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Predictors of Malignant Pathology and the Role of Trans-Thoracic Needle Biopsy in Management of Solitary Fibrous Tumors of the Pleura: A 30-Year Review of a Tertiary Care Center Patient Cohort

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Abstract

Background: Solitary fibrous tumors of the pleura (SFTP) are rare neoplasms with unpredictable behavior. Lack of unifying criteria for benign or malignant SFTP has resulted in reports of SFTP exhibiting malignant behavior years after complete surgical resection (despite benign initial diagnosis). Additionally, the role of trans-thoracic needle biopsy in initial management of SFTP is unclear. Understanding predictors of malignancy identifies patients at unacceptably high risk for non-surgical primary therapy, and for recurrence despite complete surgical resection. **Objectives:** The primary objectives were to identify clinicopathological predictors of malignancy & recurrence in SFTP. The secondary aim was to determine the role of trans-thoracic needle biopsy in the management decision algorithm of SFTP. **Methods:** Retrospective chart review was conducted (Jan. 1983-Dec. 2013) at the Ottawa Hospital for pathologically confirmed SFTP. Data were collected on biopsy-related, clinical, histopathological & immunohistochemistry (IHC) variables. Appropriate tests of statistical inference were conducted for all variables. **Results:** Pathologically confirmed SFTP was identified in 26 cases. Transthoracic needle biopsy was conducted in 22 (84.6%); with 16 (72.7%) biopsies diagnostic of SFTP with IHC; 3 (13.6%) being malignant. Primary management was surveillance in 3 and complete surgical resection in 23. Surgical pathology reported 15 (65.2%) benign and 8 (34.8%) malignant cases. Local recurrence occurred in 3 and distant recurrence in 1. Initial pathology was be-

nign in 3 (75%) with recurrence. Clinicopathologic variables analyzed did not predict recurrent disease. IHC features did not differ between malignant & benign pathology significantly. Predictors of malignant pathology included: infiltrative cellular pattern ($p = 0.042$), nuclear crowding ($p = 0.006$), tumour necrosis ($p < 0.001$) and >4 mitoses/10 high power field ($p < 0.003$). **Conclusion:** Because numerous variables analyzed did not predict recurrent disease, long-term follow-up is warranted regardless of benign or malignant initial histology. Histologic not IHC features predicted malignant pathology. Trans-thoracic needle biopsy did identify malignant SFTP; however its main use should be to differentiate SFTP from other pleural neoplasms using IHC.

Keywords

Solitary Fibrous Tumour of the Pleura, Thoracic Surgery, Thoracic Oncology

1. Introduction

Solitary fibrous tumors of the pleura (SFTP) are rare neoplasms with a difficulty predicting clinical course. Immunohistochemistry (IHC) and electron microscopy evidence reveal a mesenchymal origin for these neoplasms [1] [2]. Owing to their rarity, no prospective randomized studies exist on this topic to guide best management. The available literature on management and clinical outcomes for SFTP consists mostly of small single center retrospective case series, as well as one multicenter retrospective case series by Lococo *et al.* from 2012 [3]-[17]. Previous studies reveal that SFTP affects both females and males equally, is more common at sixth and seventh decades of life, and has not yet been reported in children [3]-[17]. They also report wide variation in initial tumor presentation, from an asymptomatic incidental finding on thoracic imaging ordered for another reason, to respiratory symptoms of dyspnea, cough, chest pain or obstructive pneumonitis. Extrathoracic paraneoplasic symptoms of digital clubbing, hypertrophic pulmonary osteoarthropathy or hypoglycemia have also been reported at presentation, with resolution following treatment.

Both pathologically malignant and benign varieties of SFTP have been reported [3]-[17]. Surgery is the accepted mainstay of treatment for both varieties of SFTP [6] [11]. Preoperative diagnostic assessment usually involves a chest X-ray, and contrast enhanced commuted tomography (CT) thorax to define pleural mass characteristics and relationship with adjacent structures. The utility of magnetic resonance imaging (MRI) of the thorax over CT thorax has not been demonstrated; the role of 18-Flurodeoxyglucose Position Emission Tomography (18-FDG-PET) scan for these tumors remains undefined; thus these studies are used selectively [18] [19].

