Contrast-Enhanced Ultrasound as a Diagnostic Procedure in Renal Diseases: A Case Report

Nefrologo in corsia

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ABSTRACT

Standard ultrasound (US) finds wide use in renal diseases as a screening procedure, but it is not always able to characterize lesions, especially in differential diagnosis between benign and malignant lesions. In contrast, contrast-enhanced ultrasonography (CEUS) is appropriate in differentiating between solid and cystic lesions as well as between tumors and pseudotumors. We show the case of a nephropathic patient who showed a complex, large, growing renal mass, characterized through a CEUS. This seventy-five-year-old diabetic heart patient showed a 6 cm-complex and plurisected cyst on ultrasound of left kidney. Laboratory data showed the presence of stage IIIb chronic renal failure with GFR 30 ml/min, creatinine 2.33 mg/dl, azotemia 88 mg/dl. The patient performed abdominal CT without contrast medium, showing at the level of the left upper pole, a roundish formation with the dimensions of approximately 70x53x50 mm. At the semiannual checkup, the nephrology examination showed a slight rise in creatinine and, therefore, after six months, it was decided to perform a CT scan without contrast medium again. CT showed a slight increase in the size of the mass located at the left kidney (74x56x57 mm). Given the increased size of the left mass, albeit modest, a CEUS was performed to reach a diriment diagnosis. CEUS concluded for complex cystic formation with presence of intraluminal solid-corpuscular material, with thrombotic-hemorrhagic etiology, in progressive phase of organization, classifiable as Bosniak type II cyst. CEUS in the kidneys is a cost-effective and valuable imaging technique; it is accurate in the characterization of indeterminate lesions and complex cysts.

KEYWORDS: Contrast-Enhanced Ultrasound, CEUS, Renal Cyst, Indeterminate Renal Mass

Introduction

Ultrasound (US) is a non-invasive technique commonly used for first level investigation in renal diseases. It is known to be an easy-to-use and relatively inexpensive approach. Computed tomography (CT) and magnetic resonance (RM) are also used for these indications, but they certainly have a higher cost and risks such as exposure to ionizing radiation in the case of CT. Standard US finds wide use as a screening procedure, but it is not always able to characterize lesions. In fact, lesions may present as isoechoic to the renal parenchyma on grey-scale imaging, and the micro-circulation can be detected with difficulty using Doppler. In addition, the standard US fails to make differential diagnosis between benign and malignant lesions [1].

In contrast, the clinical use of contrast-enhanced ultrasonography (CEUS) in the kidney has been very well defined by the guidelines of the European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB) published in 2017. Based on these indications, CEUS is appropriate in identifying suspected vascular disorders such as infarction and cortical necrosis; in differentiating between solid and cystic lesions as well as between tumors and pseudotumors. CEUS is useful in the characterization and follow-up of complex cystic masses and in the identification of renal abscesses, as also in radiofrequency ablation of non-surgical masses [2].

Microbubbles, such as those based on sulfur hexafluoride, are the contrast agents used for CEUS, recognized as safer than iodinated and gadolinium-based agents, especially in patients with renal impairment [3].

In this article we present the case of a nephropathic patient who showed a complex, large, growing renal mass. After several instrumental examinations, only the use of CEUS allowed to reach the correct diagnosis, leading the patient to begin the right diagnostic therapeutic course.

Case presentation

Seventy-five-year-old patient suffers from ischemic heart disease, treated with aortocoronary bypass, insulin-dependent diabetes mellitus, and hypertension. He suffered ten years ago from meningoencephalitis and had a partial prostectomy. Increased creatinine levels have been noted for the past year. Clinical condition is good, with no signs of pulmonary overload or declivous edema. On cardiac auscultation, sinus rhythm, reinforced second tone and free pauses were detected. Ultrasonographic examination showed right kidney of shape and size altered by the presence of voluminous cyst at the lower pole with a maximum diameter of 7.5 cm and a corticomedullar thickness at the lower limits of normal. The same examination showed left kidney of shape and size altered by the presence of voluminous complex and plurisected cyst at the upper pole with a maximum diameter of 6 cm. Again, the corticomedullary was at the lower limits of normal thickness and the bladder was apparently regular.

