelioma of the liver: report of a giant tumor studied by light and electron microscopy. *Cancer* 1983; 52: 1662-1665.
18. Young RH, Clement PB, McCaughey E. Solitary fibrous tumors ('fibrous mesotheliomas') of the peritoneum. *Arch Pathol Lab Med* 1990; 114: 493-495.
19. Alston SR, Francel PC, Jane JA. Solitary fibrous tumor of the spinal cord. *Am J Surg Pathol* 1997; 21: 477-483.
20. Batsakis JG, Hybels RD, El-Naggar AK. Pathology consultation: solitary fibrous tumor. *Ann Otol Laryngol* 1993; 102: 74-76.
21. Cameselle-Teijeiro J, Varela-Duran J, Fonseca E, Villanueva JP, Sobrinho-Simoes M. Solitary fibrous tumor of the thyroid. *Am J Clin Pathol* 1994; 101: 535-538.
22. Gelb AB, Simmons ML, Weidner N. Solitary fibrous tumor involving the renal capsule. *Am J Surg Pathol* 1996; 20: 1288-1295.
23. Gunhan O, Yildiz FR, Gelasun B, Onder T, Finci R. Solitary

- fibrous tumor arising from the sublingual gland: report of a case. *J Laryngol Otol* 1994; 108: 998-1000.
24. Kolhatkar MK, Desmukh SD, Kulkarni VB, Das RN, Desmukh NG. Solitary fibrous mesothelioma of the mesentery. *Histopathology* 1979; 16: 66-69.
 25. Sainfuddin A, DaCosta P, Chalmers AG, Carey BM, Robertson RJH. Primary malignant localized fibrous tumors of the pleura: clinical radiological and pathological features. *Clin Radiol* 1992; 45: 13-17.
 26. Stout AP, Murray MR. Localized pleural mesothelioma: investigation of its characteristics and histogenesis by the method of tissue culture. *Arch Pathol* 1942; 34: 951-964.
 27. Sano ME, Weiss E, Gault ES. Pleural mesothelioma. Further evidence of its histogenesis. *J Thorac Surg* 1960; 19: 783-788.
 28. Renshaw AA, Pinkus GS, Corson JM. CD34 and AE1/IE3 aid in distinguishing solitary fibrous tumor of the pleura from sarcomatoid mesothelioma. *Mod Pathol* 1994; 7: 154A (abstr).
 29. Van de Rijn M, Lombard CM, Rouse RV. Expression of CD-34 by solitary fibrous tumors of the pleura, mediastinum and lung. *Am J Surg Pathol* 1994; 18: 814-820.
 30. Flint A, Weiss SW. CD-34 and keratin expression distinguishes solitary fibrous tumor (fibrous mesothelioma) of pleura from desmoplastic mesothelioma. *Hum Pathol* 1995; 26: 428-431.
 31. Bolen JW, Hammar SP, McNutt MA. Reactive and neoplastic serosal tissue: a light-microscope, ultrastructural and immunocytochemical study. *Am J Surg Pathol* 1986; 10: 34-47.
 32. Craighead JE. Current pathogenetic concepts of diffuse malignant mesothelioma: progress in pathology. *Hum Pathol* 1987; 18: 544-557.
 33. Raftery AF. Regeneration of parietal and visceral peritoneum: An electron microscopical study. *J Anat* 1973; 115: 375.
 34. Skin ML, Firminger HI. Acute and chronic effects of intraperitoneal injection of two types of asbestos in rats with a study of the histopathogenesis of ultrastructure of resulting mesotheliomas. *Am J Pathol* 1973; 70: 291-314.
 35. Weiss SW, Nickoloff BJ. CD-34 is expressed by a distinctive cell population in peripheral nerve, nerve sheath tumors, and related lesions. *Am J Surg Pathol* 1982; 6: 215-222.
 36. Nickoloff BJ. The human progenitor cell antigen (CD-34) is localized on endothelial cells, dermal dendritic cells, and perifollicular cells in formalin-fixed normal skin, and on proliferating endothelial cells and stromal spindle-shaped cells in Kaposi's sarcoma. *Arch Dermatol* 1991; 127: 523-529.
 37. Okike N, Bernatz PE, Woolner LB. Localized mesothelioma of the pleura: benign and malignant variants. *J Thorac Cardiovasc Surg* 1978; 75: 363-372.
 38. Dalton WT, Zolliker T, McCaughey WTE, Jacques J, Kannerstein M. Localized primary tumors of the pleura. *Cancer* 1979; 44: 1465-1475.
