

# Calyceal Diverticulum - a Mimic of Different Pathologies on Multiple Imaging Modalities

Rebecca Mullett<sup>1\*</sup>, Jane C Belfield<sup>1</sup>, Sobhan Vinjamuri<sup>1</sup>

*1. Royal Liverpool University Hospital, Liverpool, UK*

\* **Correspondence:** Rebecca Mullett, Department of Radiology, Royal Liverpool University Hospital, Prescot Street, Liverpool, Merseyside L7 8XP, UK

 [rebeccamullett@doctors.org.uk](mailto:rebeccamullett@doctors.org.uk)

Radiology Case. 2012 Sep; 6(9):10-17 :: DOI: 10.3941/jrcr.v6i9.1123

## ABSTRACT

Calyceal diverticula are outpouchings of a renal calyx. Often found incidentally on radiological imaging, they are generally benign and usually asymptomatic, although complications include infection and stone formation. More importantly, calyceal diverticula may mimic other potentially more serious pathology on imaging, such as renal tumour or abscess on ultrasound or computed tomography and even rib metastasis on bone scintigraphy. We present a case of a patient with a calyceal diverticulum found incidentally on imaging, in which the diverticulum is demonstrated on ultrasound, computed tomography, intravenous urogram and bone scintigraphy, and discuss the potential differential diagnoses that need to be excluded in this condition.

## CASE REPORT

### CASE REPORT

A 58 year old female was undergoing follow up for breast cancer, for which she had previously undergone a mastectomy. She had no known metastases.

During postoperative follow up she complained of pain in the thoracic spine, and nuclear medicine bone scan was requested to exclude bone metastases as a cause [Figure 1]. This demonstrated no evidence of osteoblastic metastases but an incidental finding of a focal area of increased tracer uptake between the left posterior inferior ribs. This was thought to represent an abnormality in the kidney or adrenal gland, but the exact aetiology was unknown. Ultrasound scan was arranged for further characterisation.

Ultrasound scan [Figure 2] demonstrated a 2.3cm cystic lesion in the upper pole of the left kidney. Internally there was an area of calcification, which the reporting sonographer felt could represent either a calculus or wall calcification. As the aetiology of the mass was still uncertain, computed tomography (CT) scan was suggested.

CT scan was subsequently performed [Figure 3]. At that time, CT Urography was not routinely used in our hospital so

the scan was performed with an unenhanced series and a series post intravenous (IV) contrast, with images taken in portal venous phase. Unenhanced images demonstrated a 1.3 x 1.3 x 2.4cm calcified density in the upper pole of the left kidney. Post IV contrast the lesion was better demonstrated and appeared as a 3.2 x 2.3 x 2.4cm cystic lesion with no internal septations and no enhancement. This was thought to represent a complex cyst, requiring Urological referral and follow up.

After Urology referral, the diagnosis of calyceal diverticulum was considered, as an alternative to a complex cyst. As the management of complex cyst and calyceal diverticulum differs, the former potentially requiring resection because of the risk of malignancy, further investigation was requested to differentiate. CT urogram was not in regular use at that time in our institution and Intravenous Urogram (IVU) was therefore requested [Figure 4]. On the control film an area of calcification was seen in the upper pole of the left kidney. Post IV contrast, there was in-filling of the lesion, which measured 3.5cm and demonstrated communication with the left upper pole calyx. The mass was finally diagnosed as a calyceal diverticulum. No further investigations were required.

Since calyceal diverticulum was confirmed, the patient has had continued follow up for her breast cancer with both CT

and bone scans. These confirm that the calyceal diverticulum remains unchanged over a period of 4½ years.

## DISCUSSION

A calyceal diverticulum is a urine containing outpouching of a calyx into the renal parenchyma, communicating with the pelvicaliceal system via a narrow neck [1,2]. They are uncommon entities, seen in 0.2-0.6% of patients undergoing renal imaging. They occur equally in men and women and are seen in children and adults [3].

The exact aetiology of calyceal diverticula is unknown. They may be congenital lesions or acquired, secondary to, conditions such as infection, rupture of a simple cyst or vesicoureteric reflux [4]. There are two recognised types. Type 1 is the more common form, which communicates with a renal calyx and is usually found in the upper pole. Type 2 is less common, larger, communicates directly with the renal pelvis and found in the interpolar region of the kidney. Type 2 calyceal diverticula may also be termed pyelocalyceal diverticula, reflecting their communication with the renal pelvis [4,5].

Calyceal diverticula are lined by non-secretory transitional epithelium. They fill by retrograde reflux of urine from the calyx via the diverticular neck. Stones form within calyceal diverticula in up to 50% of cases [2,3]. Most diverticula are small, measuring between 0.5 and 2.0cm in diameter, but giant diverticula, measuring up to 18cm, have been reported [6].

