Renal Cell Carcinoma

Radiological diagnosis and staging

Juan Camilo Calderón Vélez

Universidad de Antioquia
Medellín-Colombia
Harvard Medical School-BIDMC
Boston-United States of America

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Agenda

• Patient presentation
• Generalities of renal cell carcinoma (RCC) and the matter of the small renal masses.
• Diagnosis of RCC: US, CT, MRI findings
• Differential diagnosis
• Staging RCC: US, CT, MRI findings
• Conclusions
• Bibliography and References
• Acknowledgments
Our patient

• A 52 year-old female was admitted with a one day history of abdominal pain and fever, more localized to left lower quadrant.

• Past surgical and medical history: visits for diverticulitis, hypertension, several abdominal surgeries.
Our patient

• Abdominal examination: soft, non-distended, bowel sounds presents, left lower quadrant tenderness with no guarding, rebound or rigidity. No masses were noted.

• An abdominal CT was requested in the emergency department for the work-up of her pain.
Abdominal CT of our patient

PACS, BIDMC
Our patient

- The diagnosis of diverticulitis was made to account for her abdominal pain.
- A small renal mass was incidentally detected on the CT.
- A consultation was made for such renal mass.
- A renal US was requested for further work-up of this renal mass.
US of our patient

Solid renal mass and blood flow within the mass

PACS, BIDMC
US of our patient

IVC and renal vein of our patient

PACS, BIDMC
Our patient abdominal CT

- An abdominal CT was requested to follow up the diverticulitis.
Solid renal mass on CT
Solid renal mass on CT
Diagnosis

Renal cell carcinoma (RCC)
Discussion

• Many renal tumors are diagnosed incidentally: 25-40% of renal cell carcinomas are diagnosed after the incidental detection of a renal mass (1,2,3).
• It is increasing the detection of small renal masses (SRM).
• SRM definition (1)
• The majority of SRM enhancing are RCC: 82% (4)

1. AJR:2000(175);945-955
2. Urol Clin N Am 2003;30;499-514
3. Radiographics 2001;S237-54
4. Eur Radiol 2002;12;575-591
Discussion cont.

- RCC accounts for 80-90% of all primary renal neoplasms (1,2) and 2-3% of adult malignancies (1,3).
- Although the incidence peak is in the fifth to sixth decade of life (4), it has been reported in all of ages (5).

1. AJR 2000;(175):945-955
2. Urol Clin N Am 2003:30;499-514
Discussion cont.

- Approximately 90% of solid renal masses are RCC, but cystic renal mass may also be due to a RCC (1,2).
- Characteristically it is seen with hemorrhages, necroses, cystic areas (3), focal central or peripheral calcifications (4,5) and is highly vascularized.

1. AJR:2003(180);755-758
3. Imaging in oncology. 1998
4. Radiographics 2001;S237-54
Menu of Radiologic for diagnosis of RCC

Sensitivity for detecting renal mass (1):
- Excretory urography: 67% (low specificity)
- US: 79%
- CCT: 94%
- CT is superior than the others for detecting SRM
- HCT may reveal RCC with a sensitivity of 95-100% and specificity of 88-95% (2).

Ultrasound for RCC

**US findings (1):**
- Usually a solid mass, but it may be almost cystic.
- Increased vascularity on Doppler.
- Remember foci of calcification, necroses and hemorrhage.

**Limits of US:** it may miss tumors in patients who are difficult to examine (2) and it is an operator-dependent method.

Ultrasound for RCC cont.

- Tumor echogenicity is related to tumor size (1):
  Compared with renal parenchyma, if greater than 3 cm:
  - Hypoechoic: 19%
  - Isoechoic: 45%
  - Hyperechoic: 36% (85% if less than 3 cm)

RCC on ultrasound

AJR 2000;175(4):945-55
CT for RCC

- Unenhanced and enhanced CT are needed: pre and postcontrast density measurements of cyst and solid mass lesions (hypo, iso, hyperdense -1-) and depicting of calcifications (2).
- Nephrographic phase is the optimal phase (2).
- Enhancement of more than 10-12 HU: malignant mass (2,3).

