Role of Multi-slice CT in Characterization of Different Retroperitoneal Masses

Abstract.

Background: Multi-slice CT imaging (MSCT) plays an integral role in the characterization of primary retroperitoneal masses and in evaluation of their extent and involvement of adjacent structures, and therefore in treatment planning. Many authors have described useful imaging features to distinguish between the different entities.

Aim of work: To evaluate the role of multi-slice CT in differentiation of primary retroperitoneal masses in correlation with pathological findings.

Patients and methods: Prospective study was performed on 43 patients aiming to determine the role of cross sectional CT imaging in the differential diagnosis of primary retroperitoneal masses. Each case was submitted for pathological analysis either following open surgical biopsy, surgical excision, or image guided biopsy by CT or US. Correlation of CT findings with pathological results was obtained.

Results: The calculated accuracy for diagnosis and differential diagnosis of primary retroperitoneal masses by multi-slice CT was 69.7% in the studded cases matched with pathological findings which represented 30 cases of our study. This was helpful in narrowing the differential diagnosis and so in treatment planning.

Conclusion: MSCT considered the basic standard in morphological evaluation and diagnosis of primary retroperitoneal masses by according to its origin first then characterization of the mass lesion depending upon the specific imaging characteristics detected on CT examination as consistency, component, vascularity and enhancement pattern as well as specific pattern of spread.

Key words: Multi-slice computed tomography (MSCT), primary retroperitoneal masses.

Introduction:
Primary retroperitoneal neoplasms are a diverse group of benign and malignant tumors that arise within the retroperitoneum but outside the major organs (7). Although computed tomography imaging can demonstrate important characteristics of these tumors, diagnosis is often challenging for radiologists. Diagnostic challenges include precise localization of the lesion, determination of the extent of invasion, and characterization of the specific pathologic type (7). Of the primary retroperitoneal neoplasms, 70%–80% are malignant in nature, and these account for 0.1%–0.2% of all malignancies in the body (6). Computed tomography is the preferred modality in imaging of the retroperitoneum. The attenuation differences between retroperitoneal fat and
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organs increase the diagnostic accuracy of CT in detection of retroperitoneal diseases (10). Familiarity with retroperitoneal anatomy and the radiographic signs to identify an intra-abdominal mass as primary retroperitoneal enable differentiation between primary and secondary masses. The differential diagnosis of primary retroperitoneal masses may be based on the predominant cross-sectional imaging appearance as either cystic or solid and neoplastic and non-neoplastic. Characteristic imaging findings, such as the composition, enhancement pattern, location, and relationship to adjacent structures, may be combined with clinical information to help narrow the differential diagnosis (11).

Anatomy of retroperitoneal space:-

The retroperitoneum is a complex compartment, the anatomy of which has yet to be fully validated (1). The currently accepted model of the retroperitoneum anatomy has been proposed by Meyers (1974, 1994) who led to an enhanced understanding of retroperitoneal anatomy and pathology (9). The retroperitoneum is the compartmentalized space bounded anteriorly by the posterior parietal peritoneum and posteriorly by the transversalis fascia. It extends from the diaphragm superiorly to the pelvic brim inferiorly. The abdominal retroperitoneum is divided by fascial planes into the anterior and posterior pararenal spaces and the perirenal (or perinephric) space, Figures 1 and 2 (2). The renal fasciae, namely, the anterior and posterior renal fasciae, represent the fundamental anatomical structures for the division of the retroperitoneal space, and they are clearly visible on computed tomography imaging Figure 3. The renal fasciae are usually not thicker than 3 mm. If renal fasciae appear thicker than 3 mm, this is often due to a retroperitoneal space disease, corresponding mainly to acute pancreatitis, renal pathologies, and abdominal aorta aneurysm rupture (9). Because of loose connective tissue in the retroperitoneum, tumors can have widespread extension before clinical presentation (3).

Patients and methods

Study design:
This prospective study was performed aiming to determine the role of MSCT imaging in the differential diagnosis of primary retroperitoneal masses.

Study population:
The study was performed at Benha university hospital, national cancer institute and informed consents were given by all patients. The study was conducted on 43 patients (24 males and 19 females) and (mean age, 52 years) presented with abdominal or pelvic swelling (on clinical examination or detected by previous imaging studies) suspected to be of retroperitoneal origin) between January 2015 till August 2016, to perform CT abdomen and pelvis for initial assessment or follow up.
Inclusion Criteria:
- Patients with retroperitoneal mass lesions were included.

