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RESEARCH ARTICLE

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Evaluation of clinical application of multi-slice computerized tomography in primary retroperitoneal tumors

Yuanchun Feng[1] | Wei Zhang[1] | Chenghua Luo[2]

[1]Radiology Department, Peking University International Hospital, Beijing, China

[2]Retroperitoneal Tumor Center, Peking University International Hospital, Beijing, China

Correspondence
Yuanchun Feng, No 1, Life Garden Road, Zhongguancun Life Science Park, Changping District, Beijing 103211, China.
Email: fyuanchun@sina.com

Abstract

Background: To accurately identify primary retroperitoneal tumors by multi-slice spiral CT (MSCT) for better treatment.

Materials and Methods: The common types of 380 cases of primary retroperitoneal tumor, lesion sites, and MSCT features were compared with pathological results. Fisher's or chi-square test approaches have been applied in this study.

Results: Multi-slice computerized tomography multi-directional reconstruction has a high accuracy for primary retroperitoneal tumors (95.7%). Seventy-three liposarcoma cases were located in peri-renal space, accounting for 76.8% (13/95) of the tumors in this region. Meanwhile, 65 cases of neurogenic tumors were located in the paravertebral column, accounting for 90.3% (65/72) of the tumors in this region. MSCT examination could effectively distinguish benign from malignant of primary retroperitoneal tumor (sensitivity = 87.2%, specificity = 82.7%, accuracy rate = 84.5%). Malignant tumors showed more irregularity shape than benign tumor (χ^2 = 20.468, P < .001). 82.7% (191/231) of the malignant tumors showed adhesion or even invasion of surrounding tissues and organs (χ^2 = 23.262, P < .001). Fat density of the lipoma is uniform, and lesion is not enhanced. Liposarcoma can be seen in varying proportions of fat and soft tissue density.

Conclusion: The accuracy of MSCT scan for retroperitoneal tumors is high. Meanwhile, the coincidence rate of qualitative diagnosis before operation and/or before biopsy is also high.

KEYWORDS

benign and malignant, liposarcoma, multi-slice computerized tomography, neurogenic tumor, primary retroperitoneal tumor

1 | INTRODUCTION

Primary retroperitoneal tumor refers to a variety of tumors and tumor-like lesions originating from various tissues of the retroperitoneal space.[1] This disease has a variety of tissue sources including adipose tissue, connective tissue, muscle, blood vessels, lymph, nerves, and embryonic residual tissue. However, tumors and metastatic tumors of the pancreas, kidney, adrenal gland, etc,

are not included.[2] Primary retroperitoneal tumors have many characteristics that are not conducive to clinical diagnosis, such as low incidence, deep location, strong adaptability, no obvious symptoms in early stage, large volume, and close relationship with surrounding organs. In particular, malignant tumors often involve multiple adjacent organs, which results in the low surgical resection rates.[3] Therefore, the accurate localization and identification of primary retroperitoneal tumors will help to select treatment strategies and improve surgical resection rates. In this study, we have collected 380 multi-slice computerized tomography (MSCT) results from 380 patients with primary retroperitoneal tumors which were confirmed by surgery or puncture pathology. The results obtained in this study could improve the understanding of this disease and accumulate experience for preoperative evaluation for primary retroperitoneal tumors.

2 | METHODS AND MATERIALS

2.1 | Patients

In this study, we have retrospectively analyzed 380 cases of primary retroperitoneal tumors diagnosed in the Department of Radiology, Peking University International Hospital, from January 1, 2016, to May 30, 2017. Pathological results were identified by surgery or needle biopsy. Of the 380 patients, there were 184 males and 196 females, aged 10-84 years, with an average of 47.68 years old. The clinical manifestations are abdominal mass, abdominal distension, abdominal pain, upper abdominal discomfort, waist discomfort or pain, high blood pressure with palpitations, and dizziness.

