**Name of journal:** **World Journal of Gastroenterology**

**ESPS Manuscript NO: 6536**

**Columns: BRIEF ARTICLES**

**Solitary fibrous tumors in abdomen and pelvis: Imaging characteristics with radiologic-pathologic correlation**

Li XM *et al*.Imaging features of solitary fibrous tumors

Xue-Ming Li, Jing Reng, Peng Zhou, Ying Cao, Zhu-Zhong Cheng, Yan Xiao, Guo-Hui Xu

**Xue-Ming Li, Jing Reng, Peng Zhou, Ying Cao, Zhu-Zhong Cheng, Yan Xiao, Guo-Hui Xu,** Department of Radiology, Sichuan Cancer Hospital, Chengdu 610041, Sichuan Province, China

**Author contributions:** Li XM and Xu GH designed the study and wrote the manuscript; Cheng ZZ and Xiao Y coordinated and provided the collection of all human and clinical materials; Reng J, Zhou P and Ying C revised the manuscript.

**Correspondence to: Dr. Guo-Hui Xu,** **MD,** Department of Radiology, Sichuan Cancer Hospital, No. 55, Lane 4, RenMin Road (South), Chengdu 610041, Sichuan Province, China. xgh0913@hotmail.com

**Telephone:** +86-28-85420198 **Fax: +**86-28-85420195

**Received:** October 22, 2013 **Revised:** January 8, 2014

**Accepted:** March 5, 2014

**Published online:**

**Abstract**

**AIM:** To describe the imaging features of solitary fibrous tumors (SFTs) in the abdomen and pelvis, with clinical and pathologic correlation.

**METHODS:** Fifteen patients with pathologically confirmed SFTs in the abdomen and pelvis were retrospectively studied with imaging techniques by two radiologists in consensus. Patients underwent unenhanced and contrast-enhanced imaging, as follows: three with computed tomography (CT) and magnetic resonance imaging (MRI) examination, eight with CT examination only, and four with MRI examination only. Image characteristics such as size, shape, margin, attenuation or intensity, and pattern of enhancement were analyzed and correlated with the microscopic findings identified from surgical specimens. In addition, patient demographics, presentation, and outcomes were recorded.

**RESULTS:** Of the 15 patients evaluated, local symptoms related to the mass were found in 11 cases at admission. The size of the mass ranged from 3.4 to 25.1 cm (mean, 11.5 cm). Nine cases were round or oval, six lobulated, and 10 displaced adjacent organs. Unenhanced CT revealed a heterogeneous isodense mass in seven cases, homogeneous isodense mass in three cases, and punctuated calcification in one case. On MRI, most of the lesions (6/7) were heterogeneous isointense and heterogeneous hyperintense on T1-weighted image (T1WI) and T21-weighted image (T2WI), respectively. All tumors showed moderate to marked enhancement. Heterogeneous enhancement was revealed in 11 lesions, and seven of them contained cysts, necrosis, or hemorrhage. Early nonuniform enhancement with radial region that proved to be a fibrous component was observed in four lesions, which showed progressive enhancement in the venous and delayed phase. No statistical difference in the imaging findings was observed between the histologically benign and malignant lesions. Three patients had local recurrence or metastasis at follow-up.

**CONCLUSION:** Abdominal and pelvic SFTs commonly appeared as large, solid, well-defined, hypervascular masses with variable degrees of necrosis or cystic change that often displaced adjacent structures.

© 2014 Baishideng Publishing Group Co., Limited. All rights reserved.

**Keywords:** Abdominal imaging; Solitary fibrous tumors; Computed tomography; Magnetic resonance imaging

**Core tip:** Few studies have investigated the imaging features of solitary fibrous tumors (SFTs) in the abdomen and pelvis. We present the computed tomography and/or magnetic resonance imaging features of fifteen cases, and correlated them with histopathological results. We found that the imaging features of abdominal and pelvic SFTs predominantly appeared as large, well-defined, hypervascular masses with variable degrees of necrosis, cystic change, or hemorrhage that tended to displace adjacent structures. SFTs usually manifested as heterogeneous hyperintensity on T2-weighted images with low signal intensity areas representing flow voids, fibrosis, or collagen. SFTs should be considered when the aforementioned imaging features are encountered.

Li XM, Reng J, Zhou P, Cao Y, Cheng ZZ, Xiao Y, Xu GH. Solitary fibrous tumors in abdomen and pelvis: Imaging characteristics with radiologic-pathologic correlation.