Exclusion Criteria:
- Patients with lesions not located at the retroperitoneal region.
- Patients with retroperitoneal lesion originating from retroperitoneal organs (example: kidneys, adrenal glands and pancreas).
- Pregnant patients.
- Patients with unstable general condition.

Multi-slice CT abdomen and pelvis abdomen and pelvis was done.

CT examination protocol design:
CT exams were performed on a GE light speed VCT 64 multislice CT scanner and Toshiba Asteion 4 slice CT scanner.

CT abdomen and pelvis with oral and IV contrast was performed using the following parameters; (350 mA, 120 KV, 0.5 second tube rotation time, slice thickness 5 mm, 8 mm table feed & 3 mm incremental reconstruction).
Noncontrast CT was done in patients with impaired renal function (creatinine level >2 mg/dl) and/or have history of hypersensitivity for contrast media.

Patient Preparation for CT examinations:
All patients were asked to fast for six hours prior to scan. All metallic items were removed from the patient, including, pants with zipper etc. and the patients were given gown to wear. An I.V. cannula was inserted in the patient’s arm for administration of contrast.

CT images interpretation:
The CT data was evaluated by two experienced radiologists in consensus; both observers were unaware of the pathological data of each patient.

CT images:
On CT, confirming site as retroperitoneal was done first, followed by assessment of definition, consistency, components of the lesion (fat, calcium, necrosis), pattern of enhancement (unenhanced, homogeneous or heterogeneous) and average CT attenuation (by measuring HU in 5 different locations and calculating the average HU).

Starting with the approach to the abdominal or pelvic mass followed by differentiation of solid primary retroperitoneal masses according to location, pattern of spread, vascularity and composition. The cystic lesions were differentiated according to the site, specific imaging characteristics and clinical history.

CT images interpretation:
In each case the CT imaging features of the lesions were interpreted as above described resulting in either reaching the most probable diagnosis, or two differential diagnoses, more than 2 differential diagnoses or failed to reach definite diagnosis.
Correlation of these results with pathological data was then done.

**Standard of reference:**
All cases were submitted for pathological analysis either following open surgical biopsy, surgical excision, or image guided biopsy by CT or US. Pathological data were taken as the standard of reference.

**Results**
A total of 43 patients presented with abdominal or pelvic swelling (detected by clinical examination or by previous imaging study suspected to be of retroperitoneal origin), the mean disease duration was 13.4 years (SD10.4) and their mean age was 31.75 ± 21.48 SD.

On CT, confirming site as retroperitoneal and excluding organ of origin was done first, followed by assessment of definition (Table 1), consistency, components of the lesion (fat, calcium, necrosis), pattern of enhancement (unenhanced, homogenous or heterogeneous), vascularity and average CT attenuation (by measuring HU in 5 different locations and calculating the average HU).

<table>
<thead>
<tr>
<th>CT definition</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well defined</td>
<td>21</td>
<td>48.8%</td>
</tr>
<tr>
<td>Ill defined</td>
<td>22</td>
<td>51.1%</td>
</tr>
</tbody>
</table>

Regarding the consistency (Table 2)
- **Nine lesions** was purely cystic which was lymphocele (n = 2), simple cysts (n = 2), lymphangioma (n = 2), Mucinous cystadenoma (n = 2), and Pancreatic pseudocysts (n = 1).
- **Six lesions** were mixed solid and cystic,, Ganglioneuroma(n = 1), Pseudomyxoma peritoneii(n = 1), teratoma(n = 3), schwannoma(n = 1).
- The rest of the lesions was solid.

<table>
<thead>
<tr>
<th>CT consistency</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid</td>
<td>28</td>
<td>65.1%</td>
</tr>
<tr>
<td>Cystic</td>
<td>9</td>
<td>20.9%</td>
</tr>
<tr>
<td>Mixed</td>
<td>6</td>
<td>14%</td>
</tr>
</tbody>
</table>
Regarding the composition (Table 3)

- **Fat:** Eight lesions contain fat, 3 of which were Liposarcoma, 3 were teratoma and two lesions were lipoma.
- **Calcification:** Twelve lesions contain calcifications as follows: neuroblastoma (n = 5), liposarcoma (n = 1), myofibroblastic tumor (n = 1), primary germ cell tumor (n = 1), Mucinous cystadenoma (n = 1) and teratoma (n = 2). Ganglioneuroma (n = 1)
- **Necrosis:** Fifteen lesions show internal necrosis as follows: neuroblastoma (n = 4), paraganglioma (n = 2), liposarcoma (n = 2), Liemysarcoma (n = 1), myofibroblastic tumor (n = 1), primary germ cell tumor (n = 1), Undifferentiated sarcoma (n = 2), schwannoma (n = 1), lymphoma (n = 1), spindle cell sarcoma (n = 1) and metastatic LN (n = 1).

