

IMAGING FINDINGS AND MANAGEMENT OF KIDNEY CYSTS – A PICTORIAL ESSAY

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Abstract: *Renal cysts have become more commonly recognized in asymptomatic patients due to the improvement and frequency of the use of advanced imaging modalities, such as CT and MRI. The purpose of the following review is to illustrate the main and most important aspects of renal cysts, including a checklist of top differential diagnoses and also, their further management and treatment options. Some renal cysts can have significant clinical implications; this is why increased awareness of these renal lesions is of the utmost importance in order to avoid diagnostic pitfalls or further complications.*

Key words: *renal cysts, Bosniak classification, computed tomography*

1. Introduction

Renal masses are abnormal tissue growths in the parenchyma or renal sinus, most of them with benign features. Lately, due to development of technology, imaging modalities such as ultrasonography, computed tomography and magnetic resonance imaging are commonly used for their identification and diagnosis. The classification of renal masses is based on their components, namely solid or cystic. [1]

In a daily routine of any Radiology Department, kidney cysts are a common finding, as such, patients are often referred to urologists to ask their opinion on potential treatment or only imaging follow-up. [2]

Kidney cysts, depending on their structure and size, can be classified into “simple” and “complex”. For a detailed characterization of kidney cysts, the Bosniak classification is used, as shown in Table 1.

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Table 1

Bosniak classification of cystic renal masses adapted with permission, from reference 3

Class	CT: Proposed Bosniak Classification, Version 2019*
I	Well-defined, <i>thin</i> (≤ 2 mm) smooth wall; homogeneous simple fluid (-9 to 20 HU); no septa or calcifications; <i>the wall may enhance</i>
II	Six types, <i>all well-defined with thin</i> (≤ 2 mm) smooth walls: <ol style="list-style-type: none"> 1. Cystic masses with thin (≤ 2 mm) and few (1–3) septa; septa and wall <i>may enhance</i>; may have <i>calcification of any type</i>[†] 2. <i>Homogeneous hyperattenuating</i> (≥ 70 HU) masses at noncontrast CT 3. Homogeneous nonenhancing masses > 20 HU at renal mass protocol CT (73), may have <i>calcification of any type</i>[‡] 4. <i>Homogeneous masses</i> -9 to 20 HU at noncontrast CT 5. <i>Homogeneous masses</i> 21 to 30 HU at portal venous phase CT 6. <i>Homogeneous low-attenuation masses that are too small to characterize</i>
IIF	Cystic masses with a smooth minimally thickened (3 mm) enhancing wall, or smooth minimal thickening (3 mm) of one or more enhancing septa, or <i>many</i> (≥ 4) smooth thin (≤ 2 mm) enhancing septa
III	One or more enhancing thick (≥ 4 mm width) or enhancing irregular (<i>displaying</i> ≤ 3 -mm <i>obtusely margined convex protrusion[s]</i>) walls or septa
IV	One or more <i>enhancing nodule(s)</i> (≥ 4 -mm <i>convex protrusion with obtuse margins, or a convex protrusion of any size that has acute margins</i>)

In this pictorial essay, we aim to underline and illustrate the importance of superior imaging modalities (CT scan and MRI) in the diagnosis and monitoring kidney cysts.

2.1. Simple renal cyst

The simple renal cyst is the most frequent type of kidney's cyst, it is usually

asymptomatic, identified incidentally at imaging examinations of the abdomen (CT scan or ultrasound).

Simple renal cysts usually do not interfere with kidney function, only in exceptional cases when it can rupture, bleed, get infected or increase in size with symptoms of a compressive mass [3]. The

simple kidney cyst become symptomatic in about 2% to 4% of cases [4].

