Bosniak Classification of Renal Cystic Masses



Morton Bosniak
1925-2016



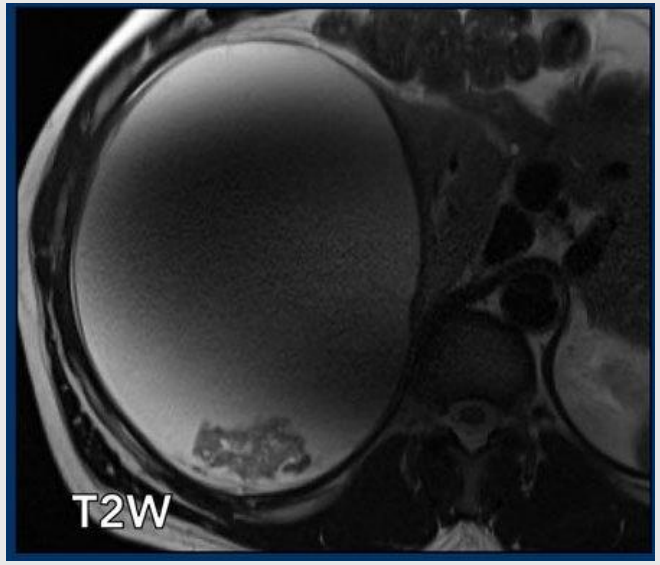
Imaging and Follow-up



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OBJECTIVES

- Renal Cysts/Cystic masses and a way to classify them – Bosniak
- Appropriate imaging for the different classifications.
- Management based on Bosniak Classification
  - Especially Bosniak IIF (2F).
  - Malignancy risk

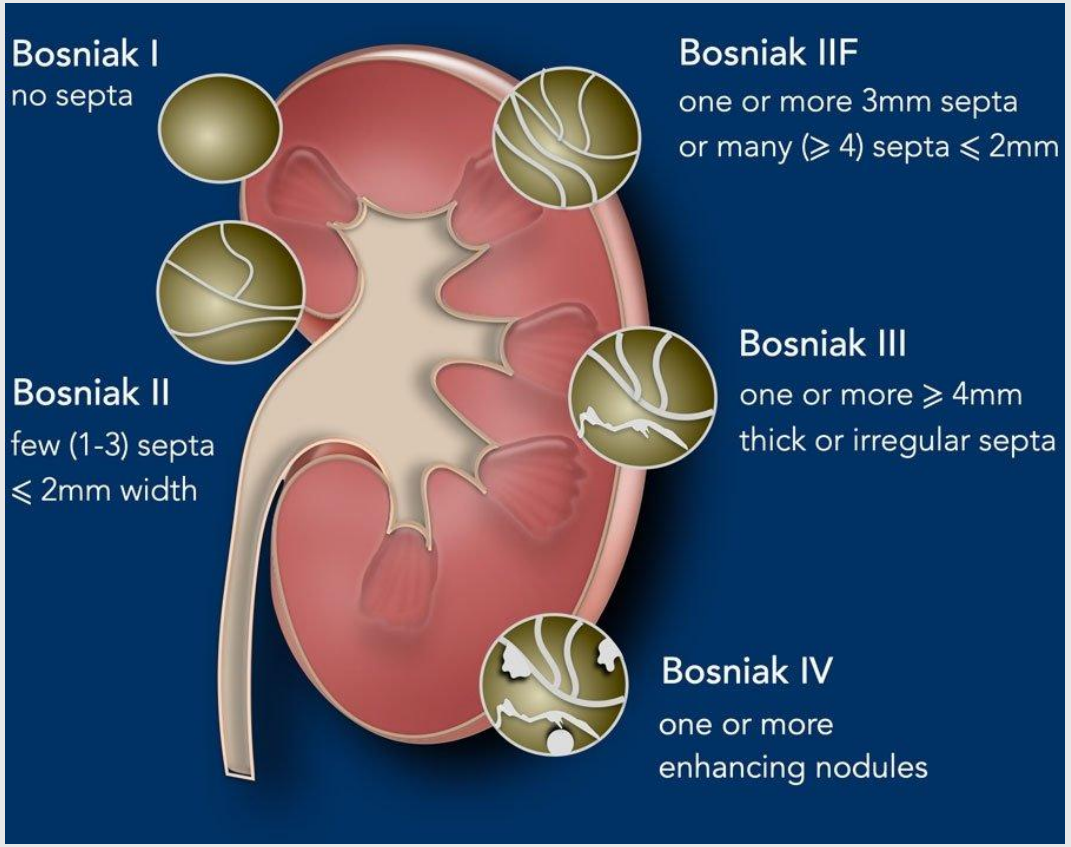
Decision in Primary Care

Action	Premise
Reassure	A confidently characterized simple cyst usually needs no surveillance.
Characterize	A cyst with internal echoes, septa or a mural abnormality may need a renal mass protocol CT or MRI.
Follow or refer	The Bosniak class and clinical context determine the next step.
Recognize diffuse disease	Numerous bilateral cysts may require a nephrology assessment. (Not discussed in this presentation).