Many calyceal diverticula are small or asymptomatic and may be found incidentally on radiological investigations. Complications include secondary infection, pain secondary to stone formation or, if large, compression on surrounding structures. Management depends on symptoms - if uncomplicated and asymptomatic there is usually no need for intervention. If symptomatic, for example with recurrent urinary tract infection or pain, then intervention is considered. Historically this included open surgery, however current practice involves less invasive techniques, including stone removal via shock wave lithotripsy, ureteroscopic lithotripsy/removal, percutaneous nephrolithotomy, or laparoscopic removal [2,3].

Although usually benign and uncomplicated themselves, calyceal diverticula may mimic other conditions on radiological imaging. Thus knowledge of calyceal diverticula is important so that they can be distinguished from other more serious pathology.

### Imaging findings

In general, calyceal diverticula have the appearance of a well defined, thin walled structure containing urine. Up to 50% contain calcifications in the form of milk of calcium or more formed calculi, which lie within the diverticulum itself [3]. Characteristically these calcifications move with changes in position [5].

Where contrast or tracer is used (for example in contrast enhanced CT, IVU or nuclear medicine bone scan) the diverticulum will usually opacify later than the pelvicaliceal system, filling via retrograde reflux via the diverticular neck. It may also demonstrate prolonged opacification, as contrast or tracer flows slowly out of the diverticulum via the thin neck [4]. The caveat to this is if there is a stone blocking the neck of the diverticulum, in which case contrast cannot reflux into the diverticulum, and it may not opacify at all [7].

The imaging findings and differential diagnoses are modality dependent. Each modality will be discussed separately.

### *Plain film*

If small, calyceal diverticula may not be seen on plain radiography. If calcifications are present, these may be visible, as with other renal calculi, as a hyperdense area projected in the region of the kidney.

### *Renal ultrasound*

As ultrasound is commonly used to image the urinary tract, this may be the first investigation in which a calyceal diverticulum is seen. A calyceal diverticulum will generally appear as a well defined, anechoic, thin-walled structure, which may not clearly be seen to communicate with a calyx. There may be internal calcifications, either in the form of stones or of milk of calcium. In one small ultrasound series, 7 of 11 cases of calyceal diverticula demonstrated mobile echogenic material. It is suggested that the presence of mobile hyperechogenic material within a cystic structure is diagnostic of a calyceal diverticulum [2]. A calyceal diverticulum should not demonstrate Doppler flow.

Due to the variable appearance on ultrasound, the differential diagnosis is wide. An anechoic structure with thin walls on ultrasound may be confused with a simple cyst. If calcifications are present then complex cyst or renal tumour should be considered. Both of these entities require at least follow up and possibly surgical resection.

Another important differential is renal abscess, which can be seen as a complex collection containing internal material, with reduced acoustic transmission [8]. Note that in addition, abscess can develop in a pre-existing calyceal diverticulum [3]. As well as imaging findings, the clinical features should also suggest a diagnosis of renal abscess.

Careful ultrasound assessment of a hypoechoic structure in the kidney should be undertaken to determine the presence or absence of mobile echogenic material, including moving the patient in different positions. If not present then further imaging, such as CT urogram, may be required to exclude more sinister pathology.

### *Computed Tomography*

On unenhanced CT scan, calyceal diverticulum appears as a well defined, thin walled, low density structure. It may contain calcific density, in the form of a stone or milk of calcium. These should lie dependently within the cystic

structure. As in our case, these calcifications may be better demonstrated using bone windowing, revealing multiple small calcifications, rather than one large stone. Following IV contrast, the structure should gradually fill with contrast, as contrast leaves the normal calyx and fills the diverticulum [9,10].

Without an excretory phase scan, this could be misinterpreted as a complex cyst or tumour. Thus, an excretory phase scan following IV contrast should be performed for clarification.

A further differential for calyceal diverticulum is a hydrocalyx (dilated calyx) due to obstruction. This can be caused by a crossing vessel, an obstructing stone, carcinoma or by infundibular stenosis secondary to tuberculosis [4]. In this case, the cause of the obstruction should usually be seen on CT scan.

Renal abscess is also an important differential. This may exhibit an irregular enhancing wall, gas within the mass, hypoattenuation in the surrounding renal parenchyma, renal fascial thickening and obliteration of the perinephric fat. None of these features should be present in uncomplicated calyceal diverticulum [11].

#### *Intravenous Urography*

Due to the increasing use of ultrasound and CT, intravenous urography is used less commonly in current practice. However, calyceal diverticulum may be readily demonstrated on IVU and may be diagnostic. An IVU series will normally begin with a control film, on which calcifications, if present, may be seen as radio-opaque densities in the region of the kidney. After contrast administration the diverticulum should be demonstrated as a space which fills after the rest of the pelvicalyceal system, and then may demonstrate prolonged opacification [7].