 39. Uzoaru I, Chou P, Reyes-Mugica M. Malignant solitary fibrous tumor of the pleura. *Pediatr Pathol* 1994; 14: 11-18.
 40. Goodland JR, Fletcher CD. Solitary fibrous tumour arising at unusual sites: analysis of a series. *Histopathology* 1991; 19: 515-522.
 41. Yousem S, Flynn S. Intrapulmonary localized fibrous tumor: intraparenchymal so-called fibrous mesothelioma. *Am J Clin Pathol* 1988; 89: 365-369.
 42. Martens B, Bonnet P, Duquesne L. Solitary fibrous tumor of the pleura. *Acta Chir Belg* 1995; 95: 127-129.
 43. Asaoka M, Oohama J, Amano N, Kuhara N. A case of pleural tumor with hypoglycaemia. *Japan J Thorac Dis* 1994; 32: 370-372.
 44. Strow EA, Skjorten F, Aarseth LB. Solitary fibrous tumor of the pleura: An immunohistochemical, electron microscopic and culture study of a tumor producing insulin-like growth factor in a patient with hypoglycaemia. *Pathol Res Pract* 1991; 187: 109-113.
 45. Khan JH, Rahman SB, Clary-Macy C et al. Giant solitary fibrous tumor of the pleura. *Ann Thoracic Surg* 1998; 65: 1461-1464.
 46. Moran CA, Suster S, Koss MN. The spectrum of histologic growth patterns in benign and malignant fibrous tumors of the pleura. *Semin Diagn Pathol* 1992; 9: 169-180.
 47. Hanau CA, Miettinen M. Solitary fibrous tumor: Histological and immunohistochemical spectrum of benign and malignant variants presenting at different sites. *Hum Pathol* 1995; 26: 440-449.
 48. Hasegawa T, Matsuno Y, Shimoda T et al. Frequent expression of bcl-2 protein in solitary fibrous tumors. *Jpn J Clin Oncol* 1998; 28: 86-91.
 49. Westra WH, Gerald WL, Rosai J. Solitary fibrous tumor. Consistent CD34 immunoreactivity and occurrence in the orbit. *Am J Surg Pathol* 1994; 18: 992-998.
 50. Flint A, Weiss SN. CD-34 and keratin expression distinguishes solitary fibrous tumor (fibrous mesothelioma) of the pleura from desmoplastic mesothelioma. *Hum Pathol* 1995; 26: 428-431.
 51. Yokoi T, Tsuzuki T, Yatabe Y. Solitary fibrous tumor: significance of p53 and CD-34 immunoreactivity in its malignant transformation. *Histopathology* 1998; 32: 423-432.
 52. Drachenberg CB, Bourquin PM, Cohran LM et al. Fine needle aspiration biopsy of solitary fibrous tumors. Report of two cases with histologic, immunohistochemical and ultrastructural correlation. *Acta Cytol* 1998; 42: 1003-1010.
 53. Apple SK, Nieberg RK, Hirschowitz SL. Fine needle aspiration of two cases with a discussion of diagnostic pitfalls. *Acta Cytol* 1997; 42: 1528-1533.
 54. Dusenbery D, Grimes MM, Frable WJ. Fine-needle aspiration cytology of localized fibrous tumor of pleura. *Diagn Cytopathol* 1992; 8: 444-450.
 55. Colby TV, Koss MN, Travis WD. Tumors of the lower respiratory tract. In: AFIP: Atlas of Tumor Pathology (3rd series), Fascicle 13, 1994, pp 338-341.
 56. Fligman I, Lonardo F, Jhanwar SC, Gerald WL, Woodruff I, Ladanyi M. Molecular diagnosis of synovial sarcoma and characterization of a variant SYT-SSX2 fusion transcript. *Am J Pathol* 1995; 147: 1592-1599.
 57. Lusota J, Jasinski M, Debiec-Rychter M, Szadowska A, Limon J, Miettinen M. Detection of the SYT-SSX fusion transcripts in formaldehyde-fixed, paraffin-embedded tissue; a reverse transcription polymerase chain reaction amplification assay useful in the diagnosis of synovial sarcoma. *Med Pathol* 1998; 11: 626-633.
 58. Vallat-Decouvelaere A, Dry SM, Fletcher CD. Atypical and malignant solitary fibrous tumors in extra-thoracic locations: evidence of their comparability to intra-thoracic tumors. *Am J Surg Pathol* 1998; 22: 1901-1911.
 59. Ordonez NG. Localized(solitary) fibrous tumor of the pleura. *Adv Anat Pathol* 2000; 7: 327-340.
 60. De Perrot M, Kurt AM, Robert JH, Borisch B, Spiliopoulos A. Clinical behavior of solitary fibrous tumors of the pleura. *Ann Thoracic Surg* 1999; 67: 1456-1459.