**Available from:**

**DOI:**

**INTRODUCTION**

Solitary fibrous tumors (SFTs) were first described by Klemperer and Rabin in 1931 as a localized fibrous mesothelioma[1]. The origin of SFTs has been controversial, and it is now considered to be a pathologically diverse, ubiquitous mesenchymal neoplasm of fibroblastic or myofibroblastic origin that can be either benign or malignant[2,3]. Clinically, they are often misdiagnosed as other hypervascular tumors by radiological and pathologic examination. Although SFTs may occur in any site of the body, they have been predominantly localized in the pleura, followed by the head and neck, and their presence in the abdomen and pelvis is rare.

Although the histopathological features of SFTs are well characterized, the appearance of these tumors on imaging is not well documented. To date, the most extensive reports regarding the imaging characteristics of SFTs in the abdomen and pelvis is by Shanbhogue *et al*[4], Zhang *et al*[5], and Ginat *et al*[6], and others focused on case reports[7-10]. To better characterize the radiological features of this rare disease, we present the computed tomography (CT) and/or magnetic resonance imaging (MRI) features of fifteen cases of SFTs within the abdomen and pelvis, and correlated them with histopathological findings. To our knowledge, this is the largest and most detailed radiologic case series reported to date for SFTs.

**MATERIALS AND METHODS**

***Study population and imaging protocol***

CT and MRI findings of 15 patients with pathologically confirmed SFTs in the abdomen and pelvis were retrospectively reviewed. Of these 15 patients, three underwent both CT and MRI examination, eight had CT examination only, and four had MRI examination only. This study was conducted according to the ethical standards of our institution and was approved by our review board.

Due to the retrospective nature of the study, the CT and MR images were acquired with varied parameters. Contrast enhanced CT was acquired 45–60 s after intravenous injection of Ominipaque-based CT contrast agent; and contrast enhanced MRI scans were acquired 25–30 s (arterial phase), 45–60 s (venous phase), and 3 min (delayed phase) after intravenous administration of gadolinium-based MRI contrast agent. For CT examinations, patients were scanned using a 64 multi-detector CT (Lightspeed VCT, GE Healthcare, Chalfont St Giles, UK) with an X-ray tube voltage of 120 kV, current of 200 mA, width of collimator 64 mm × 0.625 mm, and collimation and intervals of 5–10 mm. MRI scans were performed with a 1.5 T scanner (Avanto, Siemens Medical Systems, Munich, Germany). The scanning parameters were as follows: a T1-weighted gradient-echo sequence (TR: 90–180 ms, TE: 2–5 ms, ﬂip angle: 70°), T2-HASTE sequence (TR: 4000–6000 ms, TE: 80–100 ms, ﬂip angle: 20°), and T1-weighted VIBE sequence (TR/TE: 4.8/2.2 ms, ﬂip angle: 70°).

***Imaging analysis***

The images were reviewed by two radiologists working in consensus—one with 20 years of experience in abdominal imaging and one a fellow. Both of them were only aware of the histological diagnosis, but did not review the official preoperative radiology reports. The CT and MR images were evaluated for the location, size, shape, margin, internal architecture, CT density, and MRI signal intensity compared with adjacent muscle, pattern of enhancement, and the change of the adjacent structure. The degree of mass enhancement was assessed subjectively and categorized as follows: mild, when the enhancement was similar to that of adjacent muscle; moderate, when the enhancement was higher than that of muscle but lower than that of blood vessels; marked, when the enhancement was approaching that of blood vessels. These imaging findings were correlated with the microscopic findings of the surgically obtained specimens, and compared between the histologically benign and malignant groups. In addition, review of the patients’ charts was performed to determine demographic data, clinical presentation, and postsurgical outcome.

**RESULTS**

***Clinical results***

The study group consisted of twelve men and three women with a median age of 65.2 years (range 1 to 76 years). Of these 15 patients, 11 (73%) cases had local symptoms at admission, including a palpable mass (*n* = 4), abdominal pain or discomfort in various degrees (*n* = 5), difficulty in defecation (*n* = 3), urinary frequency or retention (*n* = 4), gross hematuria (*n* = 1), and sexual disorder (*n* = 1). A firm and non-tender mass was revealed in ten patients upon digital rectal examination. However, none had systemic symptoms; and all the routine laboratory studies were unremarkable. A Foley catheter was placed in the urethra with complete resolution of urinary symptoms in patients with urinary retention. Surgical excision was successfully performed in all patients; and embolization prior to surgery was performed in one patient to prevent excessive surgical hemorrhage. At follow-up 0–62 mo (median, 20.3 mo) after surgery, two patients had local recurrence and one had hepatic metastasis; and all were classified as malignant at initial pathological examination.