Reference [1, 2, 4]

BOSNIAK CLASSIFICATION – 3 KEY WORDS: WALL, SEPTA, NODULE (AND MEASURE)

Bosniak	I	II	IIF	III	IV
Wall thickness	≤2mm	≤2mm	3mm	≥4mm	
Septa number	0	1-3	≥4		
Smooth enhancing septal thickening	N/A	≤2mm	3mm	≥4mm	
Irregular enhancing wall/ septal thickening				≤3mm	≥4mm
Enhancing Nodule	-	-	-	-	+



Radiology Assistant, Bosniak 2019

Reference [2, 5].

Choosing the Imaging Examination

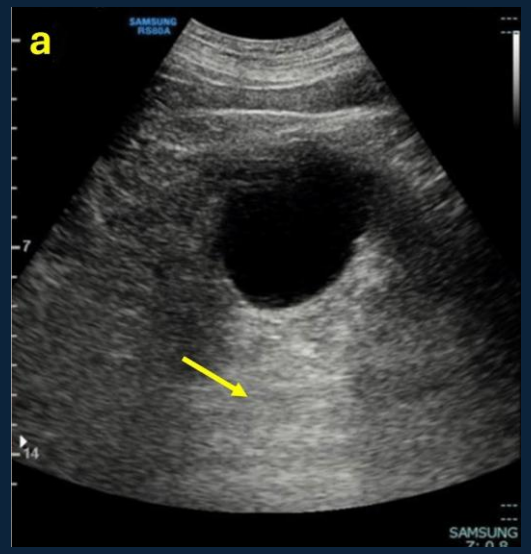
Modality	Main role	Limitation or next step
Ultrasound	First assessment. Confirms a classic simple cyst.	Standard US cannot reliably assess enhancement in an indeterminate mass.
Renal protocol CT	Unenhanced and postcontrast images assess enhancement.	Radiation and iodinated contrast considerations.
Renal protocol MRI	Problem solving, subtle enhancement, T1-bright contents.	Subtraction helps distinguish blood from enhancing tissue.
CEUS (Mentioning for completeness)	Shows vascularity of walls, septa and nodules.	Local expertise and availability. Uses a CEUS-specific adaptation.

Reference [2, 5]

Bosniak I: the simple cyst

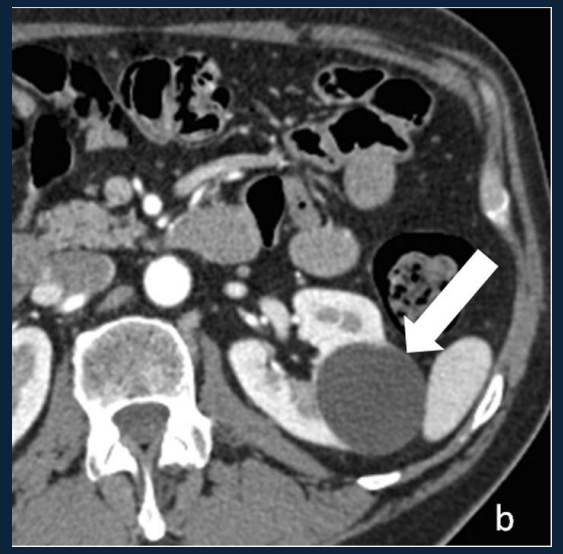
Benign appearance. No routine follow-up when asymptomatic.

Ultrasound



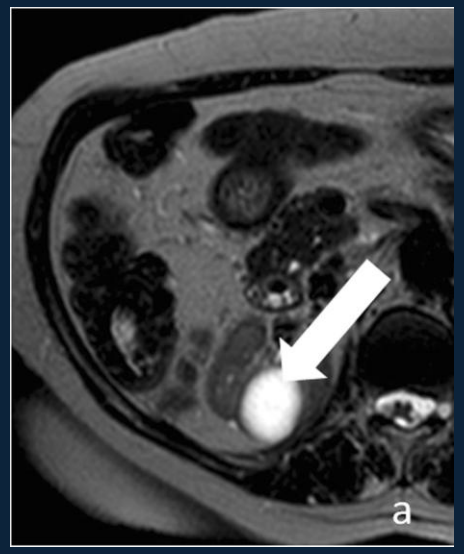
Anechoic fluid, thin smooth wall and posterior acoustic enhancement.

Contrast-enhanced CT



Homogeneous fluid attenuation. No septum or mural nodule.

