Cysts and cyst like renal tumors. The importance of the Bosniak classification system

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Learning objectives

The great majority of cystic renal masses are found incidentally as a result of the use of ultrasonography (US), computed tomography (CT), and magnetic resonance (MR) imaging. Fortunately, most of these are simple renal cysts that can be easily diagnosed and do not require treatment. However, complex cystic renal masses or cyst like tumors are also discovered, many of which are clearly malignant and need to be surgically removed, while others may not require surgical intervention. Therefore, the proper characterization of these masses is essential so that appropriate management is instituted.

In this paper we show the significance of evaluating cystic renal masses by using the Bosniak classification system.

Background

Benign renal cysts are common in the general population and are detected on CT in up to 50% of patients older than 50 years. Most renal cysts represent benign renal cortical lesions and do not require any follow-up imaging. However, as renal cysts become more complex, it becomes increasingly difficult to make the distinction between benign and malignant lesions, and also the probability of malignancy increases. Approximately 10-15% of all renal cell carcinomas can appear as complex cystic lesions on imaging studies [1].

Bosniak classified renal cysts into four main categories [2] and one more sub-category [Fig.1], on the basis of imaging appearance, in an attempt to predict the risk of malignancy.

**Category I.**- Category I lesions are simple benign cysts showing homogeneity, water content, with no wall thickening, calcification, or enhancement and have sharp distinct borders from surrounding renal parenchyma.

**Category II.**- This group consists of benign lesions that are either hyperdense benign cysts with all the features of category I cysts except for homogeneously high attenuation, or consists of cystic lesions with one or two thin (<1 mm thick) septations or thin, fine calcification in their walls or septa. A category II lesion to be considered benign must be 3 cm or less in diameter, have one quarter of its wall extending outside the kidney so the wall can be assessed, and be nonenhancing after contrast material is administered.

**Category IIIF.**- This is a group not well defined by Bosniak but consists of lesions that do not have the clearly benign characteristics of category II, but do not fall into category III.
either. These lesions are minimally complicated cysts with some suspicious features that deserve follow-up to detect any change in character.

**Category III.** Category III consists of true indeterminate cystic masses that need surgical evaluation, although many prove to be benign. They may show uniform wall thickening, nodularity, thick or irregular peripheral calcification, or a multilocular nature with multiple enhancing septa. Hyperdense lesions that do not fulfill category II criteria are included in this group (>1mm thick septations).

**Category IV.** These are lesions with a non-uniform or enhancing thick wall, enhancing or large nodules in the wall, or clearly solid components in the cystic lesion. Enhancement was considered present when lesion components increased by at least 10HU.

Furthermore, the Bosniak classification system advocates treatment for each category. Categories I and II were considered leave-alone lesions, with follow-up imaging recommended for category IIF lesions. Surgical resection was recommended for category III and IV lesions [3,4]. In series, the reported incidence of malignancy was 0% for category II, 5% for category IIF [5], 25-45% for category III, and 100% for category IV lesions. The range of probability in category III is a reflection of the qualitative parameters of evaluation, different levels of experience of the observers and suboptimal images [6]. Sometimes the distinction between categories IIF and III lesions can be difficult. In those cases there is a tendency to upgrade category II lesions to category III when any uncertainty exists and Bosniak, himself, has advocated placing borderline II-III lesions, especially hyperdense cysts, into category III [7]. It is extremely important to place a renal cyst into the right category because that will lead to the proper management; IIF=benign cyst that needs follow up, III= probably malignant cyst that immediately indicates renal excision.

![Fig. 1: Category I lesions: In Category I, are simple benign cysts with thin walls, no septa, or calcification and contains fluid with attenuation of water. Category II lesions: In category II lesions, are benign cysts with hairline-thin septa, fine calcification in the walls or septa. Category IIF (follow up) lesions: In category IIF lesions, are more complex cysts which may contain an increased number of septa and amount of calcification, which may be thicker or nodular. A change of less than 10HU from](image-url)
pre- to post-contrast images is usually considered typical of a benign cyst. Cysts in that category need follow up imaging for a period of 2 years. If there is stability in the findings then the cyst is considered to be benign. Category III lesions: In category III lesions, are cysts with thick, irregular walls or septa, and may contain either small or large amounts of calcification and wall enhancement. Category IV lesions: In category IV lesions, are malignant cystic masses which look like the ones in category III but they have also enhancing soft-tissue components independently from the wall or the septum.