***Imaging findings***

The CT and MR imaging features of the 15 patients with SFTs are shown in Table 1. Three masses were found in the upper abdominal retroperitoneum, two in the peritoneal cavity, and ten in the pelvis including two in the presacral space, one in the pararectal space, three in the rectovesical space, three in the paravesical space, and one in the prevesical space. All patients demonstrated a solitary mass with a size range from 3.4 cm x 3.4 cm to 25.1 cm x 15.0 cm, in which ten masses were larger than 10 cm in maximum diameter. Thirteen cases were well-defined, and two were ill-defined; nine cases were round or oval, and the other six were lobulated. Thirteen cases displaced and compressed the adjacent organs, such as pancreas, prostate, uterus, bladder, intestine, or vessels, and could not be separated from each other on CT and MR image. In addition, one of the patients with ill margins showed invasion of the posterior stomach wall and envelopment of the celiac trunk and its branches (Figure 1). However, no lymphadenopathy or distant metastases were detected on the CT and MR images at initial evaluation.

On unenhanced CT images, all 11 cases with CT scans manifested as an isodense mass, of which seven had relatively hypodense necrotic or cystic areas, three were homogeneous, and one had punctuated calcification. In total, seven patients underwent MRI scans. On T1-weighted images (T1WI), almost all lesions were isointense, in which five cases exhibited mostly isointense signals with patchy or radial areas of low intensity (Figure 2A), one case had mostly isointense signal with a patchy area of mild hyperintensity (Figure 3A), and one case had homogeneous isointensity. On T2-weighted images (T2WI), one lesion exhibited homogeneous hyperintensity, and the others had heterogeneous hyperintensity, in which three cases had a patchy or radial area of hypointensity (Figure 2B, 3B). In addition, intra- or extra-tumoral flow voids were found in four cases on T2WI (Figure 2B).

After intravenous injection of contrast material, feeding vessels (vascular pedicle) were seen in four of the 15 cases (26.7%) (Figure 2C). The degree of mass enhancement on CT and MRI varied from moderate to marked; and in patients with MRI examination, it was remarkable in the arterial phase and persisted in portal venous and delayed phase. Of these 15 cases, homogenous enhancement was observed in four cases and heterogeneous enhancement in 11 cases. In the latter cases, seven lesions showed necrotic or cystic areas on enhanced CT and/or MR images, and the other four lesions demonstrated early non-uniform enhancement with the center showing a radial or ﬁssured region which showed progressive enhancement spreading from the periphery to the center in portal venous and delayed phase on enhanced MR images (Figure 2D-F). However, in our case series, there was no statistical difference in the imaging findings between the histologically benign and malignant lesions.

***Pathological findings***

Of the surgical specimens, nine tumors were rounded or ovoid, six were lobulated, and ten were encapsulated. The cut surfaces were grayish white or yellowish white in color, and fish meat-like in texture. Radial or ﬁssured regions of the abundant fibrotic component were revealed in the center of four cases, cystic or necrotic foci in seven cases, and hemorrhage in one case.

Histological examination demonstrated that the tumors showed a haphazard patternless architecture of spindle or ovoid cells with a varying degree of collagenous tissues and a hemangiopericytoma-like appearance with prominent vascularity by thin-walled vessels (Figure 4A). The degree of cellularity varied for each tumor and was inversely related to the collagenous tissues. Immunohistochemical staining revealed that CD34 (Figure 4B) was positive in all cases, CD99 in 12 cases, B-cell lymphoma 2 (bcl-2) (Figure 4C) in 14 cases, S-100 in four cases, while all lesions were negative for desmin. The proportion of Ki-67 positive cells was greater than 10% in four cases (Figure 4D), and less than 5% in the other cases. In total, eight patients were classified as benign and seven presented malignant criteria at pathological analysis of the surgical specimens. All seven malignant tumors were hypercellular lesions, in which three each had mild to moderate atypia, and four displayed marked atypia.

**DISCUSSION**

SFT is a rare spindle cell mesenchymal neoplasm with age of onset around 50–60 years, with equal distribution between men and women. Patients in our series ranged from one to 76 years, but the incidence was higher in men than in women with a sex ratio of 4:1. To the best of our knowledge, we report the first case of SFT in an infant. Although SFTs were thought to occur most frequently in the pleura, they may develop virtually anywhere throughout the body, while involvement of the abdomen and pelvis is particularly rare[2]. Despite its characteristic histological and immunohistochemical features, SFTs in the abdomen and pelvis remain a diagnostic challenge to both clinicians and radiologists; and it is often poorly recognized and frequently confused with other neoplasms that more commonly occur at this site. Although rare, radiologists and surgeons must be aware of SFTs in the abdomen and pelvis.