Ultrasound is performed in abdominal routine examinations. The characteristics of a simple cyst on an ultrasound exam are: fluid structure, thin, imperceptible wall, without septa or echoes inside; when performing a CT scan in addition to the ultrasound features, the fluid inside has densities between 0-20 UH, and after contrast administration, it shows no uptake. [5]

One of the main aspects in the evaluation of a simple kidney cyst (Figure 1) is to differentiate it from those that develop within a genetic disease, such as autosomal-dominant polycystic disease (ADPKD). The difference is that simple ones do not increase the size of the kidneys, do not change their structure, and do not reduce their function, as it is in the case a polycystic kidney disease (Figure 2)[6]. Follow-up is necessary for renal cysts that cause symptoms, to exclude the rare occurrence of a malignancy [7].

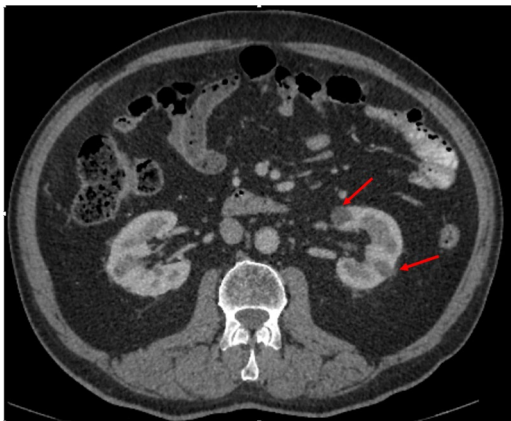


Fig. 1. *CT native scan highlights: two simple cystic lesions in the lower zone of the left kidney (Bosniak I)*



Fig. 2. *Abdominal CT scan (coronal view) with contrast administration highlights: many simple cystic lesions in both kidneys*

2.2 Complex renal cyst

The ability to accurately identify complex kidney cysts which can become malignant is a major challenge for radiologists. Normally, there isn't any ways to identify malignant characteristics other than biopsy or active supervision [8]. The Bosniak classification system provides useful information to differentiate simple and complex kidney cysts. It was originally described for CT, but it was also used in MRI. [9]

Lobulation, irregularity, calcification, the presence of septa, the appearance, and dynamics of contrast of a cyst

determine its classification in the Bosniak system (Figures 3, 4, 5, 6 and 7).

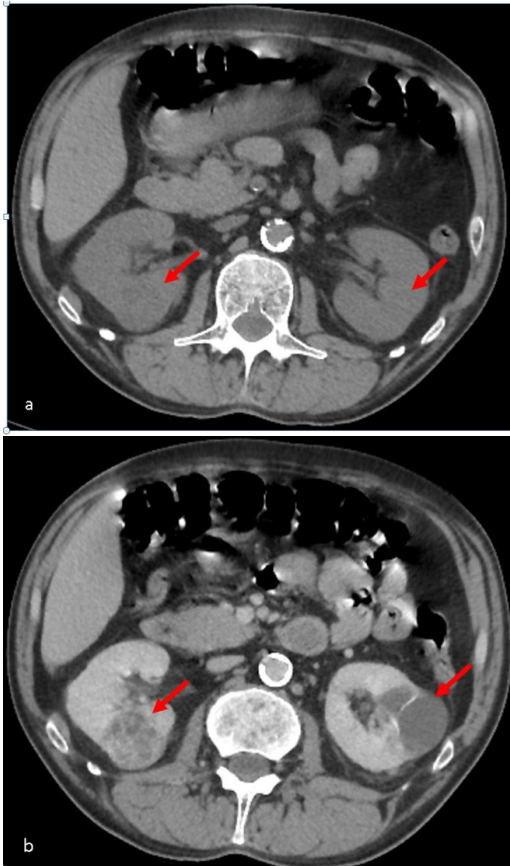


Fig. 3. CT scan (a: native and b: with contrast administration) highlights: heterogeneous exophytic nodular lesion in the lower zone of the right kidney with increased number of thick septa with enhancement. (Bosniak IV) and a nodular lesion in the lower zone of the left kidney measuring 2,3/2,7cm, with 2 thin septa with minimal enhancement (Bosniak II)