References: L. Metaxa; Veria, GREECE
One-hundred-twenty-six patients underwent MDCT at our department, during the period 2006-2010, and were diagnosed having cysts or cyst's like renal tumors. The cysts were either incidentally detected during abdominal sonography, CT scan or during clinical diagnostic workup including sonography and CT of the kidneys and urinary track for micro or macroscopic hematuria. The cystic renal masses were evaluated with a MDCT scanner (16 and 4-Slice CT). Unenhanced images (5mm slice thickness) were acquired first and then images during the corticomedullary (3 mm slice thickness) and the nephrographic phase after contrast media administration (150mL nonionic iodinated contrast agent at a rate of 2-3mL/s). The images were used to perform three dimensional reconstructions and were evaluated for lesion size, the presence of calcification, septations, nodules, the wall thickness, the density, the enhancement and were placed in a category according to the Bosniak system classification. Renal units that had cystic lesions in more than one category were placed in the greater category. The renal cysts categorized Bosniak III and IV underwent nephrectomy and the images were then compared with the histological findings.

Images for this section:

Fig. 1: 1.Category I lesions: In Category I, are simple benign cysts with thin walls, no septa, or calcification and contains fluid with attenuation of water. Category II lesions: In category II lesions, are benign cysts with hairline-thin septa, fine calcification in the walls or septa. Category IIF (follow up) lesions: In category IIF lesions, are more complex...
cysts which may contain an increased number of septa and amount of calcification, which may be thicker or nodular. A change of less than 10HU from pre- to post-contrast images is usually considered typical of a benign cyst. Cysts in that category need follow up imaging for a period of 2 years. If there is stability in the findings then the cyst is considered to be benign. Category III lesions: In category III lesions, are cysts with thick, irregular walls or septa, and may contain either small or large amounts of calcification and wall enhancement. Category IV lesions: In category IV lesions, are malignant cystic masses which look like the ones in category III but they have also enhancing soft-tissue components independently from the wall or the septum.
Imaging findings OR Procedure details

One-hundred and ten lesions were Bosniak category I, II (benign) with thin wall, no/or thin septations, no calcifications, density 0-20HU, no enhancement after intravenous administration. [Fig 2-6]

Fig. 5: 5. Bosniak I category: Coronal (A) and transverse (C) contrast-enhanced CT scans show a single, large cyst, in the right kidney with thin walls, no septa, or calcification which contains fluid with attenuation of water (2,6HU).

References: L. Metaxa; Veria, GREECE
Fig. 6: 6. Bosniak II category: Transverse (A) unenhanced, (B) contrast-enhanced, Coronal (C) and, Sagittal (D) CT scans show a large cyst in the upper pole of right kidney that contains fluid with attenuation of water (9,6HU), with thin walls and hairline-thin calcified septa(yellow arrow). There is no measurable enhancement within the mass. There is another simple cyst (Bosniak I) in the lower pole of the same kidney.

References: L. Metaxa; Veria, GREECE
Ten lesions were Bosniak category IIF with calcium, or high density. After 2 years follow up no changes were observed. [Fig. 7-8]
Fig. 7: 7. Bosniak IIF category: Hyperdense benign cyst; category IIF lesion. Transverse (A) unenhanced and (B) contrast-enhanced CT scans show a small, dense (29.6HU) mass protruding from the outer margin of the right kidney. The lesion is homogeneous and smoothly marginated and did not enhance following intravenous administration of contrast material (31HU after IV contrast media). A follow-up scan obtained 6 months and a year later showed no change.

References: L. Metaxa; Veria, GREECE

Fig. 8: 8. Bosniak IIF category: Hyperdense benign cyst; category IIF lesion. Transverse (A) unenhanced and (B) contrast-enhanced CT scans show a small hyperdense (60HU), with specific margins lesion in the parenchyma of the left kidney that lightly enhanced (less than 10HU). A follow-up scan after 6, 12 and 24 months showed no important changes in size and density.
References: L. Metaxa; Veria, GREECE

In one case [Fig. 9] of an 82-years-old man, with chronic renal failure because of kidney and ureter stones and hydronephrosis, there was a severe skepticism if the lesion should be placed in category IIF (complicated cyst) and have close follow-up or in category III and have nephrectomy (cystic carcinoma). The lesion had heterogeneity without significant enhancement and no any obvious septations. Because of the age of the patient and the medical history at first he was treated conservatively. At a follow up CT scan there were not any changes in the appearance but then a MRI scan was performed which showed a thickened wall and multiple thickened and slightly nodular septa within the mass. The patient underwent nephrectomy and a benign complex chronic hemorrhagic renal cyst was diagnosed.