MRI, T2-weighted

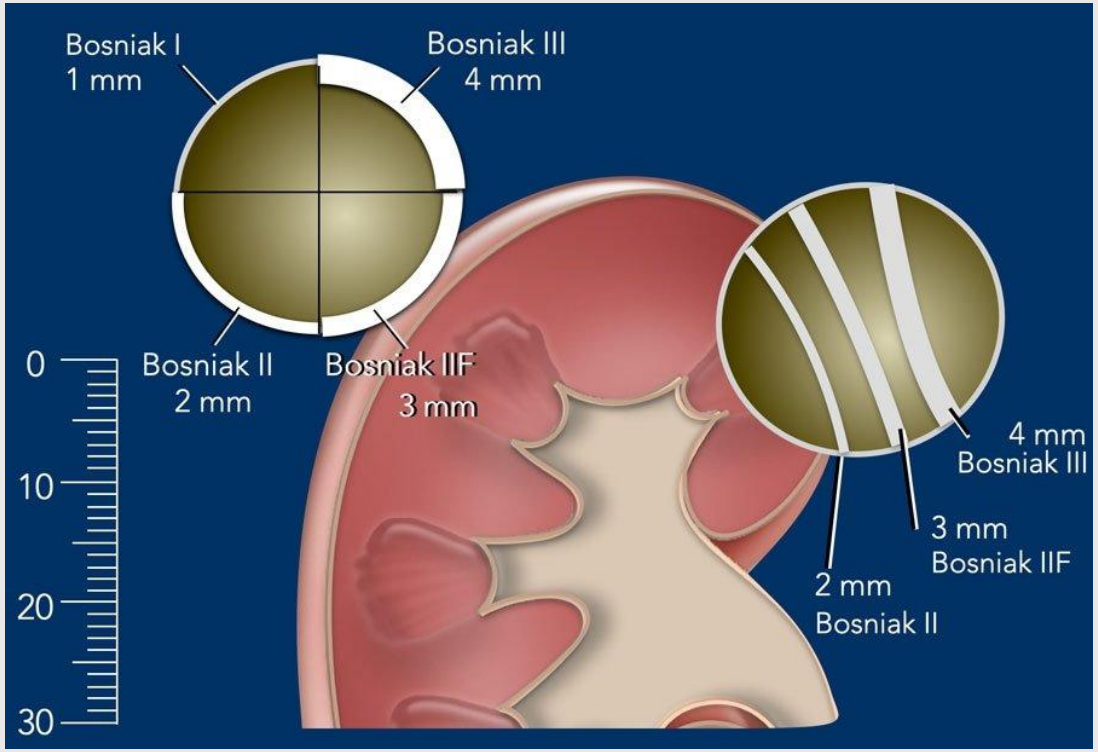


Fluid appears bright on T2 and dark on T1, without internal enhancement.

A smooth wall ≤2 mm may enhance. Classic ultrasound features can establish a simple cyst without further imaging.

Reference [1, 2, 6, 7].

Wall and Septal Thickness



Radiology Assistant, Bosniak 2019 measurements

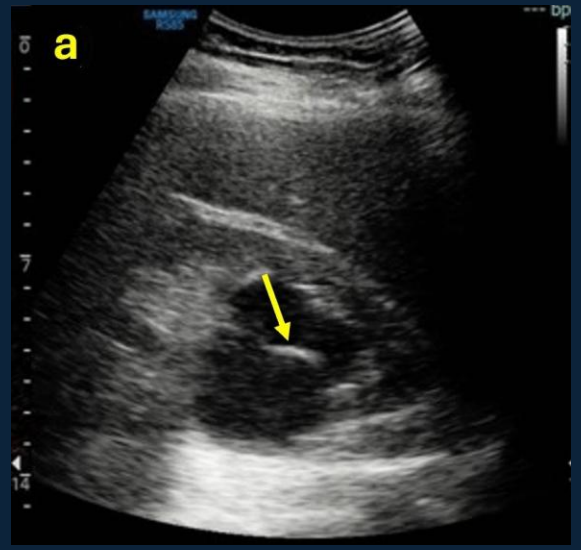
- Bosniak I and II
  - ≤2 mm: a thin smooth wall or septum.
- Bosniak IIF
  - 3 mm: minimally thickened and smooth. If enhancing, an IIF feature.
- Bosniak III
  - ≥4 mm: a thick enhancing wall or septum is a class III feature.
- Bosniak IV
  - An enhancing nodule is a separate class IV feature. Shape and size both matter.

Reference [2, 5]

Bosniak II: a few thin septa

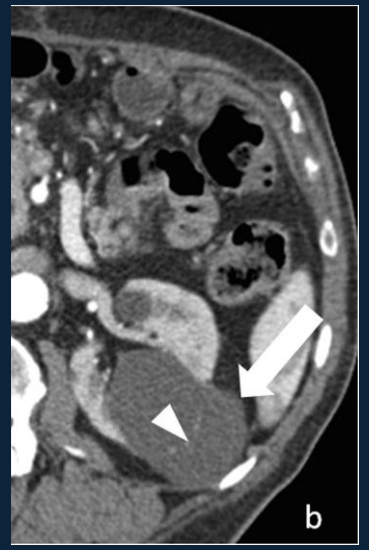
A confidently characterized Bosniak II cyst needs no routine surveillance.

Ultrasound



Thin septa may be visible. US alone cannot characterize every septated lesion.