The diagnostic utility of percutaneous transthoracic fine needle aspiration (FNA) preoperatively is also controversial in the setting of contrast enhanced CT thorax. This is because the ability of FNA to definitely rule out malignancy has not been demonstrated, and may not change the ultimate management plan of complete surgical excision [11].

Even with a pathological diagnosis of benign or malignant disease, clinical course of SFTP is extremely difficult to predict. This is because both local and distant late recurrences have been reported following complete resection of SFTP for both benign and malignant histology [6] [11] [15] [17] [20] [21] [22]. This malignant clinical behavior of local and distant recurrence reported has not been consistently associated with malignant histological features or tumor size [16] [18] [23] [24].

Despite the general acceptance in the literature of benign and malignant varieties of SFTP, there are as of yet no unifying histopathological criteria for diagnosis malignant SFTP. The initial pathologic classification to differentiate benign from malignant varieties of SFTP was originally described by England *et al.* in 1989 [24]. In this series, one of the following four morphological characteristics described criteria for malignant SFTP: high cellularity, high mitotic activity, pleomorphism and necrosis. Histopathologic diagnosis of SFTP has since been refined by the use immunohistocal markers, including CD34, vimentin, bcl-2, Ki-67 and bFGF labeling indices [25]. The association of these markers and cellular features with malignant SFTP may have prognostic significance for tumor recurrence and patient long-term survival.

Finally, possibly as a result of lack of universally accepted histopathological and radiographic diagnostic criteria of malignancy in SFTP, the role of adjuvant treatments for these is completely undefined. Both chemotherapy and radiotherapy have been reported effective in treating selected cases of SFTP [11] [15] [21] [26]. In their literature review of SFTP, de Perrot *et al.* made recommendations for adjuvant treatment on a case by case basis. They recommended adjuvant therapy based on: sessile or pedunculated SFTP appearance, and benign or malignant histological features (high cellularity with crowding and overlapping of nuclei, cellular pleomorphism, high mitotic count, necrosis, and stromal or vascular invasion) [23].

The unpredictable clinical course of benign and malignant SFTP reported in previous studies indicates that further investigation to refine and identify predictors of malignant clinical behavior is required. Integration of clinical, histopathological and immunohistochemical diagnostic resources may predict aggressive SFTP behavior and malignant pathology. By clearly identifying predictors of recurrence and malignant pathology, we may be able to better identify patients at unacceptably high risk for surveillance as primary management, and for recurrent disease despite complete surgical resection. The latter group may derive benefit from adjuvant chemotherapy and/or radiotherapy.

Thus, the primary objectives of this study were to identify clinicopathological and immunohistochemical predictors of malignancy & recurrence in SFTP over a 30-year period at the Ottawa Hospital. The secondary aim was to determine the role of transthoracic needle biopsy in the management decision algorithm of SFTP.

2. Materials and Methods

A retrospective review of all pathologically confirmed SFTP cases was conducted at the Ottawa Hospital for the period January 1983 to December 2013. Cases were identified using ICD-10 and ICD-9 medical record data codes for pleural masses. Key data on

demographic, clinical presentation, workup, primary and adjuvant management, biopsy and surgical pathology variables were collected for analysis.

Descriptive statistics for the sample, and inferential statistics for differences between patients with and without tumor recurrence, and for benign versus malignant pathology, were examined using STATA13 (StataCorp. 2013. College Station, TX: StataCorp LP). Tests utilized to assess the significance of variable association with tumor recurrence and malignant pathology included the Fisher's exact test for discrete variables, and the Student's t-test for continuous variables.