Fig. 9: Bosniak III category: Transverse (A) unenhanced and (B) contrast-enhanced CT scans in an 82-years-old man, with chronic renal failure because of kidney and ureter stones and hydronephrosis, show an exophytic mass in the lower pole of the left kidney (C) with heterogeneity (yellow arrow), grossly thickened and irregular wall with no obvious septaeas. There was a severe skepticism if the lesion was a complicated
(hemorrhagic) cyst (Bosniak IIIF) or a suspicious renal cystic mass (Bosniak III) and therefore had a nephrectomy. Because of the age of the patient and the medical history at first he was treated conservatively. 6-months later he had a follow up CT with no changes of the findings but a MRI scan; Coronal T2-weighted MR image (D) showed a thickened wall and multiple thickened and slightly nodular septae within the mass. The patient underwent nephrectomy and a benign complex chronic hemorrhagic renal cyst was diagnosed.

**References:** L. Metaxa; Veria, GREECE

Four lesions [Fig. 9, 10, 11B] were Bosniak category III with enhanced wall, thick septations or coarse calcifications, all were surgically resected (nephrectomy) and then evaluated histologically. Three of them were malignant and one was a hemorrhagic cyst [Fig.9]. In one patient [Fig. 11,12] there were two cystic lesions in the same kidney that proved to be two independent cystic cell carcinomas. The first one, in the upper pole [Fig.11B], was a multicystic lesion with multiple septa of varying thickness involving the upper pole of the left kidney. The lesion was considered to be Bosniak III. The second one, in the lower pole of the same kidney, was a single cyst with a thick mural calcification (Fig.11, 12 B, C, D, E), and a highly enhanced nodule (34->92HU) adjacent to the wall. This lesion was placed in Bosniak IV category.
**Fig. 11**: Fig. 11-12 (same patient): Bosniak III-IV categories cystic lesions in a 41-years old woman with no medical history. Coronal contrast-enhanced CT scan (A) shows two cystic lesions in the upper and lower pole of the left kidney. Transverse (B) unenhanced and contrast-enhanced CT scans at the upper pole level show a multicystic lesion with multiple septa of varying thickness. The lesion is considered to be Bosniak III category. Transverse (C) unenhanced and contrast-enhanced CT scans at the lower pole level show a single cystic lesion with thick mural calcification (Fig.11.A,C 12.D, E), and a highly enhanced nodule (34->92HU) adjacent to the wall. The lesion placed in Bosniak IV category. The patient underwent nephrectomy and a low grade clear cell carcinoma was diagnosed in both lesions on histological evaluation.

**References**: L. Metaxa; Veria, GREECE

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**Fig. 12**: Fig. 11-12: Fig. 11-12 (same patient): Bosniak III-IV categories cystic lesions in a 41-years old woman with no medical history. Coronal contrast-enhanced CT scan (A) shows two cystic lesions in the upper and lower pole of the left kidney. Transverse (B) unenhanced and contrast-enhanced CT scans at the upper pole level show a multicystic lesion with multiple septa of varying thickness. The lesion is considered to be Bosniak III category. Transverse (C) unenhanced and contrast-enhanced CT scans at the lower pole level show a single cystic lesion with thick mural calcification (Fig.11.A,C 12.D, E), and a highly enhanced nodule (34->92HU) adjacent to the wall. The lesion placed in Bosniak IV category. The patient underwent nephrectomy and a low grade clear cell carcinoma was diagnosed in both lesions on histological evaluation.

**References**: L. Metaxa; Veria, GREECE

Four lesions [Fig. 11-18] were Bosniak category IV with enhanced, thick wall and septations, small nodules and calcification. All of them were malignant. In two cases, in the sonographic images [Fig. 13A, 14A.] there was a "solid" appearance of whole or
part of the lesion that came in comparison with the CT findings. Pathology evaluation explained that bloody debris in the lesions created that "solid" appearance on the sonogram.

**Fig. 13**: Bosniak IV category: Cystic renal neoplasm in a 61-years old man with no medical history. Sonogram (A) reveals a large mass at the lower pole of the right kidney with septations and heterogeneity in different parts (considered to be hemorrhagic substances). Transverse (B, D) contrast-enhanced CT scans show a cystic mass in the lower pole of the right kidney, with septations (yellow arrow) and a focal thickened (9mm) enhanced (55HU after IV contrast media) wall (C, D). No enhancement of the central portion of the mass was noted (the fluid in the central portion of the mass measures 15HU).

**References**: L. Metaxa; Veria, GREECE
**Fig. 14**: 14. Bosniak IV category cystic lesion in an 80-years old man with benign prostatic hyperplasia A. Sonogram reveals a large mass at the lower pole of the right kidney. The mass contains multiple echoes with no through transmission, suggesting a solid tumor. B. Coronal (B) contrast-enhanced CT scan: A section taken through the lesion reveals a round, smooth cystic lesion with a solid enhancing nodule adjacent to the wall.