2.2 | Data collection

The MSCT examination used a Siemens dual-source MSCT and a Siemens 64-layer MSCT scanner. Before the examination, the patient was fasted for 4-6 hours. The spiral scanning mode is adopted, and the layer thickness is 5 mm. The scan ranged from the top of the diaphragm to the pelvic floor (including the tumor, the entire range involved). After MSCT plain scan, an enhanced scan was performed, and 80 mL of contrast agent (iohexol injection, GE Healthcare) was injected from the elbow vein using a high-pressure syringe. The injection flow rate is 2.5-3.0 mL/s. Scanning starts 70 seconds after injection. The enhanced image scanning thin-layer data is post-processed to obtain a coronal and sagittal reconstructed image.

The MSCT characteristics of the tumor inside including cystic, solid, fat components, calcification, and enhancement characteristics were observed and recorded. Meanwhile, data of tumor size, location, morphology, and relationship with surrounding organs (push, adhesion, and invasion) were also collected. In this study, we have used the retroperitoneal tumor scoring system to determine the benign and malignant primary retroperitoneal tumors. The malignant primary retroperitoneal tumors were determined as the following criterions: (a) The maximum diameter of the tumor is equal to or >5.5 cm; (b) there are symptomatic metastases; (c) it is not calcified; (d) the tumor has irregular edges, and (e) the tissue has cystic degeneration or necrosis.[4]

TABLE 1 Pathological type and number of cases of primary retroperitoneal tumor

Benign tumor		No.	Malignant tumor		No.
Neurogenic tumor (59)	Neurinoma	16 (27.1%)	Liposarcoma (138)	Dedifferentiation	72 (52.2%)
	Neurofibroma	14 (23.7%)		Highly differentiated	60 (43.5%)
	Ganglion cell neuroma	12 (20.3%)		Mucus type	4 (2.9%)
	Chromaffin tumor	11 (18.6%)		Polymorphism	2 (1.4%)
	Ectopic cytophiloma	6 (10.2%)	Leiomyosarcoma		37
Fibroma or fibroid lesions		33	Lymphoma		14
Stromal tumor		20	Malignant neurogenic tumor		6
Teratoma		16	Osteogenic tumor		6
Lipoma		8	Malignant stromal tumor		3
Castleman disease		5	Others (14)	Adenocarcinoma	5
Others (14)	Angiomyolipoma	4		Rhabdomyosarcoma	4
	Invasive hemangioma	4		Carcinosarcoma	3
	Mesothelioma	3		Synovial sarcoma	3
	Hemangioma	2		Malignant fibrous histiocytoma	2
	Granulosa cell tumor	1		Spermato cell tumor	2
				Squamous cell carcinoma	1
				Malignant mesothelioma	1

2.3 | Statistical method

This study used SPSS19.0 statistical software. The count data are expressed as a number of cases or as a percentage. The comparison between the two groups is based on the chi-square test or Fisher's exact probability method. Measurement data are expressed as mean ± standard deviation. The *t* test or analysis of variance was used for comparison between the two groups; $P < .05$ indicated that the difference was statistically significant.

3 | RESULTS

3.1 | Pathological type

The pathological types of 380 cases of primary retroperitoneal tumors are shown in Table 1. Of the 380 cases of primary retroperitoneal tumors, there are 149 cases of benign tumors, which include 59 cases of neurogenic tumors, accounting for 39.6%. Meanwhile, there were 33 cases of fibroids or fibroids, 20 cases of stromal tumors (GIST), 16 cases of teratoma, 8 cases of lipoma, 5 cases of Castleman disease, and 14 cases of other tumors. In addition, there are 231 cases of malignant tumor, which include 138 cases of liposarcoma, accounting for 59.7%. Meanwhile, 37 cases of leiomyosarcoma, 14 cases of lymphoma, 6 cases of malignant neurogenic tumor, 6 cases of bone-derived tumors (3 cases of osteosarcoma and chondrosarcoma), 24 cases of other tumors (5 adenocarcinoma, 4 cases of rhabdomyosarcoma, 3 cases of malignant stromal tumor, 3 cases of carcinosarcoma, 3 cases of synovial sarcoma, 2 cases of malignant fibrous histiocytoma, 2 cases of seminoma, 1 case of squamous cell carcinoma, and 1 case of malignant mesothelioma) were also included in this study.