3. Results

3.1. Sample, Presentation and Follow-Up

From January 1983 to December 2013, 26 patients with SFTP were identified. There were 18 (69.2%) female and 8 (30.8%) males, with mean age of 63.6 years (range 41.6 to 83.1). Mean follow-up after initial treatment was 125.8 months (range 0.25 - 581). Baseline population demographics are summarized in Table 1. The majority of patients were asymptomatic at presentation (n = 15, 57.7%), with the pleural mass identified incidentally by plain chest X-ray conducted for an unrelated reason. Dyspnea on exertion was the most common presentation in those with symptoms. A minority of patients exhibited paraneoplastic symptoms. Further data on clinical presentation is summarized in Table 2.

3.2. Trans-Thoracic Needle Biopsy

Prior to determining initial management, a trans-thoracic needle of the pleural mass was conducted in 22 (84.6%), the majority of cases (Table 3). The biopsies were diagnostic of SFTP in 16 (72.7%), and 3 (13.6%) of these diagnosed malignant SFTP. Of the 3 diagnoses of malignant pathology on pre-management biopsy, 1 was consistent on final surgical pathology with malignant SFTP and the diagnosis was revised in the other two as benign SFTP. Of the 13 other cases where benign or malignant SFTP could not be determined conclusively, 5 additional cases were deemed of malignant potential on final surgical pathology.

3.3. Primary Management and Recurrence

Primary management was surveillance in 3 and complete surgical resection in 23 (Table 4). Preoperative evaluation in the majority included CT thorax and pulmonary function tests. PET scan, bone scan and further cardiopulmonary assessment was conducted selectively on a case by case basis. Adjuvant chemotherapy or radiotherapy was not utilized in any, however 6 (26.2%) cases were discussed at multidisciplinary thoracic cancer conference for consideration of adjuvant therapy. A total of 4 cases experienced pathologically confirmed recurrence following complete surgical resection: 3 isolated local, & 1 distant recurrence. The initial surgical pathology was reported as benign SFTP in 3 (75%) and malignant SFTP in 1 (25%). Pertinent descriptive details regarding recurrent disease are displayed in Table 5.

Table 1. Patient demographics and treatment characteristics for SFTP 30-year cohort.

Variable	n = 26
Gender n (%)	
Female	8 (69.2)
Male	8 (30.8)
Age at diagnosis, years (mean, SD)	63.6 (11.4)
Current smokern (%)	14 (53.9)
Pack/year history (mean, SD)	25.5 (17.9)
Asbestos exposuren (%)	2 (7.7)
Follow-up, months (mean, SD)	125.8 (143)
Condition last follow-up, n (%)	
Alive disease free	17 (65.4)
Alive with disease	4 (15.4)
Death other cause	3 (11.5)
Death from SFTP disease	0
Missing data	2 (7.69)
Synchronous lesion at presentation	0
Primary Managementn (%)	
Surveillance	3 (11.5)
Surgical resection	23 (88.5)
Adjuvant Initial Treatmentn (%)	
MCC discussion held	6 (26.2)
Chemotherapy	0
Radiotherapy	0
Chemoradiotherapy	0
Recurrence following complete surgical resection n (%)	
Total patients with recurrence	4 out of 23 (17.4)
Isolated local recurrence	3 out of 4 (75.0)
Distant recurrence	1 out of 4 (25.0)

MCC: Multidisciplinary Thoracic Cancer Conference. SD: Standard deviation. SFTP: Solitary fibrous tumor of the pleura.

Table 2. Symptoms and paraneoplastic syndromes at presentation for SFTP 30-year cohort.

Symptom	Total = 26 n (%)
Asymptomatic	15 (57.7)
Symptomatic	11 (42.3)
Cough	7 (26.92)
Dyspnea	8 (30.8)
Chest wall pain	4 (15.4)
Pneumonitis	1 (3.9)
Hemoptysis	1 (3.9)
Fever	0
Weight loss	0
Paraneoplastic Syndrome	**Total = 26 n (%)**
Hypoglycemia	0
Digital clubbing	1 (3.9)
Osteoarthropathy	1 (3.9)

Table 3. Pre-initial management biopsy of SFTP for 30-year cohort*.

