VALUE OF MULTIDETECTOR COMPUTED TOMOGRAPHY IN STAGING OF RENAL CELL CARCINOMA

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Summary

The purpose of our paper was to show abilities of multidetector CT (MDCT) in staging of renal cell carcinoma (RCC) for proper preoperative assessment and choosing the therapy modality. MDCT has dramatically improved diagnostic evaluation of renal masses. The best results in detection and characterization of renal masses, as well as precise staging, can be achieved with a scanning protocol that includes a combination of unenhanced CT and contrast-enhanced scanning in the corticomedullary and nephrographic phases. MDCT represents the most effective imaging modality for the diagnosis and staging of RCC. In the majority of patients, MDCT is the only diagnostic imaging required for surgical planning.

KEY WORDS: *renal cell carcinoma, staging, MDCT*

VRIJEDNOST VIŠESLOJNE KOMPJUTORIZIRANE TOMOGRAFIJE U PROCJENI PROŠIRENOSTI KARCINOMA BUBREŽNIH STANICA

Sažetak

Cilj ovog rada bio je pokazati mogućnosti višeslojnog CT-a (MDCT) u procjeni proširenosti karcinoma bubrega za potrebe točnog planiranja kirurškog zahvata te za izbor terapijskog modaliteta. MDCT je znatno unaprijedio dijagnostičku procjenu tumora bubrega. Najbolji rezultati u otkrivanju i karakterizaciji tumora bubrega, kao i u preciznom određivanju proširenosti tumora, postižu se protokolom CT snimanja koji uključuje kombinaciju nativnog CT snimanja i CT snimanja uz uporabu intravenskog kontrastnog sredstva u kortikomedularnoj i nefrografskoj fazi. MDCT predstavlja najučinkovitiju slikovnu metodu za dijagnosticiranje i procjenu proširenosti karcinoma bubrega. U većine bolesnika, MDCT je jedina dijagnostička metoda potrebna za planiranje kirurškog zahvata.

KLJUČNE RIJEČI: *karcinom bubrega, procjena proširenosti, MDCT*

Renal cell carcinoma (RCC) is the most common primary neoplasm of the kidney, and its incidence has been rising over the past 50 years. Approximately 30,000 new cases are diagnosed in the United States each year (1, 2). The role of radiological assessment in RCC is to discriminate benign from malignant lesions, to adequately assess tumor size, localization and organ confinement, to identify lymph node and/or visceral metastases, and to define the presence of a thrombus in the venous system and the level of its superior extent (3-5). Surgical resection is the only effective treatment for RCC and survival depends on local and distant tumor extension. Therefore, precise staging is critical for preoperative planning and prognosis (6). Computed tomography (CT) is the most widely available and most effective modality for staging of RCC, with reported accuracy of 91% (7). The latest generation of CT device, MDCT, enables further im-

provement of precision in the evaluation of tumor extension. MDCT uses high-speed acquisition and due to its technical characteristics enables high-quality images with minimum artifacts and 3D postprocessing (2, 8).

The aim of the study was to show abilities of MDCT in the evaluation and staging of RCC for proper preoperative assessment and choosing the therapy modality.

MDCT has dramatically improved diagnostic evaluation of renal masses by rapid image acquisition in various phases of contrast enhancement (9-12). It is very important to be familiar with novel advantages offered by MDCT technology, as well as understand the values and limitations of each phase of enhancement after contrast medium administration.

Unenhanced MDCT should be the initial phase of any examination protocol for evaluation of suspicious renal masses. It gives basic information for further measuring of contrast enhancement within the lesion after the intravenous administration of a contrast medium. Contrast enhancement play a role in distinguishing a hyperdense cyst from a solid tumor: enhancement values of more than 12 HU suggest malignancy. Most RCC seen on unenhanced MDCT usually have attenuation values of 20 HU or higher. Small lesions are usually homogeneous in appearance, while large ones are mostly heterogeneous, due to necrosis or hemorrhage. Calcifications are found in up to 30% of the cases of RCC (13).