TABLE 2 Qualitative diagnosis of primary retroperitoneal species by MSCT

Items	Benign	Malignancy	Total
Benign	130 (87.2%)	19 (12.8%)	149
Malignancy	40 (17.3%)	191 (82.7%)	231
Total	170	210	380

3.2 | Location

In this study, 364 cases of tumors located in the retroperitoneal space were determined by MSCT plain and multiplanar reconstruction. Another 16 cases were judged to be abdominal sources. MSCT has a high accuracy of tumor localization. The most common tumor sites were the peri-renal space and the paraspinal area. There were 73 cases of liposarcoma found in the peri-renal space, accounting for 76.8% of the tumors in the region. Sixty-five neurogenic tumors were located in the paravertebral column, accounting for 90.3% of the tumors in the region.

3.3 | Tumor characterization

In this study, 170 cases of benign tumors and 210 cases of malignant tumors were identified by MSCT. Table 2 showed the detailed information about the patients. The sensitivity of benign and malignant primary peritoneal tumors detected by MSCT was 87.2%. The specificity was 82.7%. The accuracy was 84.5%. The MSCT characteristics of benign and malignant tumors are shown in Table 3. The results suggested that 139 cases of malignant tumors showed irregular shape. On the contrary, 54 cases of benign tumors showed irregular shape. The differences between the two tumor types were statistically significant ($\chi^2 = 20.251$, $P < .001$). Meanwhile, no differences in the boundary, density, and with or without reinforcement could be calculated between benign and

TABLE 3 Comparison of MSCT characteristics between benign and malignant tumors

MSCT characteristics	Benign tumor	Malignant tumor	χ^2	*P*
Shape				
Irregular shape	54 (28.0%)	139 (72.0%)	20.251	<.001
Quasi-circular	94 (50.5%)	92 (49.5%)		
Boundary				
Distinct	120 (42.0%)	166 (58%)	3.662	.056
Ambiguous	29 (30.9%)	65 (69.1%)		
Density				
Uniform	33 (35.1%)	61 (64.9%)	0.883	.347
Mixture	116 (40.6)	170 (59.4%)		
Intensify				
Yes	141 (38.5)	225 (61.5%)	1.961	.161
No	8 (57.1%)	6 (42.9%)		
Relationship with the surrounding tissues				
Push	149 (78.8%)	40 (21.2%)	247.702	<.001
Adhesion, invasion	0 (0)	191(100%)		

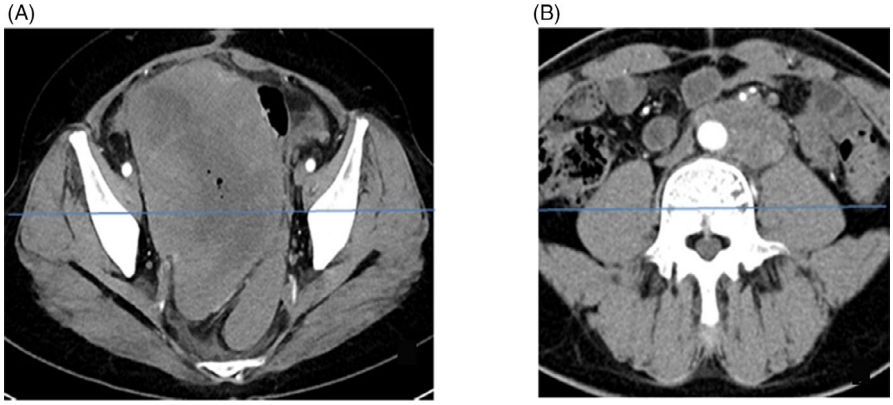

FIGURE 1 Tumor characterization. A, 50-y-old neurofibromatosis male patient. Axis plain scan. The right side of the tibia can be seen with multiple nodules and agglomerate soft tissue. The two are connected, the lesion density is uniform, and the boundary is clear. B, 53-y-old male patient with seminoma. The axial position of the enhanced arterial phase showed uneven enhancement of the lesion. The boundary was clear. The affected abdominal aortic segment was surrounded by more than half. The mesenteric artery was located in the left front of the lesion. Meanwhile, the left psoas muscle and local lumbar vertebral bodies were not affected