Variable	Total n = 26 n (%)
Any needle biopsy performed before management	22 (84.6%)
Any needle biopsy diagnostic of SFTP	16 (72.7)
TT-FNA diagnostic SFTP	6 (27.3)
TT-CNB diagnostic SFTP	13 (59.1)
Any needle biopsy diagnostic of malignant SFTP	3 (13.6)
TT-FNA diagnostic malignant SFTP	1 (4.6)
TT-CNB diagnostic malignant SFTP	2 (9.1)
TT-FNA biopsy conduct:	Total n = 22
Fluroscopy-guided	11 (50)
CT-guided	1 (4.5)
Ultrasound guided	3 (13.6)
Missing conduct details	6 (27.3)
TT-CNB biopsy conduct:	Total n = 13
Fluroscopy-guided	12 (92.3)
CT-guided	1 (7.7)
Concurrent TT-FNA and TT-CNB	Total n = 13
Biopsy immediate complication	Total n = 22
Pneumothorax	1 (4.5)

*Does not include biopsies done to diagnose recurrent SFTP disease. SD: Standard deviation. SFTP: Solitary fibrous tumor of the pleura.

Table 4. Surgical management details for SFTP 30-year cohort.

Management	Total = 26 n (%)
Surveillance	3 (11.5)
Surgical resection	23 (88.5)
Complete surgical resection	23 (100)
Side of Surgery	
Right	17 (73.9)
Left	6 (26.1)
Incision	
VATS	8 (34.78)
Thoracotomy	14 (60.87)
Sternotomy	1 (4.35)
Tumor Base at Surgery	
Pedunculated	6 (26.1)
Sessile/Inverted	16 (69.6)
Missing data	1 (4.4)
Procedure	
Isolated mass excision	4 (17.4)
Wedge resection lung	17 (73.9)
Segmentectomy lung	2 (8.70)
Lobectomy lung	3 (13.0)
Extended Procedure	
Chest wall resection	0
Diaphragmatic resection	2 (8.7)
Pericardial resection	0

SFTP: Solitary fibrous tumor of the pleura. MCC: Multidisciplinary Thoracic Cancer Conference.

Table 5. Recurrence following 23 complete surgical resections of SFTP for 30-year cohort.

Variable	Total n = 23
All Recurrence Patients	4 (4.35)
Initial surgical pathology n (%)	
Benign SFTP	3 (75)
Malignant SFTP	1 (25)
Isolated local recurrence patients (n, %)	3 (75)
Time to local recurrence, months (mean, SD)*	176.5 (82.1)
Distant Metastasis Patient (n, %)	1 (25)
Time to metastasis months (mean, SD)*	87.3, 4
Sites of metastasis**	
Brain	1 (25)
Bilateral lungs	1 (25)
Primary management recurrence	
Surgical resection	3 (75)
Best supportive care	1 (25)
Adjuvant therapy for recurrent disease	
MCC discussion held	4 (100)
Chemotherapy	1 (25)
Radiotherapy	1 (25)
Chemoradiotherapy concurrent	0

*Times to local recurrence or metastasis include patients with known pathologically proven recurrence/metastasis only. **Sites of metastasis includes all sites in a single patient with progressive multiple metastatic disease. MCC: Multidisciplinary Thoracic Cancer Conference. SD: Standard deviation. SFTP: Solitary fibrous tumor of the pleura.

3.4. Prognostic Analysis

The relationship between recurrent disease and demographic, clinical, pathological and immunohistochemical variables is summarized in Table 6. In keeping with previous series, none of the variables analyzed were predictive of SFTP recurrence following complete surgical resection (including tumor size, malignant initial histology and reported immunohistochemical stains).

