Mixed epithelial and stromal tumor (MEST) of the kidney is a rare, typically benign lesion that occurs predominantly in perimenopausal women. At computed tomography (CT), it typically manifests as a multiloculated cystic renal mass with a variable proportion of solid and cystic components and containing internal septa that demonstrate heterogeneous and delayed contrast material enhancement. MEST may mimic a variety of benign and malignant renal lesions, such as adult cystic nephroma, complex renal cyst, and cystic renal cell carcinoma. The preoperative diagnosis of MEST can be problematic, and most cases are treated surgically. However, CT with two-dimensional multiplanar reformation and three-dimensional volume rendering helps define the diagnostic features of MEST and can assist in surgical planning.

LEARNING OBJECTIVES

After reading this article and taking the test, the reader will be able to:

■ Describe clinical and pathologic features of mixed epithelial and stromal tumor of the kidney.
■ Differentiate the radiologic features of this tumor from those of other cystic renal lesions.
■ Discuss management implications of a preoperative diagnosis of mixed epithelial and stromal tumor of the kidney.

TEACHING POINTS

See last page

Abbreviations: ACN = adult cystic nephroma, MDK = multicystic dysplastic kidney, MEST = mixed epithelial and stromal tumor, RCC = renal cell carcinoma, 3D = three-dimensional, VR = volume-rendered

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Introduction

Mixed epithelial and stromal tumor (MEST) of the kidney is a rare, recently defined entity that was first described by Michal and Syrucek in 1998 (1). It was previously referred to as leiomyomatous renal hamartoma, multilocular cyst with ovarian stroma, cystic hamartoma of the renal pelvis, or adult type mesoblastic nephroma (2–5). The current literature on MEST has focused on its pathologic features (6,7), with only a small number of case reports and case series having addressed its radiologic features (8–11). In this article, we discuss and illustrate the clinical, radiologic, and pathologic features of five cases of MEST, with emphasis on the role of multidetector computed tomography (CT), the imaging differential diagnosis for MEST, and management implications.

Clinical and Pathologic Features of MEST

About 100 cases of MEST have been reported in the literature, with the tumor occurring almost exclusively in perimenopausal women (1,7,10,11). Only seven cases of MEST have been reported in men (7,8,12–14), one of whom had a history of prostatic adenocarcinoma and had been treated with diethylstilbestrol for 7 years and then with lupron for 4 years before the renal mass was detected (7). Many of the affected women reported a history of long-term oral estrogen therapy (7). Most patients presented with symptoms such as hematuria, flank pain, a palpable mass, or urinary tract infection (7,10). Approximately 25% of MESTs were identified incidentally (7,10).

MEST is a complex solid and cystic renal tumor with stromal and epithelial elements. The stromal component consists of spindle cells that mimic ovarian stroma and that express estrogen and progesterone receptors. The epithelial component contains epithelium-lined cysts or microcysts (15). In almost all reported cases, MEST has behaved in a benign fashion following surgical resection. There have been a few reported cases of malignant sarcoma associated with MEST (16–21), with local recurrence following surgical resection having been described in a subset of these cases (18,21). Given the rarity of MEST, it is difficult to determine whether these reports of malignant sarcoma represent true malignant transformation from underlying MEST, or a malignant sarcoma with entrapped tubules and cystic change. In all five cases in our study, MEST demonstrated benign histologic features.