Approximately 20-70 seconds after the intravenous injection of iodinated contrast material, the corticomedullary phase is seen (Figure 1). In this phase, the renal cortex is brightly opacified and can be easily differentiated from the renal medulla. Small masses can be missed in the corticomedullary phase, thus causing a false negative finding. False positive diagnosis can be made due to heterogeneous enhancement of the renal medulla, mistaking it for a tumor (9, 11, 12). Despite this, the corticomedullary phase represents the essential phase for precise staging of RCC.

The next phase, or the nephrographic phase (Figure 2), is seen after at least 80 seconds of scanning delay, and lasts up to 180 seconds after the intravenous administration of the contrast me-
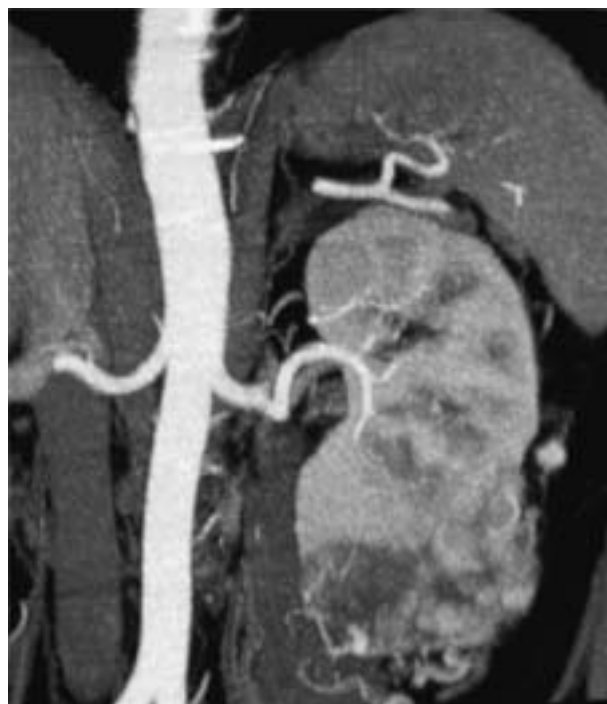

Figure 1. Corticomedullary phase of contrast enhancement: contrast agent primarily within arteries, cortical capillaries and cortical tubular lamina.

Figure 2. Nephrographic phase of contrast enhancement: contrast agent in the Loops of Henle and collecting tubules.

dium. The nephrographic phase is the most useful for detection of the renal masses and the best
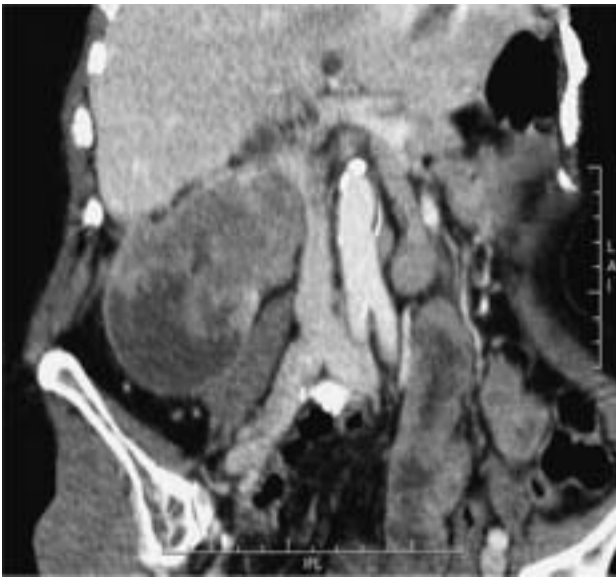
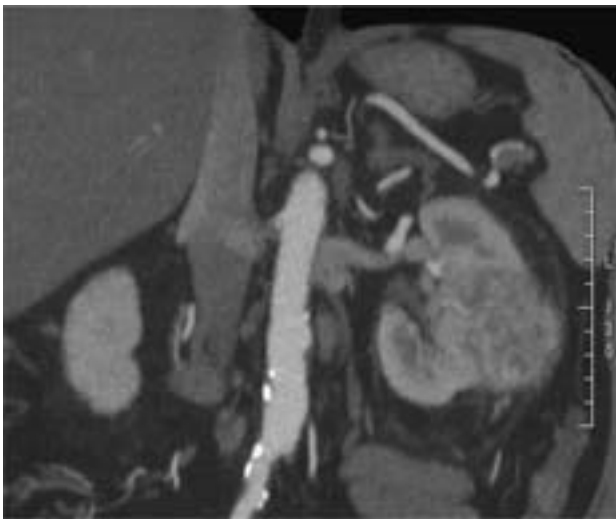*Figure 3. Tumor confined to the renal capsule (Stage T1/T2, depending on the size of the tumor mass)*