Contrast-enhanced CT



A thin septum with calcification. Calcification alone does not increase the class.

MRI after gadolinium



A few smooth thin enhancing septa can still meet class II criteria.

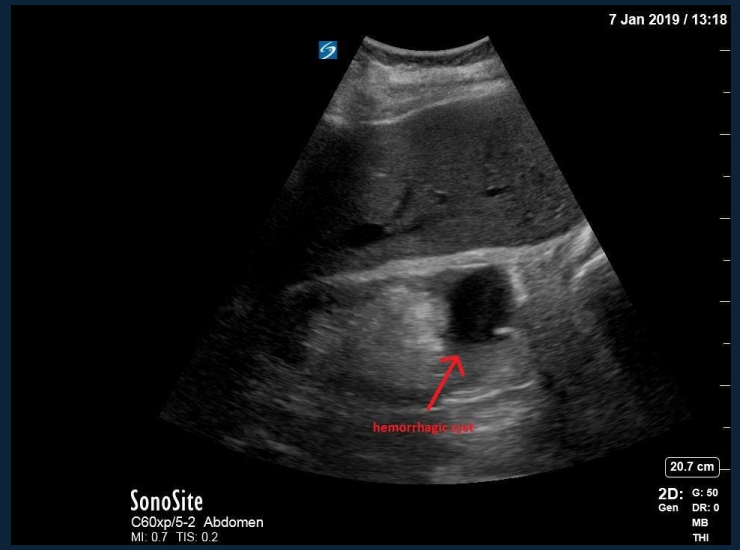
Few means 1–3 septa. Thin means ≤2 mm. Benign homogeneous hyperattenuating cysts also belong in class II.

Reference [1, 2, 5, 6, 7].

Hemorrhagic and proteinaceous cysts

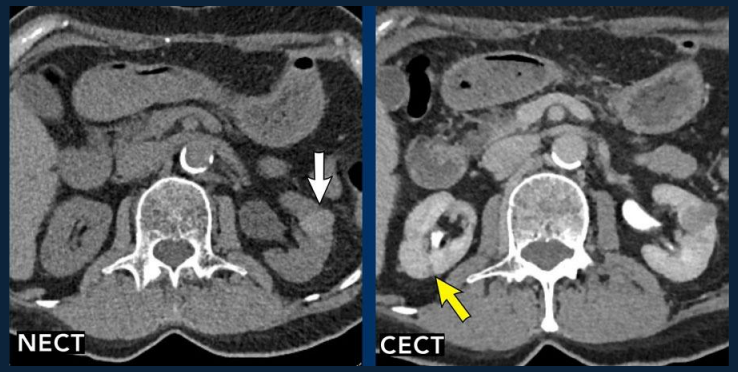
Internal echoes or T1 brightness can reflect contents rather than a tumor.

Ultrasound



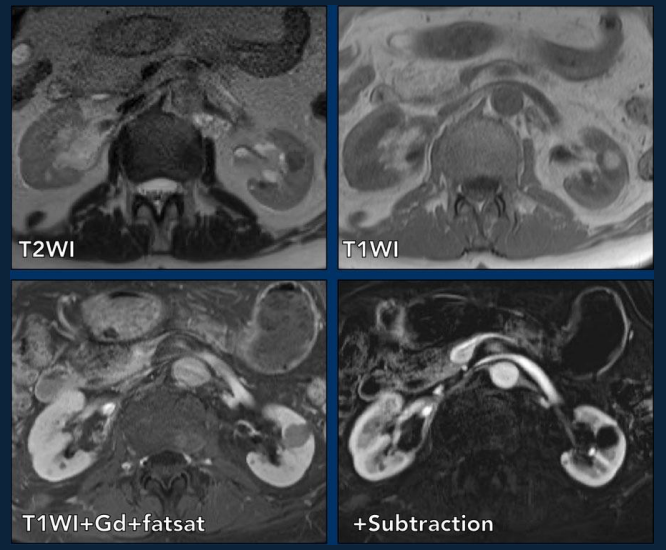
Echogenic debris can resemble solid tissue. Ultrasound alone cannot prove hemorrhage.

CT before and after contrast



The left renal lesion is dense before contrast. I.e non-enhancing. This is a II.

MRI including subtraction



T1 brightness with no internal enhancement on subtraction supports hemorrhagic contents.