3. Radiographics 2001;S237-54
CT for RCC cont.

- **CT findings** (1):
  - SRM: smooth, rounded contours, sharply marginated, solid homogeneous lesion.
  - Non-SRM: irregular, lobulated, unsharp margins, pseudocapsule, invasive, solid or cystic, ENHANCED HETEROGENEOUS lesion.

- The first option for the diagnosis of renal masses and RCC (2)

MRI for RCC

- MRI:
  - Valuable for those tumors with equivocal appearances on US or/and CT (1)
  - For diagnosis when IV iodinated contrast medium is contraindicated (2)
  - Pregnant patients (2)
  - Enhanced of a heterogeneous solid mass (2)

RCC on MRI

Courtesy Dr. Ivan Pedrosa, BIDMC
RCC vs. Renal Cysts

Remember: cysts may be complicated by a neoplasm arising from its epithelial lining (1,2).

- Evaluate (2):
  - Thickness of the wall
  - Number, contour and thickness of septations
  - Solid enhancing components
  - Attenuation of fluid in the cyst
  - Amount, character and location of calcifications

2. AJR 2003;180:755-58
Bosniak Classification of Renal Cystic Masses (1)

Category

I Cystic masses with well-defined margins, homogeneous, of water density, with no contrast enhancement.

II Cystic masses showing a few thin septa (< 1 mm) or thin fine calcifications, or appearing as hyperdense cysts.

III Cystic masses showing more extensive thickened and irregular calcifications, uniform wall thickening, and thickened and irregular or multiple septa (> 1 mm).

IV Cystic masses having irregular thickened walls or solid elements and possibly having enhancement of cyst walls, septa, or solid areas.

1. AJR 2003;180:755-58
Simple cyst on CT

Non enhanced

Enhanced

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Cysts neoplasm on CT

Fig. 2.—82-year-old man with left renal cell carcinoma. Contrast-enhanced CT scan shows exophytic low-attenuating left renal lesion with thickened walls (arrows). Biopsy results showed renal cell carcinoma, which was confirmed at surgery.

Fig. 3.—42-year-old woman with inflammatory left renal cyst. Contrast-enhanced CT scan shows multiloculated cystic lesion involving left kidney with thickened septation (straight arrow) and wall (curved arrow). Biopsy results showed inflammatory cyst, which was confirmed at surgery.

1. AJR 2003;180:755-58
Differential Diagnosis

- Angiomyolipoma
- Lymphoma
- Oncocytoma
- Metastases
- Infectious processes
- Pseudotumors
Renal lymphoma on CT

Radiographics 2000;20(1)197-212
### Table 2 – TNM staging system for renal cell carcinoma

<table>
<thead>
<tr>
<th>Primary tumour (T)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX</td>
<td>Minimum requirements to assess primary tumour cannot be met.</td>
</tr>
<tr>
<td>T0</td>
<td>No evidence of primary tumour.</td>
</tr>
<tr>
<td>T1</td>
<td>Small tumour. Minimal renal and calyceal distortion or deformity. Circumscribed neovascuature surrounded by parenchyma.</td>
</tr>
<tr>
<td>T2</td>
<td>Large tumour with deformity and/or enlargement of kidney and/or collecting system.</td>
</tr>
<tr>
<td>T3a</td>
<td>Large tumour involving perinephric tissues.</td>
</tr>
<tr>
<td>T3b</td>
<td>Tumour involving renal vein.</td>
</tr>
<tr>
<td>T3c</td>
<td>Tumour involving renal vein and infradiaphragmatic vena cava.</td>
</tr>
<tr>
<td>T3d</td>
<td>Tumour involving infra- and supradiaphragmatic vena cava and renal vein.</td>
</tr>
<tr>
<td>T4a</td>
<td>Tumour extending into neighbouring organs or abdominal wall.</td>
</tr>
<tr>
<td>T4b</td>
<td>Tumour extending intracardially.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Nodal involvement (N)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NX</td>
<td>Minimal requirements to assess nodal involvement cannot be met.</td>
</tr>
<tr>
<td>N0</td>
<td>No evidence of regional lymph node involvement.</td>
</tr>
<tr>
<td>N1</td>
<td>Single homolateral regional node involvement.</td>
</tr>
<tr>
<td>N2</td>
<td>Involvement of multiple regional or contralateral or bilateral nodes.</td>
</tr>
<tr>
<td>N3</td>
<td>Fixed regional nodes (assessable only at surgical exploration).</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Distant metastases (M)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MX</td>
<td>Not assessed.</td>
</tr>
<tr>
<td>M0</td>
<td>No (known) distant metastases.</td>
</tr>
<tr>
<td>M1</td>
<td>Distant metastases present.</td>
</tr>
</tbody>
</table>
US for staging