Radiologic Features of MEST

The classic CT appearance of MEST is that of a well-circumscribed, multiseptate cystic and solid mass with delayed contrast material enhancement (8,10,11). Because MEST so rarely occurs, its ultrasonographic (US) and magnetic resonance (MR) imaging features are less well described. Park et al (8) described a case in which MEST appeared as a heterogeneous hyperechoic mass at US and as a solid and cystic mass with heterogeneous enhancement at MR imaging. Sahni et al (11) described a case in which MEST appeared as a well-margined, partially cystic mass with a central nodule at US. At MR imaging, the cystic region demonstrated T1 hypointensity and T2 hyperintensity, whereas the central nodular component demonstrated T1 hyperintensity, T2 hypointensity, and evidence of contrast enhancement (11).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Clinical and Imaging Features in Five Cases of MEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feature</td>
<td>Case 1</td>
</tr>
<tr>
<td>Patient age (y)/gender</td>
<td>60/F</td>
</tr>
<tr>
<td>Maximum size (cm)</td>
<td>15.5</td>
</tr>
<tr>
<td>Side</td>
<td>R</td>
</tr>
<tr>
<td>Exophytic</td>
<td>Y</td>
</tr>
<tr>
<td>Renal sinus invagination</td>
<td>N</td>
</tr>
<tr>
<td>Cystic composition (%)</td>
<td>&gt;75</td>
</tr>
<tr>
<td>No. of septa</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Calcifications</td>
<td>Y</td>
</tr>
<tr>
<td>Nodule</td>
<td>N</td>
</tr>
<tr>
<td>Enhancement</td>
<td>Y</td>
</tr>
<tr>
<td>Bosniak classification</td>
<td>III</td>
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</table>
In all five cases in our study, MEST appeared as an expansile complex renal mass with heterogeneous and delayed contrast enhancement (Table 1). In three cases, MEST demonstrated the classic multiloculated cystic appearance with a variable proportion of cystic and solid components (Figs 1–3) (11). Internal septa demonstrated variable contrast enhancement, and an enhancing mural nodule was identified in one case (Fig 3). It has been postulated that the extent of delayed enhancement may depend on the spindle cell components of these tumors, with
Figure 2. Case 2. MEST in an asymptomatic 39-year-old woman in whom a 9-cm cystic right renal lesion had been diagnosed 20 years earlier during work-up for nocturnal enuresis. At routine follow-up, the mass was over 20 cm in diameter. (a) Axial nonenhanced CT scan shows a well-circumscribed mass with mixed solid and cystic components that has replaced the upper pole and midpole of the right kidney. Focal hyperattenuating regions (arrow), likely representing focal hemorrhages, and focal mural calcification (arrowhead) are also present. (b, c) On axial arterial phase (b) and excretory phase (c) contrast-enhanced CT scans, the mass is seen to contain thick septa and solid components with delayed contrast enhancement. (d, e) Coronal 3D arterial phase (d) and excretory phase (e) VR CT images better depict the enhancing internal septa. The patient underwent radical nephrectomy. (f) Photograph shows the gross specimen. Scales are in centimeters (left) and inches (right). (g) Photograph of a cut section of the gross specimen demonstrates thick solid components, thick internal septa, and multiloculated cysts.
Figure 3. Case 3. MEST in a 67-year-old woman with a history of deep venous thrombosis in the left leg caused by a fall. A cystic left renal mass was incidentally noted at CT. (a) Axial nonenhanced CT scan shows a well-defined, exophytic, multiloculated cystic mass arising from the lateral mid- to lower pole of the left kidney. (b, c) On axial arterial phase (b) and excretory phase (c) contrast-enhanced CT scans, the mass is seen to contain thick irregular septa with delayed enhancement. A small mural nodule with delayed enhancement is also seen (arrow in c). (d) Axial 3D venous phase VR CT image more clearly depicts the small, enhancing mural nodule (arrow). (e) Coronal 3D excretory phase VR CT image more clearly delineates the thick irregular septa (arrow) and the dominant cyst along the superior pole of the mass (arrowhead). The patient underwent radical nephrectomy. (f) Photograph of a cut section of the gross specimen shows thick enhancing septa along the inferior pole of the mass (arrow). The cystic portion along the superior pole of the mass (arrowhead) represents hemorrhagic acellular material. Scale is in centimeters.
Figure 4. Case 4. MEST in a 57-year-old woman with a history of urinary tract infections and right flank pain. (a) Axial nonenhanced CT scan shows a well-defined, predominantly fatty lesion with few internal septa in the middle lower pole of the right kidney. (b–d) Axial arterial phase contrast-enhanced (b), axial excretory phase contrast-enhanced (c), and coronal arterial phase multiplanar reformed (d) CT images demonstrate minimal delayed contrast enhancement of the internal septa. No appreciable cystic component was identified at CT. (e, f) Photographs of the gross specimen (e) and of a cut section of the gross specimen (f) demonstrate a predominantly fatty lesion. Scale in e is in centimeters.
more intense enhancement in densely cellular areas and minimal enhancement in fibrotic areas (8). Two cases demonstrated focal mural calcifications (Figs 1, 2), and one case demonstrated focal hyperattenuating areas compatible with hemorrhage (Fig 2).

In case 4, which is atypical of MEST, the tumor consisted of a predominantly fatty lesion with no appreciable cystic component at CT (Fig 4). The preoperative diagnosis in this case was angiomyolipoma. The results of pathologic evaluation were consistent with a diagnosis of MEST, and the presence of adipose tissue in MEST has previously been reported (7). MEST may also herniate into the renal pelvis and simulate a transitional cell carcinoma, as demonstrated in Figure 5 (10,22).

**Imaging Differential Diagnosis**

Given its variable appearance, MEST may mimic an array of cystic renal lesions, including adult cystic nephroma (ACN), cystic renal cell carcinoma (RCC), complex cyst, multicystic dysplastic kidney (MDK), an obstructed duplicated renal collecting system, and renal abscess (Table 2).
Table 2
Clinical and Imaging Features of MEST versus Other Cystic Renal Lesions

<table>
<thead>
<tr>
<th>Feature</th>
<th>MEST</th>
<th>ACN</th>
<th>Cystic RCC</th>
<th>Complex Cyst</th>
<th>MDK</th>
<th>Renal Abscess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient characteristics</td>
<td>Postmenopausal</td>
<td>Postmenopausal</td>
<td>Age 50–80 y (M &gt; F)</td>
<td>Usually older</td>
<td>Prenatal</td>
<td>History of urinary tract infection, vesicoureteral reflux, and renal calculus</td>
</tr>
<tr>
<td>Mural calcifications</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Septa</td>
<td>Thin</td>
<td>Thin</td>
<td>Thick, irregular</td>
<td>Thin</td>
<td>Thin</td>
<td>Thick, irregular</td>
</tr>
<tr>
<td>Solid nodule</td>
<td>Y/N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Enhancement</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

In the 2004 World Health Organization classification of renal neoplasms, MEST of the kidney and ACN were considered separate entities. However, recent studies suggest that MEST and ACN may represent different parts of the morphologic spectrum of the same disease (15). The two neoplasms share many clinical and pathologic features. Both have a female predilection and predominantly affect perimenopausal women, and, at CT, both appear as a complex cystic lesion with thin septa (Fig 6). In addition, both may herniate into the renal pelvis, resulting in hemorrhage or urinary obstruction (9,10).