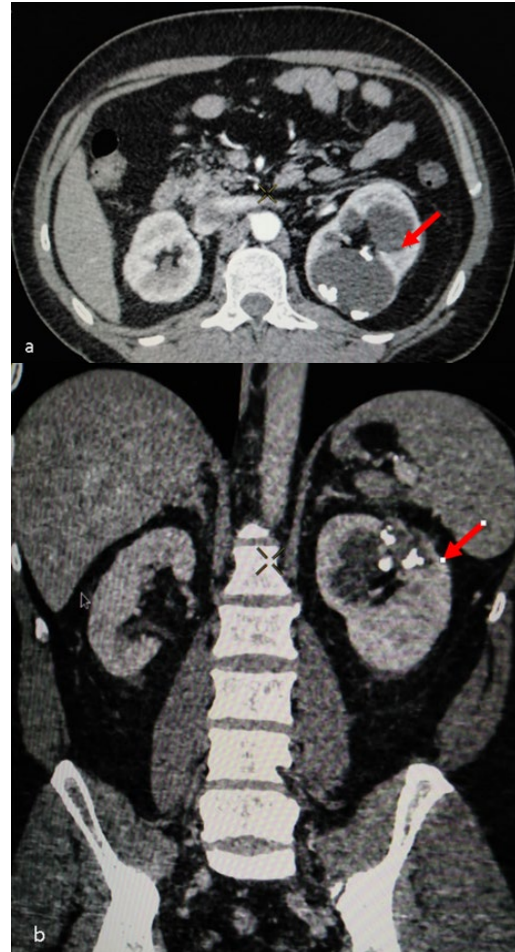


Fig. 4. CT scan with contrast administration (a: axial and b: coronal planes) highlights heterogenous polilobulate lesion in the upper zone of the left kidney measuring 3,4/3,8 cm, with wall and septal calcifications (Bosniak IIF)

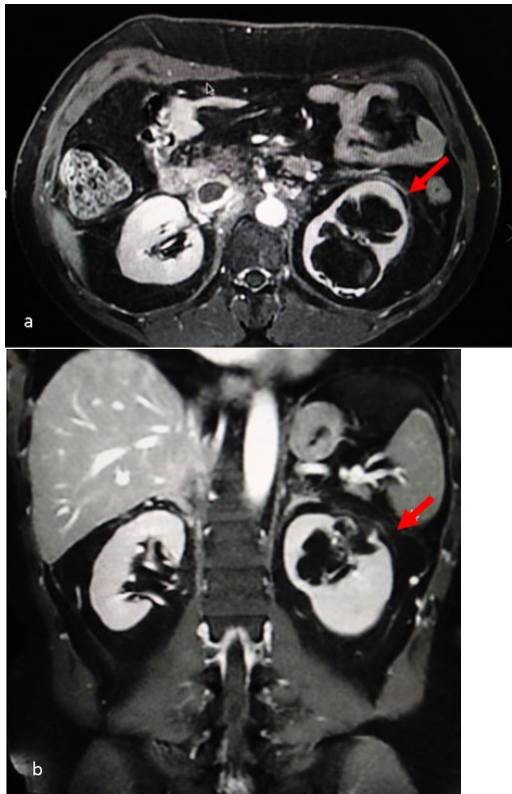


Fig. 5. MRI examination T1 sequence with contrast administration highlights (a: axial and b: coronal planes) heterogenous polilobulate lesion in the upper zone of the left kidney with a few incomplete enhancing septa and wall and septal calcifications (Bosniak IIF)