Inferential analysis of clinical, pathologic and immunohistochemical variables for their relationship with reported malignant pathologic potential did reveal several significant associations (Table 7). Mitoses >4/10 high power fields ($p = 0.003$), presence of tumor necrosis ($p = 0.001$), High cellularity ($p < 0.001$), presence of nuclear pleomorphosim ($p < 0.001$), nuclear crowding/overlapping ($p = 0.006$), and an infiltrative pattern of cells in relation to surrounding structures ($p = 0.042$), were all associated with SFTP of high malignant pathologic potential. The association with nuclear crowding and infiltrative cell pattern has not been reported previously. There was also a trend observed for larger mean tumor diameter to be associated with malignant pathology ($p = 0.070$), in particular, tumors >5 cm in diameter ($p = 0.074$). Immunohistochemical marker expression did not correlate with malignant pathology.

Table 6. Characteristics of 23 completely resected SFTP by recurrence status for 30-year cohort.

Variable	Total n (%)	No Recurrence N = 19 (82.6) n (%)	Recurrence N = 4 (17.4) n (%)	p-value*
Age at diagnosis, years (mean, SD)	23	63.7 (12.2)	63.4 (8.9)	0.96
Gender	23			
Male	6 (26.1)	4 (21.1)	2 (50)	0.27
Female	17 (73.9)	15 (79.0)	2 (50)	
Symptoms at diagnosis	23			
Symptomatic	11 (47.8)	9 (47.4)	2 (50)	0.67
Asymptomatic	12 (52.2)	10 (52.6)	2 (50)	
Surgical pathology reported:	23			
Benign	15 (65.2)	12 (63.2)	3 (75)	0.57
Malignant	8 (34.8)	7 (36.8)	1 (25)	
Tumor size cm (mean, SD, range)**	21	17	4	
		8.2 (6.3, 1.2 - 19)	13.3 (10.6, 3.5 - 27)	0.21
Closest margin (cm) (mean (SD, range))	8	7	1	
		0.79 (0.79, 0.013 - 0.18)	0.40 (n/a)	-
Pleural pattern	23			
Visceral	20 (87.0)	16 (84.2)	4 (100)	0.55
Parietal	3 (13.0)	3 (15.8)	0	
Tumor Base	22			
Pedunculated	15 (68.2)	13 (72.2)	2 (50)	0.38
Sessile/inverted	7 (31.8)	5 (27.8)	2 (50)	
Tumor border	23			
Poorly defined	1 (4.4)	1 (5.3)	0	0.83
Well defined	22 (95.7)	18 (94.8)	4 (100)	
Mitoses/10 HPF (mean, SD)	17	15	2	
		3.6 (7.8, 0 - 26)	1.5 (0.71, 1 - 2)	0.71
Mitoses/10 HPF	21			
<4/10 HPF	16 (76.2)	14 (77.8)	2 (66.7)	0.58
>4/10 HPF	5 (23.8)	4 (22.2)	1 (33.3)	
Tumor necrosis	19			
Absent	11 (57.9)	9 (60)	2 (50)	0.57
Present	8 (42.1)	6 (40)	2 (50)	
Tumor hemorrhage	18			
Absent	11 (61.1)	9 (64.3)	2 (50)	0.52
Present	7 (38.9)	5 (35.7)	2 (50)	
High Cellularity	21			
Absent	14 (66.7)	11 (64.7)	3 (75)	0.59
Present	7 (33.3)	6 (35.3)	1 (25)	
Nuclear Pleomorphism	17			
Absent	13 (76.5)	10 (76.9)	3 (75)	0.70
Present	4 (23.5)	3 (23.1)	1 (25)	
Nuclear Crowding	17			
Absent	14 (82.4)	11 (84.6)	3 (75)	0.58
Present	3 (17.7)	2 (15.4)	1 (25)	
Infiltration of adjacent structures	21			
Absent	18 (85.7)	15 (88.2)	3 (75)	0.49
Present	3 (14.3)	2 (11.8)	1 (25)	
Encapsulation	20			
Absent	1 (5.0)	1 (6.3)	0	0.80
Present	19 (95.0)	15 (93.8)	4 (100)	
Tumor contour	22			
Lobulated	12 (54.6)	9 (50)	3 (75)	0.37
Smooth	10 (45.5)	9 (50)	1 (25)	