**References**: L. Metaxa; Veria, GREECE
Fig. 16: 16. Same patient as Fig. 14. Transverse (A,C) unenhanced and (B,D) contrast-enhanced CT scans at different levels of the cystic lesion show no enhancement of the lesion, except in the nodules at the periphery which had significant enhancement (40HU : 44.9->79.2HU and 36->78.9HU). A right nephrectomy was performed and a cystic papillary RCC filled with bloody debris was found. Viable
nodules was found in the wall of the lesion. The nature of the debris apparently created the "solid" appearance on the sonogram.

References: L. Metaxa; Veria, GREECE
Fig. 17: 17. Bosniak IV category cystic lesion in a 60- years old woman with atypical abdominal pain Transverse (A,C) unenhanced and (B,D) contrast-enhanced CT scans show a lesion in the upper pole of the left kidney with high density (C) (23.4HU), mild enhancement of the central portion of the mass (D) (~10HU) and thick calcification inside the lesion. The lesion considered to be more solid rather than cystic and placed in Bosniak IV category.

References: L. Metaxa; Veria, GREECE

Fig. 18: 18. Same patient as Fig. 17. Moreover enhanced nodularity along the greater omentum and parietal mesenterium observed (A,B) (yellow arrow) (peritoneal carcinomatosis) (A,B). A metastatic papillary renal cell carcinoma was diagnosed on histological evaluation.

References: L. Metaxa; Veria, GREECE

Images for this section:
**Fig. 2:** 2. Bosniak I category: Transverse (A) unenhanced and (B) contrast-enhanced CT scans show simple cyst in the left kidney (no enhancement)

**Fig. 3:** 3. Bosniak I category: Transverse (A,C) unenhanced and (B,D) contrast-enhanced CT scans show several simple cysts in both kidneys (no enhancement, no septations, no calcification)
Fig. 4: 4. Bosniak I,II categories: Coronal (A,B) and transverse (C) contrast-enhanced CT scans show multiple simple cysts, in several sizes, in both kidneys (no enhancement, no septations, and no calcification). Also there are some cysts in the liver.
**Fig. 5:** Bosniak I category: Coronal (A) and transverse (C) contrast-enhanced CT scans show a single, large cyst in the right kidney with thin walls, no septa, or calcification which contains fluid with attenuation of water (2.6HU).
Fig. 6: 6. Bosniak II category: Transverse (A) unenhanced, (B) contrast-enhanced, Coronal (C) and Sagittal (D) CT scans show a large cyst in the upper pole of right kidney that contains fluid with attenuation of water (9.6HU), with thin walls and hairline-thin calcified septa (yellow arrow). There is no measurable enhancement within the mass. There is another simple cyst (Bosniak I) in the lower pole of the same kidney.
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Fig. 8: 8. Bosniak IIIF category: Hyperdense benign cyst; category IIIF lesion. Transverse (A) unenhanced and (B) contrast-enhanced CT scans show a small hyperdense (60HU), with specific margins lesion in the parenchyma of the left kidney that lightly enhanced (less than 10HU). A follow-up scan after 6, 12 and 24 months showed no important changes in size and density.
Fig. 9: Bosniak III category: Transverse (A) unenhanced and (B) contrast-enhanced CT scans in an 82-years-old man, with chronic renal failure because of kidney and ureter stones and hydronephrosis, show an exophytic mass in the lower pole of the left kidney (C) with heterogeneity (yellow arrow), grossly thickened and irregular wall with no obvious septae. There was a severe skepticism if the lesion was a complicated (hemorrhagic) cyst (Bosniak IIF) or a suspicious renal cystic mass (Bosniak III) and therefore had a nephrectomy. Because of the age of the patient and the medical history at first he was treated conservatively. 6-months later he had a follow up CT with no changes of the findings but a MRI scan; Coronal T2-weighted MR image (D) showed a thickened wall and multiple thickened and slightly nodular septae within the mass. The patient underwent nephrectomy and a benign complex chronic hemorrhagic renal cyst was diagnosed.
Fig. 10: 10. Bosniak III category: A 67-year-old man with a large (12.2x8cm) cystic lesion in right kidney. Transverse (A,B,C) contrast-enhanced CT scan shows a large mostly fluid-
filled mass with multiple, enhancing septa throughout. Some areas of confluence of septa, indicating solid elements, are seen.