<table>
<thead>
<tr>
<th>CT components</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>8</td>
<td>18.6%</td>
</tr>
<tr>
<td>Calcifications</td>
<td>12</td>
<td>27.9%</td>
</tr>
<tr>
<td>Necrosis</td>
<td>15</td>
<td>34.9%</td>
</tr>
</tbody>
</table>

Regarding the vascularity of the lesions (Table 4)

- **Hyper-vascularity:** only one lesion was hyper-vascular; paraganglioma
- **No or hypo-vascularity:** 20 lesions show no or hypo-vascularity as follows retroperitoneal fibrosis (n = 1), liposarcoma (n = 3), schwannoma (n = 1), lymphoma (n = 4), ganglieneuroma (n = 1), Mucinous cystadenoma (n = 1), pancreatic pseudocysts (n = 1), neuroblastoma (n = 1), lymphanglioma (n = 1), cystic mesotheliomas (n = 2), lipoma (n = 2), lymphocele (n = 2).
- **Moderate vascularity:** The rest of the lesions show moderate vascularity.

<table>
<thead>
<tr>
<th>CT vascularity</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No or Hypo</td>
<td>20</td>
<td>46.5%</td>
</tr>
<tr>
<td>Moderate</td>
<td>22</td>
<td>51.1%</td>
</tr>
<tr>
<td>Hyper</td>
<td>1</td>
<td>2.3%</td>
</tr>
</tbody>
</table>
Regarding lesion enhancement (Table 5)

- Eleven lesions were unenhanced as follows: retroperitoneal fibrosis (n = 1), lymphocele (n = 2), schwannoma (n = 1), pancreatic pseudocysts (n = 1), neuroblastoma (n = 1), lymphangioma (n = 1), cystic mesotheliomas (n = 2), lipoma (n = 2)

- Five lesions show homogenous enhancement as follows: Paraganglioma (n = 1) which was markedly enhanced and lymphoma (n = 4) which was mildly enhanced

- The rest of the lesions show heterogeneous enhancement.

<table>
<thead>
<tr>
<th>CT enhancement</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unenhanced</td>
<td>11</td>
<td>25.6%</td>
</tr>
<tr>
<td>Homogenous</td>
<td>5</td>
<td>11.6%</td>
</tr>
<tr>
<td>Heterogeneous</td>
<td>27</td>
<td>62.8%</td>
</tr>
</tbody>
</table>

Matching of pathological diagnosis & CT imaging diagnosis (Table 6)

- Twenty five lesions matched the only diagnosis by CT as follows: Liposarcomas (n = 3), lymphomas (n = 4), neuroblastoma (n = 3), retroperitoneal fibrosis (n = 1), lymphocele (n = 2), paraganglioma (n=1) Retroperitoneal metastatic LN (n = 2), cystic mesotheliomas (n = 2), lipoma (n = 2), lymphangioma (n = 1), teratoma (n=3) and Pancreatic pseudocysts (n=1)

- Five lesions matched two differential diagnoses by CT as follows: neuroblastoma (n = 1), ganglioneuroma (n = 1) and schwannoma (n =2) Mucinous cystadenoma (n=1)

- Three lesions were one of more than two differential diagnoses by CT as follows: Neuroblastoma (n=1) and the Pseudomyxoma retroperitonei (n=1), myofibroblastic tumor (n = 1)

- Ten lesions didn't match the pathological diagnosis as follows: lymphoma (n = 1), myofibroblastic tumor (n = 2), other sarcomas (n = 6) and primary germ cell tumor (n =1)
Table (6) Matching of pathological diagnosis and CT imaging diagnosis

<table>
<thead>
<tr>
<th>Matching of pathological diagnosis and CT imaging diagnosis</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistent with the only diagnosis by CT</td>
<td>25</td>
<td>58.1%</td>
</tr>
<tr>
<td>Was one of two differential diagnoses by CT</td>
<td>5</td>
<td>11.6%</td>
</tr>
<tr>
<td>Was one of more than two differential diagnoses by CT</td>
<td>3</td>
<td>6.9%</td>
</tr>
<tr>
<td>Was not included as a differential diagnosis by CT or no definite diagnosis was reached by CT</td>
<td>10</td>
<td>23.2%</td>
</tr>
</tbody>
</table>

The ability of CT to narrow the differential diagnosis of primary retroperitoneal masses (Table 7)

- **Positive**: if the pathological diagnosis matched with the only diagnosis by CT or was one of two differential diagnoses by CT
- **Negative**: if the pathological diagnosis was one of more than two differential diagnoses by CT, was not included as differential diagnosis by CT or no definite diagnosis was reached by CT.