Laboratory and instrumental data showed the presence of stage IIIb chronic renal failure with eGFR 30 ml/min, creatinine 2.33 mg/dl, azotemia 88 mg/dl, electrolytes and blood tests in the normal range. Six months later, the patient carried out a second ultrasound examination that showed the replacement of the cyst at the upper pole of the left kidney with a solid-liquid, septate formation of equal size. Uro-CT and tumor marker assay were recommended. The patient performed abdominal CT without contrast medium. At the level of the left upper pole, a roundish formation with the dimensions of approximately 70×53×50 mm was appreciated. The formation was inhomogeneous, tenuously, and subtly hyperdense, in the walls of which microcalcifications were appreciated. The examination appeared to lead back to a complex, plurisected cyst, but its non-unambiguous interpretation prompted the recommendation of periodic ultrasound follow-up and possible further

investigation with MRI. Multiple renal cysts were evident on the right, the largest of which was approximately 80 mm in mesorenal location, on which septum likely calcific on parietal eversion was appreciated. The kidneys were mildly reduced in size, with a modest inhomogeneity and thickening of the renal bands and the renal-fascial septa. After six months, an ultrasound examination of the abdomen showed kidneys in place with reduced corticomedullar thicknesses. Cysts in the right kidney were present at the upper and lower poles, and a 19.7 mm hyperechogenic area at the upper pole was appreciated, likely to be attributable to angiomyolipoma. Same examination confirmed complex formation at the upper pole of the left kidney, silent on power-Doppler. Once again CT with contrast medium or MRI was recommended. A further ultrasound examination performed in the following months did not add any other useful information to ascertain a diagnosis.

At the semiannual checkup, the nephrologist examination showed a slight rise in creatinine and a slight increase in the diameter of the cyst located at the lower pole of the right kidney. Therefore, after six months, it was decided to perform a CT scan without contrast medium again, which showed a slight increase in the size of the round formation located at the left kidney, which reached the size of 74×56×57 mm (Figure 1).

Figure 1. CT shows a round formation located at the left kidney.

On the inferior side, there were also an increase in the inhomogeneous internal hyper density with cortico-juxtacortical focus and a greater density on the super-mesial side. Slightly increased cystic formations located on the right were confirmed. Since the increase, albeit modest, in the size of the left cyst had raised some suspicions, it was decided to perform a CEUS to reach a diriment diagnosis. CEUS was chosen because the patient did not tolerate the CT contrast medium, due to his renal impairment. At CEUS examination, kidneys are found to be normal in location, shape, and size with rough edges. Slightly altered cortico-medullary differentiation, absence of calcific aggregates and calico-pelico-ureteral dilatation bilaterally were showed. Few simple cystic anechogenic formations were present at the right kidney: the largest partially exophytic at the upper pole were 1.98×2.09 cm, those in middle third were 3.25×3.09 cm and that in lower middle third of 8.74×7.38 cm. A simple, exophytic, cystic anechogenic formation with diameter of 0.79×1.07 cm was present at the middle-lower third of the left kidney. A complex, oval-looking, partially exophytic, complex formation with diameter of 6.27×4.7 cm was present at the upper pole of the left kidney (Figure 2).