Extrapleural SFTs were typically demonstrated as large, slow-growing soft tissue tumors[4]. Symptoms related to the site are frequent in these locations, such as a palpable mass, pain, gross hematuria, bowel obstruction, and urinary retention or obstruction[11,12], as seen in some of our patients. Systemic symptoms such as hypoglycemia (< 5% patients), arthralgia, hypertrophic osteoarthropathy, and clubbing have also been documented in the literature[4,13]; however, they were not present in any of our patients. These symptoms usually resolve upon removal of the tumor.

In the last 20 years, the classification of SFTs and hemangiopericytoma has changed, and most hemangiopericytomas are now thought to be cellular variants of SFTs[2,3]. Grossly, SFTs are usually well-demarcated and partially encapsulated in neoplasm[2]. These tumors are highly vascular and have a propensity to undergo hemorrhage, necrosis, and myxoid degeneration. Microscopically, they show a wide range of morphological features, from predominantly ﬁbrous lesions containing alternating fibrous areas and hyalinized thick-walled vessels (fibrous variants) to more cellular and less ﬁbrous neoplasms with a “patternless pattern” (a monotonous appearance) and thin-walled branching vessels (cellular variant)[2,3,14]. Immunohistochemically, both of them variably express CD34, CD99, and bcl-2 antigens; and the fibrous form demonstrates strong reactivity with CD34, whereas the cellular form demonstrates weak reactivity[2].

General histological features that may help to identify a malignant lesion include large size, infiltrative margins, hypercellularity, nuclear atypia, mitotic activity (≥ 4/10 high-power fields), and the presence of necrosis and hemorrhage[2,15,16]. In addition, malignant SFTs tend to lose CD34 immunoreactivity and overexpress Ki-67, P53, and S-100[17]. In our cases, eight tumors were classified as benign, and seven as malignant. Although most extrapleural SFTs have been reported to be benign histologically, approximately 10%–15% of SFTs demonstrate malignant behavior in the form of recurrence or metastasis[2,18]. Local recurrences and distant metastases may be expected in malignant SFTs, as seen in three of our patients. Although none were found in our patients, some cases of ‘‘histologically benign’’ SFTs that do recur or metastasize have been reported in the literature[19,20]. The most important risk factor for recurrence is invaded surgical margins. Therefore, complete resection with negative surgical margins is the treatment of choice, and long-term follow-up of all patients is highly recommended, regardless of anatomic location[20,21]. The vascular nature and the presence of large feeding vessels made surgical removal technically difficult and preoperative embolization that can reduce intraoperative hemorrhage may be required[22], as seen in one of our patients.

Radiological information provides useful information, such as detection, characterization, and localization of tumors. In addition, it can depict the local extent, possible invasion into adjacent structures, and locoregional and distant metastases. Importantly, these images provide a road map in the future for the operating surgeons. The most common imaging finding, recently reported in the literature, was a large, well-defined, round, oval, or lobulated hypervascular mass that tended to displace or invade adjacent structures such as the bowel, urinary bladder, seminal vesicle, ureter, and vessels[4,5,12]. The largest mass measured in our cases was 25.1 cm x 15.0 cm. The site of origin of the mass could not be defined on some images because margins were blended with adjacent structures. We inferred that the lobulated shape was due to different growth rates of the tumor. In addition, the difference of the resistance against the growth of the tumor may also be an important factor.

Most of our patients with plain CT scans demonstrated an isodense mass with patchy hypodensity. The attenuation likely depended upon the collagen content, as hyperdense lesions have abundant collagen[6]. Calcification is rare and can be seen in large benign or malignant tumors, but its presence or absence is not necessarily a helpful distinguishing feature[4,6]. On MRI, SFTs were usually isointense or slightly hyperintense on T1WI and heterogeneously hyperintense on T2WI, relative to muscle. Heterogeneous signal intensity was observed in some cases and was likely related to the components of hemorrhage, necrosis, cystic, or myxoid degeneration, and hyalinized stromal content[4,5,7]. However, the presence of low-signal-intensity foci on both T1WI and T2WI were mainly attributed to the components of dense collagen and fibrosis, low cellularity, and associated reduced proton mobility[6]. In addition, lesions with high fibrous content may demonstrate progressive enhancement during the arterial and portal phases that become marked on delayed images[5,8], as seen in some of our patients.