- **US** staging of tumors has been reported to have an accuracy of 50-70% (1).
- Kidneys, liver, and enlarged lymph nodes are well seen
- Thrombi in the renal vein, IVC or right atrium can be identified as an areas of diffuse echoes within the lumen of the vessels. Color Doppler can be helpful (1).

US for staging

Normal kidney

Normal IVC

Courtesy Dr. Nicole Nelson, BIDMC
CT for staging

- CT accuracy for staging: 72-91% (1,2,3,4)
- Look for direct invasion of adjacent organs: loss of tissue planes and irregular margins between the tumor and surrounding structures (1).
- Fails to detect extracapsular tumor: extent to perinephric fat (1,2).

1. Radiographics 2001;S237-54
Liver invasion from RCC on CT

Courtesy Dr. Raja Kyriakos, BIDMC
Lymph nodes on CT

Sensitivity for lymph node staging is reported as 83-89% (1): metastases vs. inflammatory changes (2). Renal, aorta and mediastinal nodes. They may enhance.

2. Radiographics 2001;S237-54
Two different patients with CT of RCC with lymph node metastases

Patient 1

Patient 2

Courtesy Dr. Raja Kyriakos, BIDMC
Renal vein and IVC involvement

- In 23% of patients the tumors can extent to renal vein (79% sensitivity on CT) and up to 10% to IVC (89%) (1,2)
- Look for: low attenuation filling defects and others (1)

1. Radiographics 2001;S237-54

Clin Radiol 1994;49(4):223-230
IVC involvement

Courtesy Dr. Raja Kyriakos, BIDMC
Distant metastases

- CT is appropriate for the diagnosis of distant metastases (1).
- Metastases are seen in up to 30-40% of the cases at diagnosis (2).
- Common sites (1,3): lungs, mediastinum, bones, liver
- Less common and rare sites (1,3,4,5,6): contralateral kidneys, adrenal glands, brain, pancreas, head and neck, female genitalia.

2. AJR 2000;(175):945-955
3. Radiographics 2001;S237-54
Lung metastases on CT

Courtesy Dr. Raja Kyriakos, BIDMC
Mediastinal lymphadenopathy

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Mediastinal lymphadenopathy

PACS, BIDMC
Extensive nodal and parenchymal metastases
MRI for RCC

- MRI accuracy for staging: 80-96% (1)
- It is as accurate as CT for detection of lymph node involvement, spread to adjacent organs, and metastases, it is helpful for visualizing thrombus in IVC if CT fails (1,2).

2. Semin Oncol 2000;27(2)150-59
Normal renal vein and IVC on MRI
Different Patients with RCC

Lossy Compressed

BIDMC

Courtesy Dr. Ivan Pedrosa, BIDMC
Conclusions

- When a physician is faced with a solid renal mass, approximately 80-90% of such masses will be RCC.
- CT is the method of choice for diagnosis, staging and follow up of RCC.
- If a RCC is detected and staged with CT, no more studies are needed.
- There has been a great improvement in radiological methods that have enhanced the ability to characterize SRM.
- Any renal mass that enhances with IV contrast medium should be considered a RCC until proven otherwise, however not all enhancing solid renal masses represent RCC.
Bibliography and References

Bibliography and References cont.

Bibliography and References cont.

Acknowledgments

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