Figure 5. Formation of a tumor thrombus, located inside the renal vein only (Stage T3b)

Figure 4. Spread of the tumor into the perinephric fat tissue (Stage T3a)

Figure 6. Thrombus in the infradiaphragmatic part inferior vena cava: filling defect within the lumen (Stage T3c)

results in detection and characterization of renal masses, as well as precise staging, can be achieved with a scanning protocol that includes a combination of unenhanced CT and contrast-enhanced scanning in the corticomedullary and nephrographic phases (10) and characterization of indeterminate lesions. (11, 14)

The excretory phase starts approximately 180 seconds after the injection of the contrast medium. This phase is used for better delineation between a centrally located mass and the collecting system, as well as for defining a potential involvement of the calices or renal pelvis.

Figure 7. Involvement of the supradiaphragmatic part of IVC by the thrombus

Figure 8. Large tumor thrombus extending above the diaphragm, reaching the right atrium and invading the wall of IVC (Stage T4b)

Figure 9. Regional lymph node involvement (Stage N1-N3)

The 3D MDCT images can be obtained in multiple planes and orientations, and are useful for better definition of the tumor and its relationship to the renal surface, the collecting system, and adjacent organs. MDCT angiography (MDCTA), combined with 3D images, can provide some crucial information required for the surgical procedure planning (16).

Accurate staging at the time of diagnosis is essential to determine prognosis and formulate a therapeutic plan. Two classification systems are commonly used for staging of RCC. The Robson's classification is older and simpler (17), and the TNM classification is more detailed, with more subgroups defined (18). The main drawback of the Robson's classification is that stage III is consiste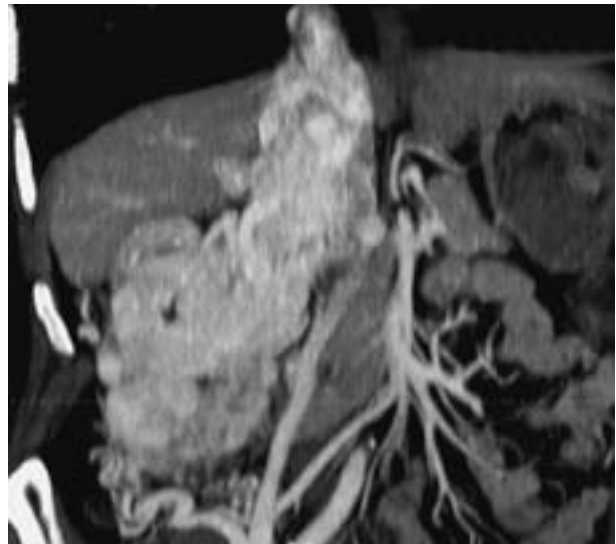d of a heterogeneous patient population with venous spread of the tumor, as well as lymph node involvement (19-24). Patients with venous spread are candidates for surgical treatment, while patients with lymph node metastases have poorer prognosis, and undergo palliative therapy (6).