**Positive** results include 30 lesions and negative results include 13 lesions with the accuracy 69.7%.

Table (7) Ability of MSCT to narrow the differential diagnosis.

<table>
<thead>
<tr>
<th>Ability of MSCT to narrow the diagnosis</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>30</td>
<td>69.7%</td>
</tr>
<tr>
<td>Negative</td>
<td>13</td>
<td>30.1%</td>
</tr>
</tbody>
</table>
Fig (1): Drawing of the anatomy of the retroperitoneal spaces at the level of the kidneys. The anterior pararenal space (APRS) is located between the parietal peritoneum (PP) and the anterior renal fascia (ARF) and contains the pancreas (Pan), the ascending colon (AC), and the descending colon (DC). The posterior pararenal space (PPRS) is located between the posterior renal fascia (PRF) and the transversalis fascia (TF). The perirenal space (PRS) is located between the anterior renal fascia and the posterior renal fascia. Ao = aorta, IVC = inferior vena cava, LCF = lateroconal fascia (12).

Fig (2): Diagram of the left retroperitoneal space detailing the fasciae and compartments (1).

Fig (3): Computed tomography. Anatomy of the retroperitoneal space. AA abdominal aorta, ARF anterior renal fascia, DC descending colon, IVC inferior vena cava, LCF lateroconal fascia, PRF posterior renal fascia, PM psoas muscle, QL quadratus lumborum muscle, UR ureter (9).
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Fig (5): Post contrast CT scan of 50 years old male patient with Hodgkin lymphoma axial cut show large isodense soft tissue showing with no necrotic changes or calcification, no significant contrast enhancement detected.

Fig (6): Post contrast CT scan of 4.5 years old female with neuroblastoma, axial cut revealed large left retroperitoneal mass with dense scattered calcifications and heterogenous enhancement.

Fig (4): Axial contrast enhanced CT scan of 61 years old male patient with retroperitoneal fibrosis show mantle like lesion encasing the aorta and I.V.C. as well as medial deviation of both ureters toward the lesion. Bilateral double J catheters are seen.
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Fig (7): Post contrast CT scan of 23 years old female with paraganglioma, axial cut show large hypervascular mass lesion showing internal necrosis as well as dense contrast enhancement.

Fig (8): Contrast enhanced CT scan of 22 years old female showing retroperitoneal lipoma. Axial cut show anterior and leftward displacement of the small bowel loops by a large right iliac well defined lobulated fat containing lesion with no calcification within.

Fig (9): Contrast enhanced CT scan of 53 years old female showing retroperitoneal teratoma. Axial cut show anterior displacement of the pancreas by a well defined mixed mass lesion (soft tissue and fat attenuation) with calcification within.

Fig (10): Contrast enhanced CT scan of 53 years old female with malignant fibrous histiocytoma. Revealed large right lumbar retroperitoneal mass with scattered calcifications and faint enhancement.
Discussion

Diagnosis of a primary retroperitoneal mass may be made once the location is confirmed as within the retroperitoneal space and after an organ of origin is excluded.

Although computed tomography imaging can demonstrate important characteristics of these tumors, diagnosis is often challenging for radiologists. Diagnostic challenges include precise localization of the lesion, determination of the extent of invasion, and characterization of the specific pathologic type.

The differential diagnosis of primary retroperitoneal masses may be based on the predominant CT imaging appearance as either cystic or solid and neoplastic and non-neoplastic.

Characteristic imaging findings, such as the composition (Fat, calcification and necrosis), enhancement pattern, vascularity, location, and relationship to adjacent structures, may be combined with clinical information to help narrow the differential diagnosis.

In each case of our patients the CT imaging features of the lesions were interpreted by two experienced radiologists, resulting in either reaching the most probable diagnosis, or two differential diagnoses, more than 2 differential diagnoses or failed to reach definite diagnosis.