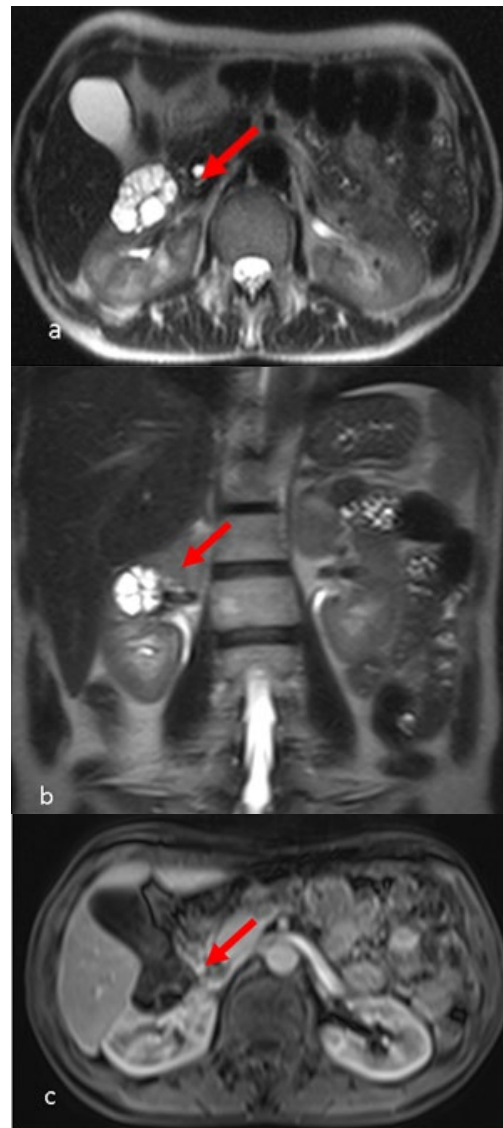


Fig 6. MRI examination (a: axial plane T2 sequence, b: coronal plane T2 sequence, c: axial plane T1 sequence with contrast administration) highlights: nodular cystic lesion with multiple enhancing septa in the middle portion of the right kidney (Bosniak III)



Fig. 7. MRI examination (a: axial plane T2 sequence, b: coronal plane T2 sequence, c: axial plane T1 sequence with contrast administration) : nodular cystic lesion with multiple thick enhancing septa in the upper zone of the right kidney (Bosniak IV)

In the evaluation of cystic renal masses, the best diagnostic method is represented by contrast enhanced CT, because it can identify thin septa and small iodophilic

nodules. MRI is used when CT is not indicated and has the advantage of identifying the contrast uptake of the septa in haemorrhagic cysts, as shown in figures 4 and 5 which shows CT and MRI abdominal examinations performed at the same patient with Bosniak IIF left renal cyst. [10]

3. Differential diagnosis

Top differential diagnoses include:

A. SOLITARY CYST:

- RCC;
- Cystic nephroma;
- Renal abscess;
- Renal metastases;
- Renal lymphoma;
- Epithelial cyst;
- Parapelvic/ peripelvis cysts;
- Dilated renal calyx.

B. MULTIPLE CYSTS:

- ADPKD;
- Uremic cystic disease;
- Lithium-related cysts: multiple tiny cysts;
- Disorders that include multiple renal cysts: von Hippel Lindau disease; tuberous sclerosis. [11]

Literature believes that the presence of 2-4 Bosniak IV cysts and clear characteristics of Bosniak III should be surgically removed. Indefinite IIF and III classes should be CT-monitored at 3, 6, 12 months and then annually. Cysts I and II are considered benign, but they can be followed up by ultrasound in the first two, three years, especially in young patients, whose dimensional growth rate is faster, and in cysts with diameters >3 cm. [12,13].

4. Management of Renal Cysts

Thorough imaging interpretation and classification of renal cystic lesions are key to further accurate management and treatment.

BOSNIAK class 1: benign simple cysts - no follow-up; no treatment.

BOSNIAK class 2: benign cysts - no follow-up; no treatment.

BOSNIAK class 2F: minimally complex cysts: requires imaging follow-up through ultrasound or CT or MRI within the next half year and one year after diagnosis

- recommended for follow-up: four, five years.
- imaging features and findings, which are considered red flags:
 - ✓ solid nodules or thick septations with contrast media enhancement;
 - ✓ increased thickness of the wall which enhance contrast media.