*t-test for comparison of means or Fisher exact test for comparison of binary categorical variables. **Tumor size by CT Thorax or Surgical pathology. CT Thorax used for tumor size only if primary management was not surgical.

Table 7. Malignant potential IHC & histologic characteristics of resected SFTP for 30-year cohort.

Variable	Total n, (%)	Low malignant potential (Benign) n = 15 (65.2)	High malignant potential (Malignant) n = 8 (34.8)	p-value*
Age at diagnosis, years) (mean, SD)	23 62.6 (12.6)	12 65.5 (9.4)	8 0.58	
Gender	23			
Male	6 (26.1)	3 (20)	3 (37.5)	0.334
Female	17 (73.9)	12 (80)	5 (62.5)	
Symptoms at diagnosis	23			
Symptomatic	11 (47.8)	6 (40)	5 (62.5)	0.28
Asymptomatic	12 (52.2)	9 (60)	3 (37.5)	
Tumor diameter, cm (mean, SD, range)	21 9.1 (7.3, 1.2 - 27)	13 6.9 (5.3, 1.5 - 16)	8 12.8 (8.8, 1.2 - 27)	**0.070**
Tumor diametersubgroup	21			
<5 cm	8 (38.1)	7 (53.9)	1 (12.5)	**0.074**
>5 cm	13 (61.9)	6 (46.2)	7 (87.5)	
Tumor base	22			
Sessile/Inverted	7 (31.8)	4 (28.6)	3 (37.5)	0.51
Pedunculated	15 (68.2)	10 (71.4)	5 (62.5)	
Mitoses/10 HPF	21			
<4/10 HPF	16 (76.2)	13 (100)	3 (37.5)	**0.003**
>4/10 HPF	5 (23.8)	0	5 (62.5)	
Tumor necrosis	19			
Absent	11 (57.9)	10 (90.9)	1 (12.5)	**0.001**
Present	8 (42.1)	1 (9.1)	7 (87.5)	
Tumor hemorrhage	18			
Absent	11 (61.1)	7 (63.6)	4 (57.1)	0.58
Present	7 (38.9)	4 (36.4)	3 (42.9)	
Nuclear Crowding/overlap	17			
Absent	14 (82.4)	13 (100)	1 (25)	**0.006**
Present	3 (17.7)	0	3 (75)	
Infiltration of adjacent structures	21			
Absent	18 (85.7)	13 (100)	5 (62.5)	**0.042**
Present	3 (14.3)	0	3 (37.5)	
Stromal Invasion	4			
Absent	4 (80)	1 (100)	3 (75)	0.80
Present	1 (20)	0	1 (25)	
Vascular Invasion	5			
Absent	4 (80)	1 (100)	3 (75)	0.80
Present	1 (20)	0	1 (25)	
Encapsulation	20			
Absent	1 (5)	0	1 (14.3)	0.350
Present	19 (95)	13 (100)	6 (85.7)	
Tumor contour	22			
Lobulated	12 (54.6)	6 (42.9)	6 (75)	0.156
Smooth	10 (45.5)	8 (57.1)	2 (25)	
Tumor border with adjacent structures	23			
Poorly defined	1	0	1 (12.5)	0.348
Well defined	22	15 (100)	7 (87.5)	
Pleural pattern	23			
Visceral	20 (87)	13 (86.7)	7 (87.5)	0.73
Parietal	3 (13)	2 (13.3)	8 (100)	

Table does not include biopsies or surgery for recurrent disease. *t-test for comparison of means, Fisher exact test for comparison of binary categorical variables.