malignant. All benign retroperitoneal tumors show a pushing change in surrounding tissues and organs (Figure 1A). However, 82.7% of the malignant tumors showed adhesion or even invasion of surrounding tissues and organs (Figure 1B). Significantly differences could be calculated between benign and malignant tumors (χ^2 = 247.702, P < .001).

3.4 | MSCT characteristics of different types of tumor lesions

All well-differentiated liposarcomas showed uneven fat density (100%). The enhanced examination showed uneven cord-like, nodular, and reticular reinforcement. The pathological picture shows adipose-like cells and septal fat cells (Figure 2). The fat component of dedifferentiated liposarcoma is reduced. Enhanced examination showed no enhanced fat density and unevenly enhanced soft tissue density. Meanwhile, pathological images showed increased dedifferentiation (Figure 3). Teratomas are more common in young people. The results obtained in this study showed fat and calcification density (Figure 4A). Neurogenic tumors are commonly located near the spine (Figure 4B). Patients with functional colitis are often associated with hypertension and palpitations and dizziness.

4 | DISCUSSION

Primary retroperitoneal tumor is a general term for multiple tumors in the retroperitoneal space and manifests as tumor-like lesions. It does not include tumors that appear mainly in organs in the retroperitoneal organs, such as liver, duodenum, pancreas, spleen, kidney, adrenal gland, ureter, and bone. Meanwhile, the primary retroperitoneal tumor tissue may be mesenchymal tissue, neurogenic tissue, lymphoid tissue, and primitive ectoderm tissue.[5,6] The clinical symptoms of primary retroperitoneal tumors are non-specific, a wide range of growth and deep location, which is not conducive to clinical diagnosis. However, tumors from different tissue sources have different predilection sites, components, and growth characteristics.[7] Imaging studies can be used to assess the location, extent, internal structure, and relationship to surrounding organs. In this study, the MSCT results of 380 primary

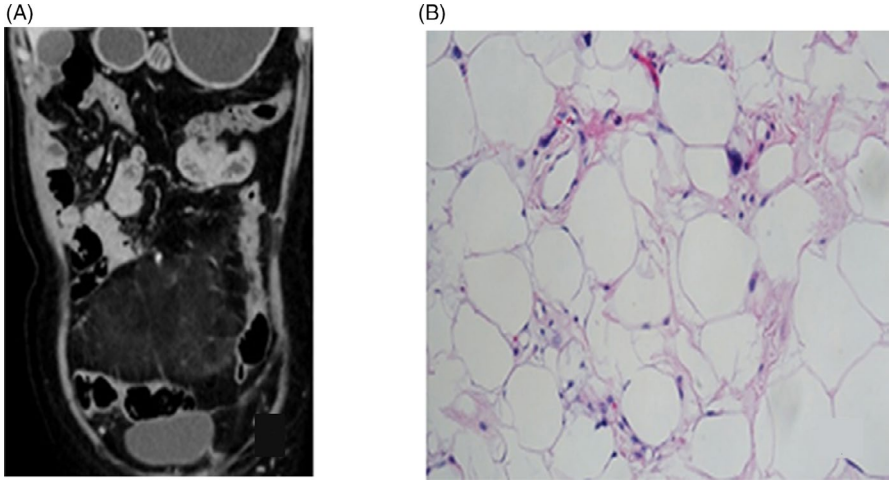

FIGURE 2 Highly differentiated liposarcoma. A, Enhanced examination venous coronal reconstruction showed lesion separation enhancement. B, HE staining (200×) showed adipose-like cells and cell size. Fat mother cells can be observed