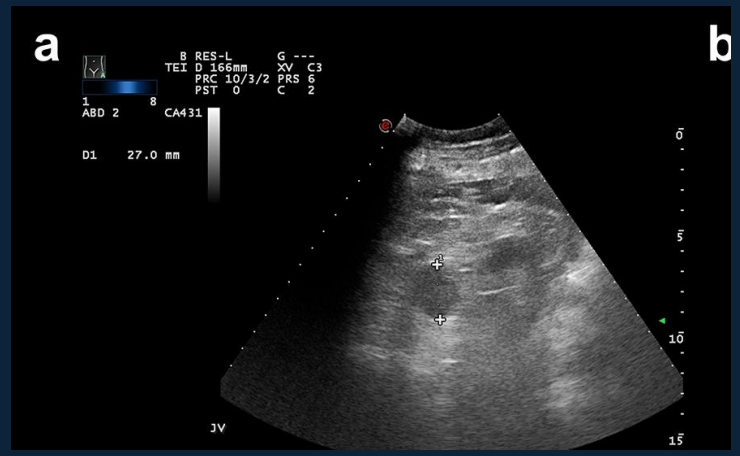
Homogeneous benign nonenhancing patterns can be Bosniak II. Heterogeneous T1 hyperintensity may be IIF at MRI.

Reference [2, 4, 5, 12].

Bosniak IIF: surveillance is appropriate

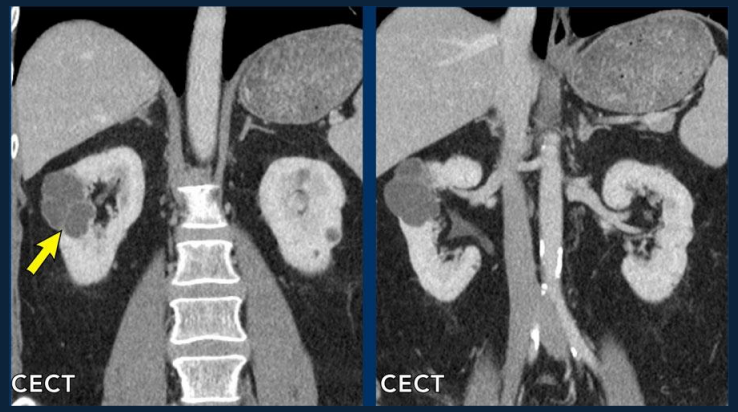
Many thin enhancing septa, or minimal smooth enhancing thickening (3mm).

Ultrasound, initial exam



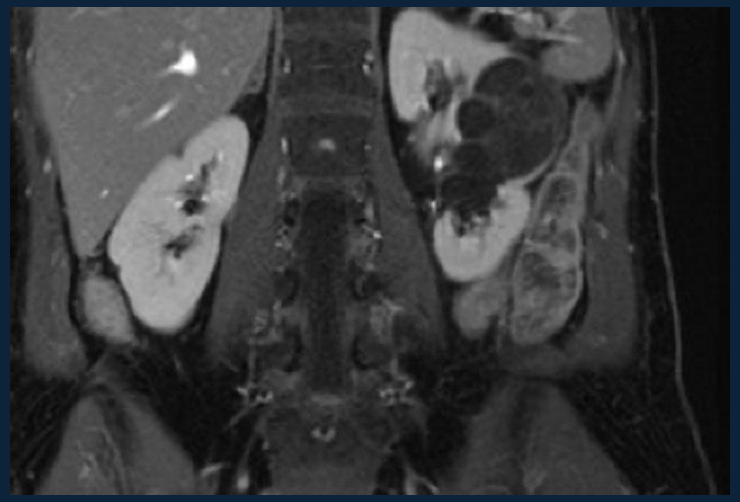
An indeterminate lesion with internal echoes. Cross-sectional imaging clarifies its nature.

Renal protocol CT



Multiple smooth thin enhancing septa support an IIF category.

MRI after gadolinium



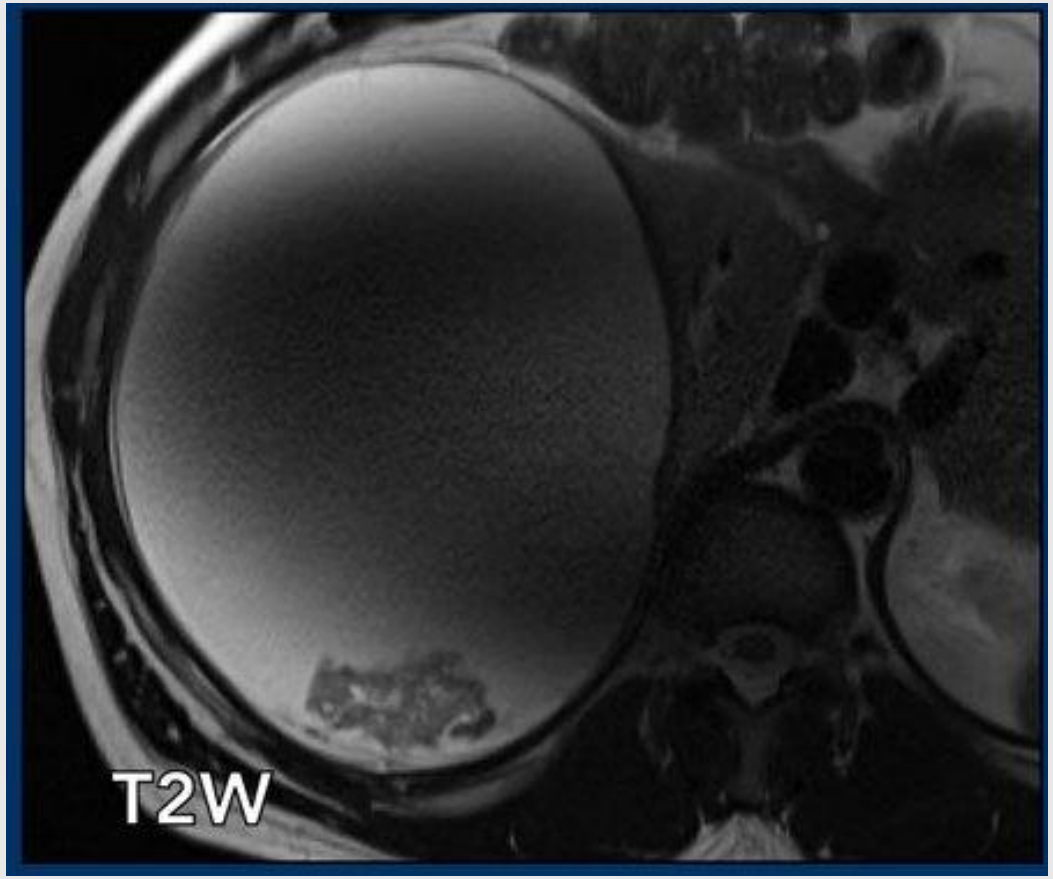
The enhancing septa are easier to see after contrast.