Correlation of these results with pathological data was then done. The accuracy of CT assisted by the postulated scheme to narrow the differential diagnosis was 69.7%

Our study was carried upon 43 cases, most of them were suspected to be of retroperitoneal origin (location), and the rest of them were accidentally discovered. These cases were classified as primary retroperitoneal origin into solid and cystic masses,

Most of the previous studies were assessing the ability of CT in the diagnosis of retroperitoneal masses regarding exact localization and being benign or malignant, without addressing reaching the exact diagnosis or narrowing the differential diagnosis of the primary retroperitoneal mass. Lane et al., (1989) in their study, CT scans obtained at initial presentation in 90 patients with primary retroperitoneal neoplasms were reviewed. Pathologic specimens and clinical histories were reviewed and correlated with CT findings. They concluded that although CT is nonspecific in many cases, a number of CT features and clinical findings may suggest specific diagnoses when present (1) presence of calcification
in malignant fibrous histiocytoma; (2) presence of fat in a mass lesion of heterogeneous density in liposarcoma; (3) large regions of necrosis in leiomyosarcoma; (4) calcified tumor in a child in neuroblastoma; (5) hypervascularity of hemangioma and hemangiopericytoma; (6) catecholamine excess and paraaortic location in paraganglioma; (7) homogeneous, low density of neurofibroma; (8) homogeneous, fat density of lipoma; and (9) characteristic mixed components of teratoma.

The clinical findings and radiological features of 25 patients with primary retroperitoneal tumors were retrospectively evaluated in a study done by Jun Nakashima, (1997) to find the signs that might contribute to the preoperative distinction between benign and malignant tumors. Of 25 primary retroperitoneal tumors, 15 were benign. A retroperitoneal tumor scoring system was developed to distinguish primary retroperitoneal benign tumors from their malignant counterparts based on the: 1) maximum diameter equal to or larger than 5.5 cm, 2) presence of symptoms, 3) absence of calcification, 4) presence of irregular margins, and 5) presence of cystic degeneration or necrosis. Their study suggests that the size of tumor, the presence of symptoms, irregular margins, and the absence of calcification may be valuable predictors of primary retroperitoneal malignant tumor.

As discussed above most of the previous studies were assessing the ability of CT in the diagnosis of retroperitoneal masses regarding exact localization and being benign or malignant, However our study is considered unique in addressing reaching the exact diagnosis or narrowing the differential diagnosis of the primary retroperitoneal masses.

**Conclusion**

Familiarity with retroperitoneal anatomy and the radiographic signs to identify an intra-abdominal mass as primary retroperitoneal enable differentiation between primary and secondary masses.

The differential diagnosis of primary retroperitoneal masses may be based on the predominant cross-sectional CT imaging appearance as either cystic or solid and neoplastic and non-neoplastic. Characteristic imaging findings, such as the composition (Fat, calcification and necrosis), enhancement pattern, vascularity, location, and relationship to adjacent structures, may be combined with clinical information to narrow the differential diagnosis.
References

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الملخص العربي

دور الأشعة المقطعية الحلزونية في تشخيص أورام ما خلف الغشاء البريتوني.

الأورام الأولية خلف الصفاق هي مجموعة متنوعة من الأورام الحميده والخبيثه والتي تنشأ خلف الصفاق ولكن خارج الأعضاء الرئيسية.

يعتبر التصوير المقطعي بواسطة الأشعة المقطعية الحلزونية وسيلة هامة في معرفة الكتال والأورام التي تنشأ خلف العضلة البريتوني وذلك بتحديد منشأها والتفرقة بينها بناء علي عدة صفات هامة.

التوصيف التفريقي بين الكتال الأولية خلف الصفاق عن طريق الأشعة المقطعية الحلزونية قد يبنى على المظهر الغالب في التصوير المقطعي إما كيس أو صلب وورم أو غير ورم. نتائج التصوير المميزه مثل التكوين (دهون، نكس ونخر)، ونطاع التعزيز التبائي، الأوعية الدموية، الموقع، والعلاقة مع ما حوله، بالإضافة للمعلومات الإكلينيكية يساعد في تضيق التشخيص التفريقي.

تم البحث علي 43 مريضا من مختلف الراحل العمرية بإجراء فحوص أشعة مقطعية متعددة المقاطع على البطن والحوض في الفترة ما بين يناير 2015 حتى أغسطس 2016 وقد تمت المقارنة بين نتائج الفحص المقطعي ونتائج التحليل الباثولوجي لنفس الحالات.

ومن خلال الدراسة تبين أن التشخيص الأولي للحالات باستخدام الأشعة المقطعية المتعددة المقاطع كان صحيح بنسبة 69.7% وذلك بالمقارنة بنتائج التحليلي الباثولوجي...وэтому فقد ساعدت الأشعة المقطعية الحلزونية في إزاحة تكبيث خلف الصفاق الطبيعية، مثل أعضاء خلف الصفاق أو الأوعية الدموية.