Fig. 11: Fig. 11-12 (same patient): Bosniak III-IV categories cystic lesions in a 41-years old woman with no medical history. Coronal contrast-enhanced CT scan (A) shows two cystic lesions in the upper and lower pole of the left kidney. Transverse (B) unenhanced and contrast-enhanced CT scans at the upper pole level show a multicystic lesion with multiple septa of varying thickness. The lesion is considered to be Bosniak III category. Transverse (C) unenhanced and contrast-enhanced CT scans at the lower pole level show a single cystic lesion with thick mural calcification (Fig.11,A,C 12.D, E), and a highly enhanced nodule (34->92HU) adjacent to the wall. The lesion placed in Bosniak IV category. The patient underwent nephrectomy and a low grade clear cell carcinoma was diagnosed in both lesions on histological evaluation.
Fig. 12: Fig. 11-12 (same patient): Bosniak III-IV categories cystic lesions in a 41-years old woman with no medical history. Coronal contrast-enhanced CT scan (A) shows two cystic lesions in the upper and lower pole of the left kidney. Transverse (B) unenhanced and contrast-enhanced CT scans at the upper pole level show a multicystic lesion with multiple septa of varying thickness. The lesion is considered to be Bosniak III category. Transverse (C) unenhanced and contrast-enhanced CT scans at the lower pole level show a single cystic lesion with thick mural calcification (Fig.11,A,C 12.D, E), and a highly enhanced nodule (34->92HU) adjacent to the wall. The lesion placed in Bosniak IV category. The patient underwent nephrectomy and a low grade clear cell carcinoma was diagnosed in both lesions on histological evaluation.
Fig. 13: Bosniak IV category: Cystic renal neoplasm in a 61-years old man with no medical history. Sonogram (A) reveals a large mass at the lower pole of the right kidney with septations and heterogeneity in different parts (considered to be hemorrhagic substances). Transverse (B, D) contrast-enhanced CT scans show a cystic mass in the lower pole of the right kidney, with septations (yellow arrow) and a focal thickened (9mm) enhanced (55HU after IV contrast media) wall (C, D). No enhancement of the central portion of the mass was noted (the fluid in the central portion of the mass measures 15HU).
**Fig. 14:** 14. Bosniak IV category cystic lesion in an 80-years old man with benign prostatic hyperplasia. A. Sonogram reveals a large mass at the lower pole of the right kidney. The mass contains multiple echoes with no through transmission, suggesting a solid tumor. B. Coronal (B) contrast-enhanced CT scan: A section taken through the lesion reveals a round, smooth cystic lesion with a solid enhancing nodule adjacent to the wall.

**Fig. 15:** 15. Same patient as Fig. 14. Transverse (A) unenhanced and (B) contrast-enhanced CT scans reveal a round, smooth cystic lesion with some irregularity and wall thickened on its outer surface in the right kidney.
Fig. 16: 16. Same patient as Fig. 14. Transverse (A,C) unenhanced and (B,D) contrast-enhanced CT scans at different levels of the cystic lesion show no enhancement of the lesion, except in the nodules at the periphery which had significant enhancement (40HU: 44.9->79.2HU and 36->78.9HU). A right nephrectomy was performed and a cystic papillary RCC filled with bloody debris was found. Viable nodules was found in the
wall of the lesion. The nature of the debris apparently created the "solid" appearance on the sonogram.
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![CT scans showing a cystic lesion](image)

**Fig. 18:** 18. Same patient as Fig. 17. Moreover enhanced nodularity along the greater omentum and parietal mesenterium observed (A,B) (yellow arrow) (peritoneal carcinomatosis) (A,B). A metastatic papillary renal cell carcinoma was diagnosed on histological evaluation.
Conclusion

Most renal cystic lesions are benign fulfilling Bosniak I criteria and require no further evaluation. Bosniak IIF requires at least a two year follow up. Lesions at Bosniak III-IV are treated as malignant and require nephrectomy. Sometimes there is a significant difficulty in making the distinction between category IIF and III lesions, and this is one of the drawbacks of the system. In those cases there is a tendency to upgrade category IIF lesions to category III that need renal removal.

Therefore, the proper evaluation and characterization of those cysts according the Bosniak system is essential for the appropriate management [4].

Personal Information

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References

2. Curry N., Cochran S., Bissada N., Cystic Renal Masses: Accurate Bosniak Classification Requires Adequate Renal CT, AJR2000;175:339-342
5. Israel GM, Bosniak MA, Follow-up CT of moderately complex cystic lesions of the kidney (Bosniak category IIF), AJR Am J Roentgenol. 2003 Sep;181(3):627-33
7. Bosniak MA., Diagnosis and management of patients with complicated cystic lesions of the kidney, AJR 1997;169:819-821