MRI: heterogeneous hyperintensity on unenhanced fat-suppressed T1 can qualify as IIF without enhancement.

Reference [1, 2, 4, 5, 11].

Exercise your knowledge…

- Classify the following
  - Heterogeneous T2 with debris
  - No enhancement post contrast



"F" is for Follow-up

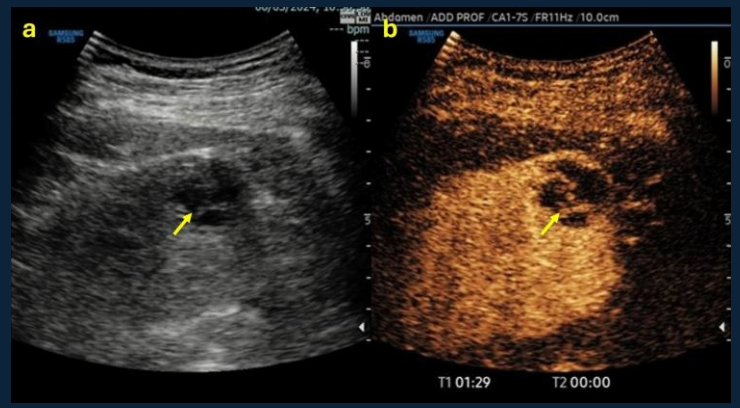
First Year	Imaging at 6 months and 12 months
If stable	Continue at 24, 36, 48 and 60 months
Duration	Total is Five year if no progression.
Escalation	New enhancing nodule, increasing wall/septal complexity or move to higher class, urology follow-up

Reference [1, 2, 4]

Bosniak III: thick or irregular enhancing tissue

Substantial malignancy risk. Urology review determines surveillance or treatment.

Ultrasound and CEUS



Irregular margins and thick septa. CEUS demonstrates septal enhancement.

Contrast-enhanced CT



Irregular enhancing tissue. Final pathology was benign oncocytoma (vs. Chromophobe RCC).

MRI after gadolinium



An enhancing thick wall and thick septa meet class III morphology.

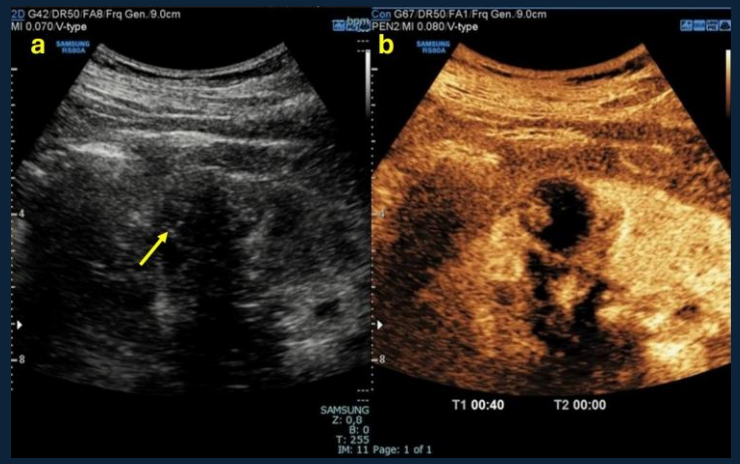
Smooth enhancing wall/septa ≥4 mm, or irregular enhancing thickening. No qualifying enhancing nodule.

Reference [1, 2, 6, 7, 11]

Bosniak IV: an enhancing nodule

High likelihood of malignancy. Urology referral essential, including for small lesions.