SFTs were highly vascular and vigorously enhancing on both enhanced CT and MR images. These tumors are usually heterogeneous, with hypervascular areas showing early intense enhancement, hypercellular areas showing moderate enhancement, and areas of necrosis or of cystic or myxoid degeneration showing no enhancement[5,23]. In addition, hypercellular areas demonstrated persistent enhancement in the venous and delayed phases. However, there is considerable overlap in the type of enhancement, during which 100% of malignant and 60% of benign SFTs show heterogeneous enhancement[23], as seen in our patients. Enhanced CT and MR images can depict the supplying arteries, and intra- or extra- tumoral flow voids can be readily revealed on unenhanced T2WI. Wignall *et al*[24] and Garcia-Bennett *et al*[25] thought that the presence of a vascular pedicle, although not specific, is a useful distinguishing feature of SFTs; it was seen in four of our patients.

The differential diagnosis for these imaging characteristics includes other hypervascular tumors or tumors with predominant fibrous content, such as leiomyosarcoma, neurogenic tumor, pheochromocytoma, lymphoma, desmoid tumor, malignant fibrous histocytoma, mesothelioma, and fibroma. Using imaging findings alone, differentiating among these is not possible. Therefore, complete excision and histopathologic examination are necessary to establish the diagnosis.

In conclusion, the imaging features of SFTs in the abdomen and pelvis predominantly appeared as well-defined, hypervascular masses with variable degrees of necrosis, cystic change, or hemorrhage. They usually manifested as heterogeneous hyperintensities on T2WI with low signal intensity areas representing flow voids, fibrosis, or collagen. Although we believe that the radiologist may diagnose SFT when a mass presents with the aforementioned imaging features, histopathologic examination remains necessary to confirm the diagnosis.

**COMMENTS**

***Background***

Solitary fibrous tumors (SFTs) may occur in any site of the body, but their presence in the abdomen and pelvis is rare. Clinically, they are often misdiagnosed as other hypervascular tumors by radiological and pathologic examination. Few studies to date have investigated the imaging features of SFTs in the abdomen and pelvis.

***Research frontiers***

The imaging appearance of SFTs on imaging is much less well reported than the histopathologic features. To better characterize the radiological features of this rare disease, the authors present the computed tomography and/or magnetic resonance imaging features of fifteen cases of SFTs within the abdomen and pelvis, and correlated them with histopathological results.

***Innovations and breakthroughs***

This is the largest and most detailed radiologic case series of SFTs in the abdomen and pelvis reported to date.

***Applications***

This study indicated that the imaging features of SFTs in the abdomen and pelvis predominantly appear as a well-defined, hypervascular mass with a variable degree of necrosis, cystic change, or hemorrhage. It was usually manifested as heterogeneous hyperintensity on T2-weighted images with low signal intensity areas representing flow voids, fibrosis, or collagen. The radiologist may suggest the diagnosis of SFTs when a mass with the above imaging features is encountered.

***Terminology***

Solitary fibrous tumors (SFTs) can be benign or malignant and are considered a pathologically diverse, ubiquitous mesenchymal neoplasm of fibroblastic or myofibroblastic origin.

***Peer review***

This is a retrospective clinical analysis of 15 cases of SFTs in the abdomen and pelvis. SFTs in the abdomen and pelvis are rarely encountered in the clinics. Only anecdotal case reports could be seen in the journals. This case series is important and sheds light on these uncommon neoplasms.

**REFERENCES**

1 **Klemperer P**, Rabin CB. Primary neoplasms of the pleura. A report of ﬁve cases. *Arch Pathol* 1931; **11**: 385-412

2 **Gengler C**, Guillou L. Solitary fibrous tumour and haemangiopericytoma: evolution of a concept. *Histopathology* 2006; **48**: 63-74 [PMID: 16359538 DOI: 10.1111/j.1365-2559.2005.02290.x]

3 **Fletcher CD**. The evolving classification of soft tissue tumours: an update based on the new WHO classification. *Histopathology* 2006; **48**: 3-12 [PMID: 16359532 DOI: 10.1111/j.1365-2559.2005.02284.x]

4 **Shanbhogue AK**, Prasad SR, Takahashi N, Vikram R, Zaheer A, Sandrasegaran K. Somatic and visceral solitary fibrous tumors in the abdomen and pelvis: cross-sectional imaging spectrum. *Radiographics* 2011; **31**: 393-408 [PMID: 21415186 DOI: 10.1148/rg.312105080]