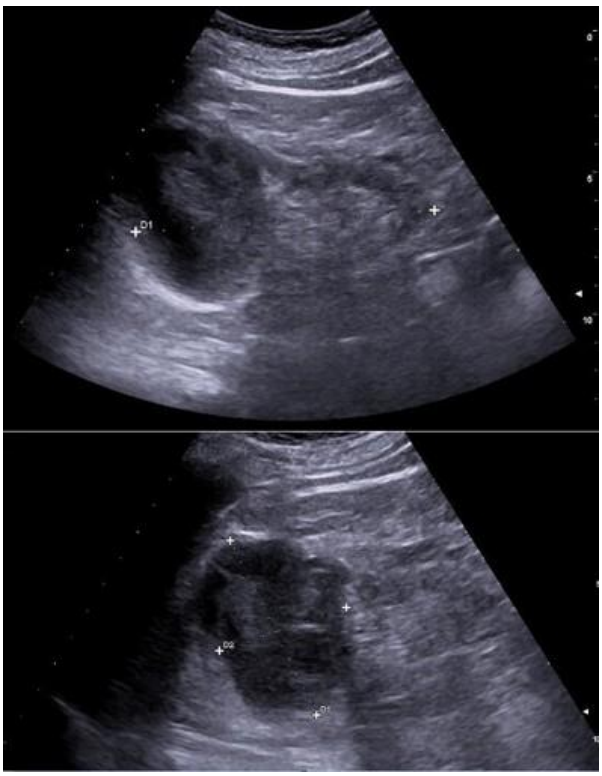

Figure 2. The left renal formation, previously seen on CT, with its corpuscular/pseudo-solid echogenic material is showed in B-mode US.

Here, sharp, well-defined margins and diffuse intraluminal corpuscular/pseudo-solid echogenic material, with contextual more frankly fluid anechogenic microareas, lacking vascularization with color Doppler and Power Doppler, were showed. Bilaterally, flowmetric sampling at the level of intracortical branches of the renal arteries showed flow tracings with an irregular profile, with Resistance Indices between 0.7 and 0.8, compatible with a chronic renal failure. After injection of contrast medium, there was no contrastographic impregnation of the formation at the upper pole of the left kidney. No lesions with solid type contrastographic impregnation were revealed in the cystic lumen. At the upper pole of the left kidney, CEUS concluded for complex cystic formation with presence of intraluminal solid-corpuscular material, with thrombotic-hemorrhagic etiology, in progressive phase of organization, classifiable as Bosniak type II cyst (Figure 3).

Figure 3. CEUS shows the left renal formation previously seen on CT, after injection of contrast medium.

Discussion

The patient, after carrying out several instrumental analyses, reached the diagnosis of a benign left renal lesion. This result was achieved after the patient underwent CT ionizing radiation several times, but only thanks to CEUS the left renal lesion was diagnosed as benign. While unenhanced US may not distinguish benign from malignant lesions, CEUS has been found to be comparable to CT in characterizing complex cystic lesions [4–6]. At CT, which is the gold standard, such lesions are classified according to Bosniak's classification into four classes. Classes I and II are considered benign, up to class IIF indicating a probably benign lesion requiring follow-up. Classes III and IV are suggestive of a higher probability of malignancy, including lesions which would require surgery. CEUS uses a modified Bosniak classification for complex cysts, identifying benign lesions that show no enhancement with a high positive predictive value, as reported in EFSUMB 2020 Position Statement [4, 7]. Compared with CT, CEUS can detect more septa, it can better characterize their thickness, and can more often detect solid components within cystic lesions. The greater sensitivity in identifying septa thickness at CEUS compared with CT results in an upgrading in the evaluation of cysts from grade IIF to III (thick septa) or grade III to IV (malignant lesion). In addition, CEUS does not appear to significantly increase the number of false positives compared to CT. CEUS provides great imaging of the renal vessels, being very accurate in characterizing focal infarction and cortical necrosis. It can be used in case of contraindications to CT or MRI, with the advantage that it does not involve exposure to ionizing radiation [4, 6, 8]. Hypoperfused masses are identified with greater sensitivity and the contrast agents used are not nephrotoxic. In fact, for our patient's CEUS a non-nephrotoxic contrast medium based on sulfur hexafluoride was used. The dose administered for diagnostic purposes is minimal, in fact a dose of 2 ml microbubbles contains 16 µl of gas. Sulfur hexafluoride dissolves in the blood and is subsequently eliminated with the exhaled air [9]. CEUS, performed by qualified personnel, is quick and relatively simple and could also be executed immediately after a standard US, if it is unclear. It should be remembered that the interpretation of renal diagnostics on CEUS is simpler than that of the liver. While in the first it is enough to observe whether enhancement occurs and whether this occurs in a homogeneous manner compared to the rest of the kidney, for the liver we will also have to consider the timing of enhancement and contrast washout [10].