In our daily practice we use the TNM classification, which is widely accepted, because it de-
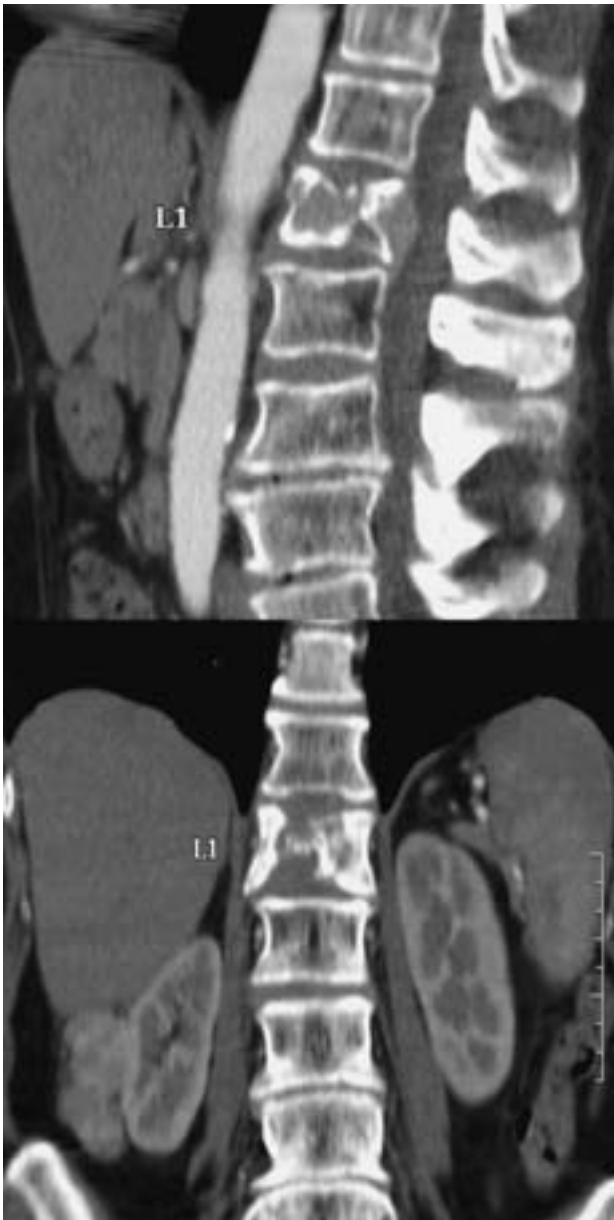
Figures 10, 11. Distant RCC metastases: metastatic lesion in the body of L1 vertebra (Stage M1)

fines the anatomic extent of the tumor more precisely.

Tumor confined to the renal capsule has the best prognosis, and is classified as T1 or T2 stage after TNM, depending on its diameter (<7 cm, ≥7 cm, respectively) (Figure 3) (6).

Perinephric spread of the tumor, stage T3a (Figure 4), causes the majority of problems in CT staging, because of the perinephric stranding,

which does not necessarily indicate the tumoral spread (7, 10). Although prognostically significant, this problem does not affect the therapy modality, because patients of this stage are still candidates for radical nephrectomy or nephron-sparing surgery.

Venous extension of the tumor is classified as T3b stage, meaning the existence of tumor thrombus in the renal vein only (Figure 5), T3c stage as involvement of infradiaphragmatic part of the inferior vena cava (IVC) (Figure 6), and T4b stage as involvement of the supradiaphragmatic part of IVC (Figure 7, Figure 8) (2). The level of venous spread of the tumor thrombus directly affects the surgical approach and prognosis (25-27).

Regional lymph node involvement implicates poorer prognosis (Figure 9). The CT diagnosis of lymph node metastasis is based on nodal enlargement more than 1 cm in its short-axis diameter. Nodal enlargement found on CT does not disqualify patients for nephrectomy (28).

Distant RCC metastases are most common in the lungs and mediastinum, bones (Figure 10, Figure 11), and liver. Less common metastatic sites include the contralateral kidney, adrenal gland, brain, pancreas, mesentery, and abdominal wall (7, 16). Patients with a solitary metastasis may benefit from aggressive management with nephrectomy and surgical removal of the metastatic lesion (6).

According to all of the above, MDCT represents the most effective imaging modality for the diagnosis and staging of RCC. In the majority of the patients, MDCT is the only diagnostic imaging required for surgical planning. Advances in the speed of data acquisition and display, including three-dimensional volume rendering, provide unparallel capabilities for the detection, staging, and management of RCC (2).

In conclusion we may say that MDCT is the best and the fastest technique for diagnosing and staging of the RCC, especially for the tumor spread into the venous system, and for planning the surgical approach and choosing the therapy modality. It is important to know the advantages of MDCT imaging, as well as understanding the values and limitations of each phase of enhancement in the assessment of RCC staging.

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