Ultrasound and CEUS



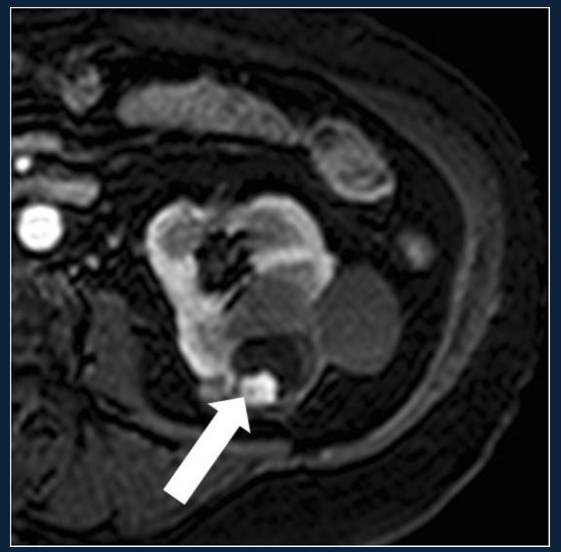
CEUS clarifies a mural protrusion within a lesion that appears indeterminate on B-mode.

Contrast-enhanced CT



A soft-tissue component within the cystic mass needs assessment for enhancement.

MRI after gadolinium



An enhancing mural nodule is the defining feature.

A nodule has acute margins at any size, or obtuse margins and size ≥4 mm. Class IV does not automatically mandate immediate surgery.

Reference [1, 2, 5, 6, 7]

Common Classification Pitfalls

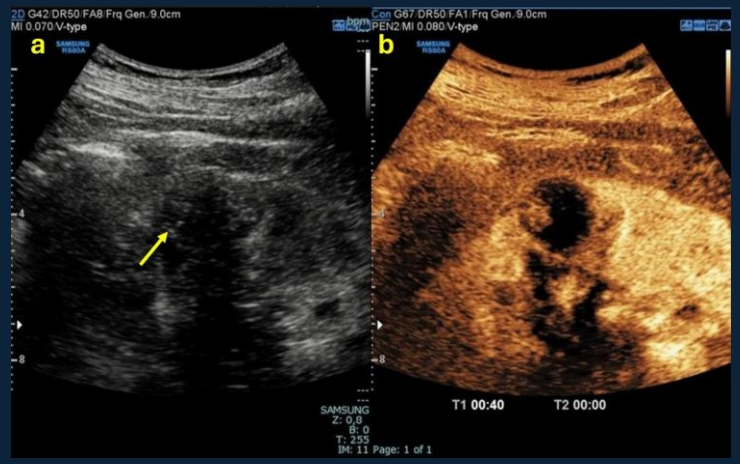
Finding	Correct interpretation
Cyst grows but remains simple	Size alone does not upgrade a Bosniak class. Symptoms may still justify treatment.
Calcification looks extensive	Calcification alone is a **II** feature. MRI may be needed if it obscures enhancement.
Thin septa enhance	A few thin enhancing septa can remain class II.
No flow on color Doppler	Absence of Doppler flow does not exclude a vascular mural component.
T1-bright contents	Compare precontrast and postcontrast images, ideally with subtraction.

Reference [2, 3, 4, 5, 8]

Bosniak IV: an enhancing nodule

High likelihood of malignancy. Referral remains essential, including for small lesions.

Ultrasound and CEUS



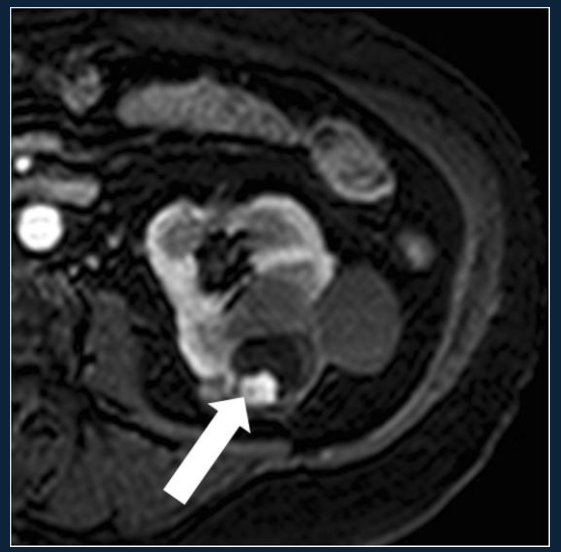
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Malignancy Estimates

Class	2025 Bosniak v2019 meta-analysis	How to explain the result
I–II	Clinically treated as benign when correctly characterized	Routine surveillance adds little value after confident classification.
IIF	26% pooled in included cohorts	This is not the risk for every incidental IIF lesion. Selection and verification bias matter.
III	80% pooled	A substantial risk, with some benign pathology. A urologic decision is needed.
IV	88% pooled	High likelihood of cancer. Size and competing risks still influence management.