Conclusions

CEUS in the kidneys is a cost-effective and valuable imaging technique. As shown in our case, it is accurate in the characterization of indeterminate lesions and complex cysts, but it is also useful in the case of infectious diseases. The accuracy in the diagnosis of renal lesions is high and often leads to a definitive diagnosis, therefore it can be considered of the same usefulness as CT and MRI, when used appropriately.

BIBLIOGRAFIA

1. Nicolau C, Buñesch L, Paño B, Salvador R, Ribal MJ, Mallofré C, Sebastià C. Prospective evaluation of CT indeterminate renal masses using US and contrast-enhanced ultrasound. Abdom Imaging. 2015 Mar;40(3):542-51. https://doi.org/10.1007/s00261-014-0237-3.
2. Jenssen C, Gilja OH, Serra AL, Piscaglia F, Dietrich CF, Rudd L, Sidhu PS. European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB) Policy Document Development Strategy – Clinical Practice Guidelines, Position Statements and Technological Reviews. Ultrasound Int Open. 2019 Jan;5(1):E2-E10. https://doi.org/10.1055/a-0770-3965.
3. Nanda NC. History of echocardiographic contrast agents. Clin Cardiol. 2009 Feb 3;20(Suppl 1):7–11. https://doi.org/10.1002/clc.4960201304.
4. Ascenti G, Mazziotti S, Zimbaro G, Settineri N, Magno C, Melloni D, Caruso R, Scribano E. Complex cystic renal masses: characterization with contrast-enhanced US. 2007 Apr;243(1):158-65. https://doi.org/10.1148/radiol.2431051924.
5. Park BK, Kim B, Kim SH, Ko K, Lee HM, Choi HY. Assessment of cystic renal masses based on Bosniak classification: comparison of CT and contrast-enhanced US. Eur J Radiol. 2007 Feb;61(2):310-4. https://doi.org/10.1016/j.ejrad.2006.10.004.
6. Quaia E, Bertolotto M, Cioffi V, Rossi A, Baratella E, Pizzolato R, Cov MA. Comparison of contrast-enhanced sonography with unenhanced sonography and contrast-enhanced CT in the diagnosis of malignancy in complex cystic renal masses. AJR Am J Roentgenol. 2008 Oct;191(4):1239-49. https://doi.org/10.2214/AJR.07.3546.
7. Cantisani V, Bertolotto M, Clevert DA, Correas JM, Drudi FM, Fischer T, Gilja OH, Granata A, Graumann O, Harvey CJ, Ignee A, Jenssen C, Lerchbaumer MH, Ragel M, Saftoiu A, Serra AL, Stock KF, Webb J, Sidhu PS. EFSUMB 2020 Proposal for a Contrast-Enhanced Ultrasound-Adapted Bosniak Cyst Categorization – Position Statement. Ultraschall Med. 2021 Apr;42(2):154-166. English. https://doi.org/10.1055/a-1300-1727.
8. Xue LY, Lu Q, Huang BJ, Ma JJ, Yan LX, Wen JX, Wang WP. Contrast-enhanced ultrasonography for evaluation of cystic renal mass: in comparison to contrast-enhanced CT and conventional ultrasound. Abdom Imaging. 2014 Dec;39(6):1274-83. https://doi.org/10.1007/s00261-014-0171-4.
9. Dietrich CF, Averkiou M, Nielsen MB, Barr RG, et al. How to perform Contrast-Enhanced Ultrasound (CEUS). Ultrasound Int Open. 2018 Jan;4(1):E2-E15. https://doi.org/10.1055/s-0043-123931.
10. Tenant SC, Gutteridge CM. The clinical use of contrast-enhanced ultrasound in the kidney. Ultrasound. 2016 May;24(2):94-103. https://doi.org/10.1177/1742271X15627185.