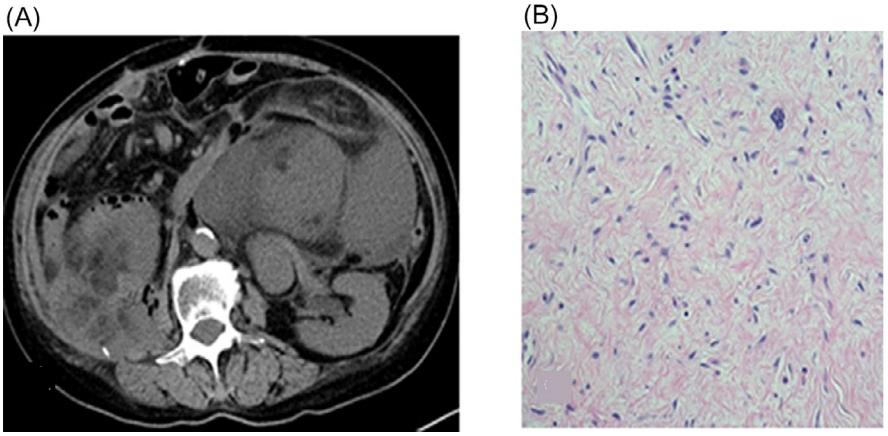

FIGURE 3 Dedifferentiated liposarcoma. A, CT plain axial position showed multiple soft tissue masses in the middle and lower abdomen. Fat density shadow was observed. B, HE Staining (200×) showed low-grade fibrosarcoma-like changes in tumors, which were obese fibroblast-like cells with sparse cell distribution and rich collagen fibers

FIGURE 4 Teratomas and neurogenic tumors. A, 10-y-old female patient with anterior teratoma. Enhanced scanning of the venous coronal position revealed multiple solid parts within the lesion. The solid lesion envelope is intact and calcified. No damage to the pelvic bone morphology. No damage to the pelvic bone morphology could be observed. B, 25-y-old male patients with schwannomas. Enhanced scan of the coronal position showed that the lesion was located next to the spine and was lobulated. This result indicates that more calcifications in the lesion, unreinforced necrotic areas (*)

retroperitoneal tumors were collected and analyzed. The results of this study provide new ideas for clinical diagnosis of lesions.

In this study, the results revealed that liposarcoma occurred commonly in the peri-renal space, accounting for 76.8% (13/95) of tumors in the region. Neurogenic tumors occur commonly in the paravertebral column. In the study, 65 neurogenic tumors were located near the spine, accounting for 90.3% (65/72) of the tumors in the region. This is consistent with previous research.[8,9] Fujimoto et al analyzed a total of 167 patients with primary retroperitoneal tumors during a 12-year study and found that liposarcoma and schwannomas are the most common histological types of malignant and benign tumors.[10]

Soft tissue tumors are usually classified into benign and malignant types. Benign tumors are closer to normal tissue and have limited ability to grow autonomously. These tumors hardly invade locally and have a low incidence of local recurrence after complete resection. In contrast, malignant tumors or sarcomas are locally invasive. Moreover, the malignant tumor can lead to invasive, destructive growth, recurrence, and distant metastasis.[11] Therefore, the malignant identification of primary retroperitoneal tumors has a guiding role in the choice of clinical treatment options. This study suggests that malignant tumors generally have the following characteristics: (a) the maximum diameter of the tumor is equal to or >5.5 cm, (b) the presence of symptoms, (c) the absence of calcification of the lesion, (d) the presence of irregular margins, and (e) cystic degeneration or necrosis. Of the 380 patients, 170 were judged to be benign tumors, and another 210 were judged to be malignant tumors. The sensitivity of benign and malignant primary peritoneal tumors by MSCT was 87.2%, and the specificity was 82.7%. The accuracy rate is 84.5%. Moreover, malignant tumors showed irregular shape. Meanwhile, benign retroperitoneal tumors showed a change in the surrounding tissues and organs. 82.7% (191/231) of malignant tumors showed adhesion or even invasion of surrounding tissues and organs. Primary retroperitoneal tumors are often found to be large in size and have a wide variety of pathological types. Therefore, MSCT assessment of tissue types is challenging. However, some tumor types have unique characteristic manifestations and clinical changes. In this study, liposarcoma accounted for 36.3% of all primary tumors. Most of the liposarcoma lesions found different proportions of fat components. Previous studies believe that the performance of MSCT in liposarcoma is associated with pathological typing.[11] Teratoma has its characteristic characteristics. Three or more components of tissue can be found in the tumor, including fat, soft tissue, and calcification density. Based on the evidences mentioned above, we speculated that multi-directional reconstruction of MSCT can effectively display