5 **Zhang WD**, Chen JY, Cao Y, Liu QY, Luo RG. Computed tomography and magnetic resonance imaging findings of solitary fibrous tumors in the pelvis: correlation with histopathological findings. *Eur J Radiol* 2011; **78**: 65-70 [PMID: 19815359 DOI: 10.1016/j.ejrad.2009.09.001]

6 **Ginat DT**, Bokhari A, Bhatt S, Dogra V. Imaging features of solitary fibrous tumors. *AJR Am J Roentgenol* 2011; **196**: 487-495 [PMID: 21343490 DOI: 10.2214/AJR.10.4948]

7 **Rosenkrantz AB**, Hindman N, Melamed J. Imaging appearance of solitary fibrous tumor of the abdominopelvic cavity. *J Comput Assist Tomogr* 2010; **34**: 201-205 [PMID: 20351504 DOI: 10.1097/RCT.0b013e3181c84154]

8 **Moser T**, Nogueira TS, Neuville A, Riehm S, Averous G, Weber JC, Veillon F. Delayed enhancement pattern in a localized fibrous tumor of the liver. *AJR Am J Roentgenol* 2005; **184**: 1578-1580 [PMID: 15855118 DOI: 10.2214/ajr.184.5.01841578]

9 **Wat SY**, Sur M, Dhamanaskar K. Solitary fibrous tumor (SFT) of the pelvis. *Clin Imaging* 2008; **32**: 152-156 [PMID: 18313582 DOI: 10.1016/j.clinimag.2007.07.003]

10 **Joe BN**, Bolaris M, Horvai A, Yeh BM, Coakley FV, Meng MV. Solitary fibrous tumor of the male pelvis: findings at CT with histopathologic correlation. *Clin Imaging* 2008; **32**: 403-406 [PMID: 18760732 DOI: 10.1016/j.clinimag.2008.02.032]

11 **Gold JS**, Antonescu CR, Hajdu C, Ferrone CR, Hussain M, Lewis JJ, Brennan MF, Coit DG. Clinicopathologic correlates of solitary fibrous tumors. *Cancer* 2002; **94**: 1057-1068 [PMID: 11920476 DOI: 10.1002/cncr.10328]

12 **Yi B**, Bewtra C, Yussef K, Silva E. Giant pelvic solitary fibrous tumor obstructing intestinal and urinary tract: a case report and literature review. *Am Surg* 2007; **73**: 478-480 [PMID: 17521003]

13 **Fridlington J**, Weaver J, Kelly B, Kelly E. Secondary hypertrophic osteoarthropathy associated with solitary fibrous tumor of the lung. *J Am Acad Dermatol* 2007; **57**: S106-S110 [PMID: 17938018 DOI: 10.1016/j.jaad.2006.10.045]

14 **Ide F**, Obara K, Mishima K, Saito I, Kusama K. Ultrastructural spectrum of solitary fibrous tumor: a unique perivascular tumor with alternative lines of differentiation. *Virchows Arch* 2005; **446**: 646-652 [PMID: 15909170 DOI: 10.1007/s00428-005-1261-z]

15 **England DM**, Hochholzer L, McCarthy MJ. Localized benign and malignant fibrous tumors of the pleura. A clinicopathologic review of 223 cases. *Am J Surg Pathol* 1989; **13**: 640-658 [PMID: 2665534 DOI: 10.1097/00000478-198908000-00003]

16 **Vallat-Decouvelaere AV**, Dry SM, Fletcher CD. Atypical and malignant solitary fibrous tumors in extrathoracic locations: evidence of their comparability to intra-thoracic tumors. *Am J Surg Pathol* 1998; **22**: 1501-1511 [PMID: 9850176 DOI: 10.1097/00000478-199812000-00007]

17 **Yokoi T**, Tsuzuki T, Yatabe Y, Suzuki M, Kurumaya H, Koshikawa T, Kuhara H, Kuroda M, Nakamura N, Nakatani Y, Kakudo K. Solitary fibrous tumour: significance of p53 and CD34 immunoreactivity in its malignant transformation. *Histopathology* 1998; **32**: 423-432 [PMID: 9639117 DOI: 10.1046/j.1365-2559.1998.00412.x]

18 **Daigeler A**, Lehnhardt M, Langer S, Steinstraesser L, Steinau HU, Mentzel T, Kuhnen C. Clinicopathological findings in a case series of extrathoracic solitary fibrous tumors of soft tissues. *BMC Surg* 2006; **6**: 10 [PMID: 16824225 DOI: 10.1186/1471-2482-6-10]