Reference [1, 2, 9, 10]

Bosniak v2019: Core criteria

Bosniak Classification	Defining Morphology
I	Smooth fluid-filled cyst. Smooth wall ≤2 mm. No septa or calcification.
II	1–3 thin septa ≤2 mm. Wall/septa may enhance. Any non-enhancing septa. Calcifications of any type. Non-enhancing masses. Low attenuation masses that are too small to characterize. MRI – homogenous high T2 signal. Includes homogeneous T1 hyperintense lesions.
IIF	Cystic mass with smooth minimally thickened enhancing wall or septa ≤3 mm. Many ≥4 thin enhancing septa. MRI, heterogeneous high T1 signal pre-contrast, heterogenous.
3	Enhancing wall/septa ≥4 mm, or irregular enhancing thickening. No qualifying nodule.
4	Enhancing mural nodule. One or more enhancing nodules ≥4 mm convex protrusion with obtuse margins, or Convex protrusion of any size that has acute margins.

Bosniak Summary & Follow-up

Bosniak Classification	Main feature	Usual next Step
I	Smooth fluid-filled cyst.	Reassurance
II	A few thin septa may be present.	Reassurance
IIF	More septa or minimal smooth thickening.	Imaging surveillance
3	Thick or irregular enhancing walls or septa.	Urology
4	Enhancing mural nodule.	Urology

What Urology may offer (I am not a Urologist)

Management	Procedure
Active Surveillance	Scheduled imaging, reassessment and treatment if oncologic concern increases or the patient prefers treatment.
Surgery	Partial nephrectomy when helps preserve kidney tissue.
Ablation	An option for selected small lesions. Cystic-mass evidence is less certain than for surgery.
Biopsy	Useful selectively when a substantial solid target exists and the result would change care. Cyst fluid alone has low yield.

Reference [1, 10]

Symptomatic benign cyst - Management

- Confirm the link
  - A cyst may be incidental. Consider other causes of pain or hematuria.
- Recognize Complications
  - Bleeding, infection or collecting-system compression changes the clinical pathway.
- Consider Referral when symptoms PERSIST
  - Urology may consider aspiration with sclerotherapy or laparoscopic decortication.
- Avoid Tx for size alone
  - A large, asymptomatic, confidently benign cyst can often remain untreated.

Reference [1, 12]

Take home messages

1. Classic simple cysts and confidently characterized Bosniak II lesions need no routine imaging follow-up.

2. An indeterminate ultrasound finding needs appropriate characterization with CT or/and MRI.

3. Enhancing wall, septal and nodular features drive Bosniak v2019 classification.

4. IIF means a documented surveillance plan. III–IV means urology review and individualized management.

5. Numerous bilateral cysts – different talk (need to start thinking of polycystic kidneys)

Reference [1, 2]

Reference

1. Richard PO, Violette PD, Bhindi B, et al. 2023 UPDATE: Canadian Urological Association guideline: Management of cystic renal lesions. CUAJ. 2023;17:162–174.
2. Silverman SG, Pedrosa I, Ellis JH, et al. Bosniak Classification of Cystic Renal Masses, Version 2019: An Update Proposal and Needs Assessment. Radiology. 2019;292:475–488.
3. Schieda N, et al. Bosniak Classification of Cystic Renal Masses, Version 2019: A Pictorial Guide to Clinical Use. RadioGraphics. 2021.
4. Krishna S, et al. Update on MRI of cystic renal masses including Bosniak version 2019. Journal of Magnetic Resonance Imaging. 2021.
5. Lunt C, Elsinger F. Bosniak Classification 2019. The Radiology Assistant. Published 2022.
6. Agnello F, Albano D, Micci G, et al. CT and MR imaging of cystic renal lesions. Insights Imaging. 2020;11:5.
7. Masino F, Eusebi L, Bertolotto M, et al. Contrast-enhanced ultrasound in renal cystic lesions: an update. J Med Ultrason. 2024;51:635–647.
8. Cantisani V, Bertolotto M, Clevert DA, et al. EFSUMB 2020 Proposal for a Contrast-Enhanced Ultrasound-Adapted Bosniak Cyst Categorization: Position Statement. Ultraschall Med. 2021;42:154–166.
9. McGrath TA, Davenport MS, Silverman SG, et al. Bosniak Classification of Cystic Renal Masses Version 2019: Proportion of Malignancy by Class and Subclass. Systematic Review and Meta-Analysis. AJR. 2025;224:e2432342.
10. European Association of Urology. Guidelines on Renal Cell Carcinoma. Diagnostic Evaluation, Bosniak classification and renal tumor biopsy sections.
11. Járay Á, Farkas PI, Semjén D, Botz B. The value of contrast-enhanced ultrasound in the follow-up of Bosniak IIF cystic renal lesions. BMC Med Imaging. 2025;25:358. Figure 4. CC BY 4.0.
12. Rometti M, Bryczkowski C, Mirza MR. Hemorrhagic Renal Cyst, a Case Report. JETem. 2020;5(1). Ultrasound image. CC BY 4.0.