punctate calcification. Neurogenic tumors occur in the paravertebral column. Sixty-five neurogenic tumors in this study have been suggested to be located near the spine. Meanwhile, coronal reconstruction showed better results for tumor localization.

There were also some limitations in this study. First, this was a retrospective study. Further prospective study was needed. Second, this study was performed in one center. Further study with multi-center and larger sample size was needed.

5 | CONCLUSION

The accuracy of MSCT scan for retroperitoneal tumors was high. The coincidence rate of qualitative diagnosis before operation or before biopsy was high. In addition, the MSCT results of well-differentiated liposarcoma, neurogenic tumor, teratoma, and lipoma showed their unique characteristics.

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None.

CONFLICT OF INTEREST

All authors declare no conflict of interest.

ETHICAL APPROVAL

The Research Ethics Committee of Peking University International Hospital approved the collection of tissue samples for research.

ORCID

Yuanchun Feng https://orcid.org/0000-0003-0274-5906

REFERENCES

1. Nishino M, Hayakawa K, Minami M, Yamamoto A, Ueda H, Takasu K. Primary retroperitoneal neoplasms: CT and MR imaging findings with anatomic and pathologic diagnostic clues. *Radiographics*. 2003;23(1):45-57.
2. Strauss DC, Hayes AJ, Thomas JM. Retroperitoneal tumours: review of management. *Ann R Coll Surg Engl*. 2011;93(4):275-280.
3. Wang J, Grignol VP, Gronchi A, Luo CH, Pollock RE, Tseng WW. Surgical management of retroperitoneal sarcoma and opportunities for global collaboration. *Chin Clin Oncol*. 2018;7(4):39.
4. Vasu PP, Leelamma JP, Mohammed BA, Yesodharan J. Primary granulosa cell tumor of retroperitoneal origin: a rare presentation with emphasis on cytomorphology. *J Cytol*. 2016;33(1):52-54.
5. Wu YX, Liu JY, Liu JJ, et al. A retrospective, single-center cohort study on 65 patients with primary retroperitoneal liposarcoma. *Oncol Lett*. 2018;15(2):1799-1810.
6. Dayan D, Abu-Abeid S, Klausner JM, Sagie B. Primary retroperitoneal mucinous cystic neoplasm: authors' experience and review of the literature. *Am J Clin Oncol*. 2016;39(5):433-440.
7. Fichera D, Luciano R, Nini A, et al. Clinical and pathological characteristics of a series of patients with newly diagnosed primary renal liposarcoma: natural history and effect on survival. *Arch Esp Urol*. 2018;71(6):555-558.
8. Vozdvizhenskiĭ MO, Dudko SM, Stadler VV, Shvets DS, Tkachev MV. Treatment of the neurogenic tumor of the retroperitoneal space with the invasion of vena cava inferior. *Khirurgiia (Mosk)*. 2013;6:69-71.
9. Fujimoto N, Kubo T, Hisaoka M, et al. Kyushu cooperative urological research group. Demographics, management and treatment outcomes of benign and malignant retroperitoneal tumors in Japan. *Int J Urol*. 2018;25(1):61-67.
10. Virseda Rodríguez JA, Donate Moreno MJ, Pastor Navarro H, et al. Primary retroperitoneal tumors: review of our 10-year case series. *Arch Esp Urol*. 2010;63(1):13-22.
11. Nakashima J, Ueno M, Nakamura K, et al. Differential diagnosis of primary benign and malignant retroperitoneal tumors. *Int J Urol*. 1997;4(5):441-446.

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