19 **Hasegawa T**, Matsuno Y, Shimoda T, Hasegawa F, Sano T, Hirohashi S. Extrathoracic solitary fibrous tumors: their histological variability and potentially aggressive behavior. *Hum Pathol* 1999; **30**: 1464-1473 [PMID: 10667425 DOI: 10.1016/S0046-8177(99)90169-7]

20 **Cranshaw IM**, Gikas PD, Fisher C, Thway K, Thomas JM, Hayes AJ. Clinical outcomes of extra-thoracic solitary fibrous tumours. *Eur J Surg Oncol* 2009; **35**: 994-998 [PMID: 19345055 DOI: 10.1016/j.ejso.2009.02.015]

21 **Park MS**, Araujo DM. New insights into the hemangiopericytoma/solitary fibrous tumor spectrum of tumors. *Curr Opin Oncol* 2009; **21**: 327-331 [PMID: 19444101 DOI: 10.1097/CCO.0b013e32832c9532]

22 **Zerón-Medina J**, Rodríguez-Covarrubias F, García-Mora A, Guerrero-Hernandez M, Chablé-Montero F, Albores-Saavedra J, Medina-Franco H. Solitary fibrous tumor of the pelvis treated with preoperative embolization and pelvic exenteration. *Am Surg* 2011; **77**: 112-113 [PMID: 21396319]

23 **Rosado-de-Christenson ML**, Abbott GF, McAdams HP, Franks TJ, Galvin JR. From the archives of the AFIP: Localized fibrous tumor of the pleura. *Radiographics* 2003; **23**: 759-783 [PMID: 12740474 DOI: 10.1148/rg.233025165]

24 **Wignall OJ**, Moskovic EC, Thway K, Thomas JM. Solitary fibrous tumors of the soft tissues: review of the imaging and clinical features with histopathologic correlation. *AJR Am J Roentgenol* 2010; **195**: W55-W62 [PMID: 20566782 DOI: 10.2214/AJR.09.3379]

25 **Garcia-Bennett J**, Olivé CS, Rivas A, Domínguez-Oronoz R, Huguet P. Soft tissue solitary fibrous tumor. Imaging findings in a series of nine cases. *Skeletal Radiol* 2012; **41**: 1427-1433 [PMID: 22349595 DOI: 10.1007/s00256-012-1364-y]

**P-Reviewers:** Beltran MA, Youn HS **S-Editor:** Ma YJ **L-Editor: E-Editor:**

**Figure 1 Computed tomography findings of a solitary fibrous tumor in the retroperitoneum.** A: Contrast-enhanced axial image showed a lobulated, ill-defined, and heterogeneously moderate enhancing mass in the retroperitoneum. The mass invaded the pancreas and stomach (arrows), and the celiac trunk and its branches were enveloped; B: Contrast-enhanced coronal reconstruction image showed that the branches of celiac trunk were enveloped.

**Figure 2 Magnetic resonance images of a solitary fibrous tumor in the presacral space.** A:T1-weighted magnetic resonance (MR) image showed that the mass is lobulated and almost isointense to the muscle. Radial hypointensity is seen in the center; B: Axial fat-suppressed T2-weighted MR image revealed that the mass is predominantly hyperintense with radial areas of low signal intensity. In addition, intra- and extra-tumoral flow void can be detected (arrow); C: Sagittal fat-suppressed T2-weighted MR image showed that the rectum was compressed anteriorly by the mass (arrow); D: The mass demonstrated intense heterogeneous enhancement in the arterial phase. The feeding vessels (vascular pedicle) can be demonstrated clearly (arrow); E, F: The mass showed persistent and progressive enhancement in the portal venous (E) and delayed phase (F).

**Figure 3 Magnetic resonance images of a solitary fibrous tumor in the rectovesical space.** A: T1-weighted magnetic resonance (MR) image showed an oval isointense mass with patchy mild hyperintensity (arrow). The patchy mild hyperintensity was proven to be a hemorrhage; B: Fat-suppressed T2-weighted MR images revealed that the mass was a heterogeneous hyperintensity with patchy hypointensity; C: Contrast-enhanced MR images demonstrated moderate heterogeneous enhancement of the mass, which displaced the bladder anteriorly and rectum posteriorly (arrow).