BOSNIAK 3: indeterminate cystic mass; more complicated cysts:

- treatment (according to patient's conditions): partial nephrectomy or RF ablation.
- For Bosniak III and IV cysts, patients with age >75 years and comorbidities - active surveillance.
- however, there are the following items perceived as being important for intervention in patients during active surveillance:
 - ✓ progression of renal cyst from Bosniak type III to type IV;
 - ✓ growth of solid component;
 - ✓ multiple septa and change of septa or calcifications - thickening;

- ✓ changing of the enhancement aspects of cyst the wall or septa;
- ✓ progression or development of nodules in the cyst wall.

BOSNIAK 4: clearly malignant cystic mass

- treatment (according to patient's conditions) - partial or total nephrectomy. [14,15].

5. Conclusion

Detailed expertise and proper imaging identification of renal cysts are fundamental to a precise evaluation and diagnosis, also in order to identify other abnormalities or syndromes associated to renal cysts. Anyhow for the management and treatment of these masses, accurate diagnosis is essential in some cases and can avoid potential complications.

A careful examination of renal masses on contrast CT would be an useful algorithm in the current medical imaging examinations.

Conflict of interest statement

The authors declare that they have no conflict of interest.

References

1. Chang CC, Kuo JY, Chan WL, Chen KK, Chang LS. Prevalence and clinical characteristics of simple renal cyst. *J Chin Med Assoc* 2007;70(11), 486-491.
2. O'Connor SD, Pickhardt PJ, Kim DH, Oliva MR, Silverman SG. Incidental finding of renal masses at unenhanced CT: prevalence and analysis of features for guiding management. *AJR Am J Roentgenol.* 2011;197(1):139-45
3. Silverman SG, Pedrosa I, Ellis JH, Hindman NM, Schieda N, Smith AD et al. Bosniak Classification of Cystic

- Renal Masses, Version 2019: An Update Proposal and Needs Assessment. *Radiology* 2019; 292:2, 475-488.
4. Eknoyan G. A clinical view of simple and complex renal cysts. *J Am Soc Nephrol*. 2009;20:1874–1876.
 5. Simms RJ, Ong ACM. How simple are 'simple renal cysts'?, *Nephrol Dial Transplant*. 2014; 29(4):106–112.
 6. Bergmann C, Guay-Woodford LM, Harris PC, Horie S, Peters D J, Torres VE. Polycystic kidney disease. *Nat. Rev. Dis. Primers* 2018; 4(1): 1-24.
 7. Hélénon O, Crosnier A, Verkarre V, Merran S, Méjean A, Correas JM. Simple and complex renal cysts in adults: Classification system for renal cystic masses. *Diagn Interv Imaging*. 2018; 99(4): 189-218.
 8. Prasad SR, Surabhi VR, Menias CO, Raut A A, Chintapalli KN. Benign Renal neoplasm in adults: Cross-Sectional Imaging Findings. *AJR Am J Roentgenol*. 2008; 190:158-164.
 9. McGuire BB, Fitzpatrick JM. The diagnosis and management of complex renal cysts. *Curr Opin Urol* 2010;20(5):349-54.
 10. Schiedaa RS, LimaMDF, McInnesal, ThomassinR, Renard-PennabS, Tavarolob et al. Characterization of small (<4 cm) solid renal masses by computed tomography and magnetic resonance imaging: Current evidence and further development. *Diagn. Interv. Imaging* 2018; 99(7-8): 443-455.
 11. Park H, Kim CS. Natural 10-year history of simple renal cysts. *Korean J Urol*. 2015; 56(5):351-6
 12. Muglia VF, Westphalen AC. Bosniak classification for complex renal cysts: history and critical analysis. *Radiol Bras*. 2014; 47(6): 368–373.
 13. Agnello F, Albano D, Micci G, Di Buono G, Agrusa A, Salvaggio G, et al. CT and MR imaging of cystic renal lesions, *Insights Imaging*. 2020; 11:5.
 14. Whelan TF, Guidelines on the management of renal cyst disease. *Can Urol Assoc J*. 2010; 4(2): 98–99.
 15. Bosniak MA. Diagnosis and management of patients with complicated cystic lesions of the kidney. *AJR Am. J. Roentgenol*. 1997;169(3), 819-821.