4. Discussion

4.1. The Diagnostic Role of Trans-Thoracic Needle Biopsy in SFTP

The majority of patients in our series received an image-guided trans-thoracic needle biopsy 22(84.6%) prior to initial management, and of these the majority were diagnostic of SFTP 16/22 (72.7). Thus the role of biopsy in this setting remains diagnostic, namely to distinguish SFTP from other pleural neoplasms on the differential diagnosis requiring a different management strategy. We found that trans-thoracic fine needle aspiration biopsy provided tissue for histological analysis of cellular & nuclear features of malignancy (mitotic count, nuclear pleomorphism, nuclear crowding, etcetera), but may not provide sufficient tissue for definitive diagnosis based on immunohistochemistry (CD34, bcl-2, etcetera) (Table 3). As such, we recommend that a core needle biopsy be completed concurrently with FNA in order to provide sufficient tissue for IHC analysis and SFTP diagnosis. Given the unpredictable potentially aggressive behavior of these tumors (discussed in next section below), a diagnosis of SFTP on biopsy without observed malignant pathological features is not sufficient to call the tumor "benign". A more apt description in this scenario is "SFTP with uncertain malignant potential". For definitive diagnosis of malignant potential, while simultaneously providing optimal tumor management, we recommend surgical resection.

4.2. Predictors of Recurrence and Malignant Pathology in SFTP

The findings regarding predictors of recurrent disease in our study were in keeping with previous of series [16] [18] [23] [24]. Aggressive behavior in these tumors is unpredictable. Despite analysis of a large range of clinical, histopathological and immunohistochemical variables, there were no significant predictors of recurrent disease identified (Table 5). We also showed that 3 or our 4 cases with recurrent disease initially displayed "benign" surgical pathology following complete resection. We did identify several predictors of "malignant pathology" based on accepted histopathological features (Table 7). However, statistical comparison of the relationship between benign or malignant final surgical pathology did not reveal a significant association with tumor recurrence. This is particularly concerning regarding the concept of "benign" SFTP nomenclature, and suggests that all tumors are best considered potentially malignant. It may be most prudent to describe these tumors in pathological terms of "lower malignant potential" and "higher malignant potential" instead of "benign" and "malignant."

Long-term clinical follow-up with imaging, regardless of initial benign or malignant final pathological diagnosis, is required for these tumors given their documented unpredictable aggressive behavior. The best imaging modality (CT thorax, Chest X-ray), optimal surveillance intervals, and which clinician is best suited to conduct such follow-up, remain unclear.

4.3. Study Limitations

Limitations in any study of SFTP arise from its rarity. In our study, despite a 30 year review a small study sample remained. This necessitated consideration of a potentially

underpowered small sample size when conducting statistical analysis and interpreting the results. Additional limitations arose from the retrospective nature of the series and associated reporting bias. In particular, the promising role of bFGF and Ki-67 immunohistochemical labeling indices role in prognostication of recurrence could not be evaluated due to limited reporting.

Standards of practice and nomenclature for this tumor also evolved over the 30 year study period. Accepted tumor nomenclature changed following the rise in knowledge of the mesenchymal origin for these neoplasms from benign mesothelioma, to SFTP, to benign or malignant SFTP [1] [2]. Practice and diagnostic capability also differed over the study period with development of new technology and expertise in IHC marker interpretation. Finaly, despite evolving diagnostic pathological expertise, accepted criteria to determine benign or malignant SFTP pathology remains unstandardized.

5. Conclusions

Trans-thoracic core needle biopsy is capable of identifying cases of malignant SFTP. However, the main use of biopsy should be to differentiate SFTP from other pleural neoplasms on the differential diagnosis with immunohistochemical marker expression.

Long-term clinical follow-up is warranted for SFTP regardless of benign or malignantinitial histology because of its unpredictable potential for aggressive malignant behavior despite a "benign" pathological appearance.

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