**Figure 4 Pathologic features of the solitary fibrous tumor.** A: Hematoxylin and eosin (HE) staining, × 40, indicates monotonous spindle cell proliferation with a hemangiopericytoma-like vascular growth pattern; B, C, and D: Immunohistochemical staining, x 40, indicates that the tumor was diffusely positive for CD34 (B) and Bcl-2 (C), and Ki67 was 15% (D).

**Table 1 Radiological findings of the 15 cases with solitary fibrous tumors**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No/age/sex** | **Benign/malignant** | **Location** | **Size (cm)** | **Shape, margin** | **CT density/MRI intensity** | **Degree, pattern of enhancement** |
| 1/1/M | Benign | Adrenal region-L | 3.4 x 3.4 | Rounded, well-deﬁned | Isodensity with dot calcification | Moderate, homogeneous |
| 2/76/M | Benign | Pararectal space-L | 4.0 x 4.1 | Oval, well-deﬁned | Homogeneous isodensity | Moderate, homogeneous |
| 3/39/M | Benign | Rectovesical space | 11.3 x 11.5 | Lobulated, well-deﬁned | Isodensity with patchy necrosis | Marked, heterogeneous |
| 4/41/M | Benign | Paravesical space-R | 10.8 x 14.0 | Oval, well-deﬁned | Isodensity with patchy necrosis | Moderate, heterogeneous |
| 5/29/F | Benign | Paravesical space-L | 8.1 x 6.3 | Oval, well-deﬁned | Homogeneous isodensity | Marked, homogeneous |
|  |  |  |  |  | Homogeneous isointensity (T1WI) |  |
|  |  |  |  |  | Homogeneous hyperintensity (T2WI) |  |
| 6/43/F | Benign | Presacral space | 15.3 x 18.0 | Oval, well-deﬁned | Isodensity with patchy necrosis | Marked, heterogeneous |
|  |  |  |  |  | Heterogeneous isointensity with patchy hyperintensity (T1WI) |  |
|  |  |  |  |  | Heterogeneous hyperintensity with patchy hypointensity (T2WI) |  |
| 7/60/F | Benign | Intraperitoneal | 18.0 x 20.2 | Lobulated, well-deﬁned | Heterogeneous isointensity with patchy hypointensity (T1WI) | Marked, heterogeneous |
|  |  |  |  |  | Heterogeneous hyperintensity (T2WI) | Progressive enhancement |
| 8/33/M | Benign | Presacral space | 11.3 x 12.0 | lobulated, well-deﬁned | Isointensity with radial hypointensity (T1WI) | Marked, heterogeneous |
|  |  |  |  |  | Heterogeneous hyperintensity with radial hypointensity (T2WI) | Progressive enhancement |
| 9/69/M | Malignant | Retroperitoneal | 15.3 x 20.8 | Lobulated, ill-defined | Isodensity with patchy necrosis | Moderate, heterogeneous |
| 10/59/M | Malignant | Prevesical space | 9.3 x 10.2 | Oval, well-deﬁned | Homogeneous isodensity | Moderate, homogeneous |
| 11/52/M | Malignant | Intraperitoneal | 7.4 x 8.1 | Lobulated, well-deﬁned | Isodensity with patchy necrosis | Marked, heterogeneous |
| 12/61/M | Malignant | Paravesical space-R | 11.6 x 12.0 | Oval, well-deﬁned | Isodensity with patchy necrosis | Marked, heterogeneous |
| 13/47/M | Malignant | Rectovesical space | 10.4 x 11.3 | Oval, well-deﬁned | Isodensity with patchy necrosis | Moderate, heterogeneous |
|  |  |  |  |  | Heterogeneous isointensity with patchy hypointensity (T1WI) |  |
|  |  |  |  |  | Heterogeneous hyperintensity (T2WI) |  |
| 14/51/M | Malignant | Retroperitoneal | 15.0 x 25.1 | Lobulated, Ill-deﬁned | Heterogeneous isointensity with patchy hypointensity (T1WI) | Marked, heterogeneous |
|  |  |  |  |  | Heterogeneous hyperintensity (T2WI) | Progressive enhancement |
| 15/57/M | Malignant | Rectovesical space | 4.7 x 4.8 | Oval, Well-deﬁned | Isointensity with radial hypointensity (T1WI) | Marked, heterogeneous |
|  |  |  |  |  | Heterogeneous hyperintensity with radial hypointensity (T2WI) | Progressive enhancement |

M: Male; F: Female; L: Left; R: Right; CT: Computed tomography; MRI: Magnetic resonance imaging; T1WI: T1-weighted imaging; T2WI: T2-weighted imaging.