By definition, ACN is a multilocular cystic lesion with no solid area at gross examination and with cystic septa less than 5 mm in thickness at microscopy, whereas MEST is a cystic or partially cystic mass with solid areas at gross examination and cystic septa greater than or equal to 5 mm (15). However, it is difficult to differentiate between MEST and ACN on the basis of imaging findings alone. Because both ACN and MEST are benign cystic renal lesions, the precise preoperative radiologic diagnosis may not be critically important, as long as the lesion in question can be differentiated from malignant lesions such as RCC and transitional cell carcinoma.

Because most MEST’s represent Bosniak category III or IV lesions, a cystic RCC is an important consideration in the differential diagnosis. Cystic change occurs in up to 15% of RCCs. The spectrum of cystic RCC includes multilocular cystic RCC, RCC arising from a preexisting benign cyst, and cystic degeneration of a previously solid RCC (23). Compared with MEST; cystic RCC tends to have thicker, irregularly enhancing septa and enhancing nodular or solid components (Fig 7). Complex renal cyst is also part of the spectrum of cystic renal lesions. Complex renal cysts contain thin, nonenhancing internal septa with thin mural calcifications and no mural nodularity (Fig 8).

Given its multiloculated cystic appearance, MEST may also mimic MDK or an obstructed duplicated renal collecting system. MDK demon-
strates replacement of normal renal parenchyma with variable-sized cysts that do not interconnect (Fig 9). There is minimal or no contrast enhancement, and no contrast material excretion is seen during the excretory phase (Fig 9). Figure 10 demonstrates a duplicated renal collecting system with obstructed upper pole calices, a finding that may simulate a cystic renal lesion. This finding can be identified at CT urography, which demonstrates delayed contrast material excretion into the obstructed collecting system (Fig 10).
Figure 10. Incidentally noted duplicated right renal collecting system with obstructed upper pole calices in a 28-year-old woman with a history of familial adenomatous polyposis. (a) Coronal arterial phase multiplanar reformatted CT image shows a duplicated renal collecting system with obstruction of the upper pole calices in the right kidney. (b) Axial excretory phase CT scan shows delayed contrast material excretion into the upper pole calices (arrow).

Figure 11. Renal abscess in an 80-year-old man with *Pseudomonas* urosepsis. Axial arterial phase CT scan shows an ill-defined area of decreased heterogeneous contrast enhancement in the anterior upper pole of the right kidney (white arrow), a finding that represents pyelonephritis. Note the cystic lesion with a thick enhancing wall in the posterior upper pole of the right kidney (black arrow), a finding that represents a renal abscess. The patient underwent treatment with antibiotics, and at 3-month follow-up imaging, the renal abscess had resolved with minimal residual cortical scarring.

MEST may also simulate a renal abscess. Renal abscesses demonstrate a thick, irregularly enhancing wall with infiltration of the perirenal fat (Fig 11). The patient's clinical history is essential to the diagnosis.

**Role of Multiplanar Reformation and VR**

Isotropic imaging with multiplanar reformation and especially with VR more clearly depicts enhancing intratumoral septa, which are key diagnostic features of MEST (Figs 1d, 1e, 2d, 2e). It also helps determine tumor extent, involvement of the vascular and collecting system, and the anatomic relationship between the tumor and surrounding organs (Fig 5d, 5e). Therefore, 3D VR CT allows optimal visualization of the tumor (thereby helping identify appropriate candidates for nephron-sparing surgery) and of aberrant vasculature that might be difficult to assess laparoscopically (24).

**Management Implications**

Preoperative radiologic diagnosis of MEST is problematic, since 70% of these tumors are Bosniak category IV or solid lesions (10). Therefore, MEST is treated surgically in most cases. The
diagnosis of MEST should be considered in (a) middle-aged women, (b) women with a history of exposure to exogenous estrogen, (c) cystic renal tumors with delayed contrast enhancement, and (d) tumors arising from the renal pelvis with negative urine cytologic findings (12).

Conclusions
MEST of the kidney is a rare, benign cystic neoplasm that predominantly affects perimenopausal women. Its typical CT appearance is that of a multiloculated cystic lesion with a variable proportion of solid and cystic components. Two-dimensional multiplanar reformatted and 3D VR CT scans help define the diagnostic features of MEST and can assist in surgical planning.

References
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