The caveat to this is if a stone obstructs the diverticulum neck, in which case there may be no infilling of contrast. In this case, confirming the diagnosis may be more difficult.

#### *Nuclear medicine bone scan*

Nuclear medicine bone scan is not a primary investigation for calyceal diverticula and so the finding will usually be incidental. The most commonly used radionuclide in bone scintigraphy is technetium 99m Methylene diphosphonate (Tc99m MDP). This is normally excreted by the kidneys into the collecting system. In calyceal diverticulum, tracer may accumulate in the diverticulum, rather than being excreted, and thus be detected by the gamma camera.

As in our case, a calyceal diverticulum may be seen on bone scan as an area of focal uptake in the region of the kidney, usually the upper pole [12]. There is a potential pitfall for the reporter if this focal uptake appears to lie within a rib, in which case the differential is that for any focal increased bone uptake, including osteoblastic metastasis or fracture.

It is therefore important, when reporting an area of focal uptake in this region, to consider the diagnosis of calyceal diverticulum, so as not to make an incorrect diagnosis of rib fracture or metastasis.

#### *PET-CT*

Calyceal diverticula may be misdiagnosed as renal tumours using fluorodeoxyglucose F-18 positron emission tomography (FDG-PET) [8]. Tracer may accumulate in the diverticulum, similar to the process in bone scintigraphy and may not be excreted, leading to intense areas of focal uptake on the scan.

With the increasing use of PET-CT as an imaging modality, it is important to recognise this as a potential pitfall, and to correlate the PET findings with the CT component of the examination. If the diagnosis cannot be confidently made using the unenhanced CT component, further imaging should be considered, such as CT urogram.

#### TEACHING POINT

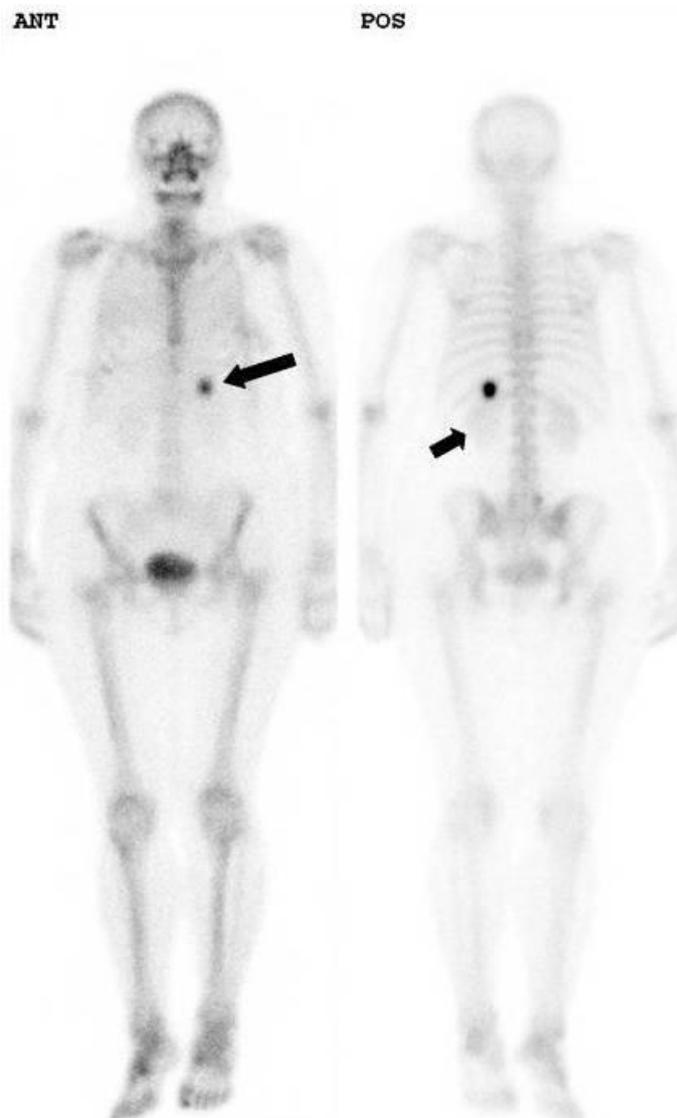
Calyceal diverticula are common incidental findings and can be demonstrated on multiple imaging modalities. Although benign and usually asymptomatic, they may mimic more significant pathology such renal tumor on cross-sectional imaging, or rib metastases on bone scan. Recognition of classical findings may help to differentiate from this more serious pathology. CT urogram or IVU is more likely to be diagnostic by demonstrating communication with the pelvicalyceal system, but ultrasound may also be diagnostic if mobile echogenic material is demonstrated.

#### REFERENCES

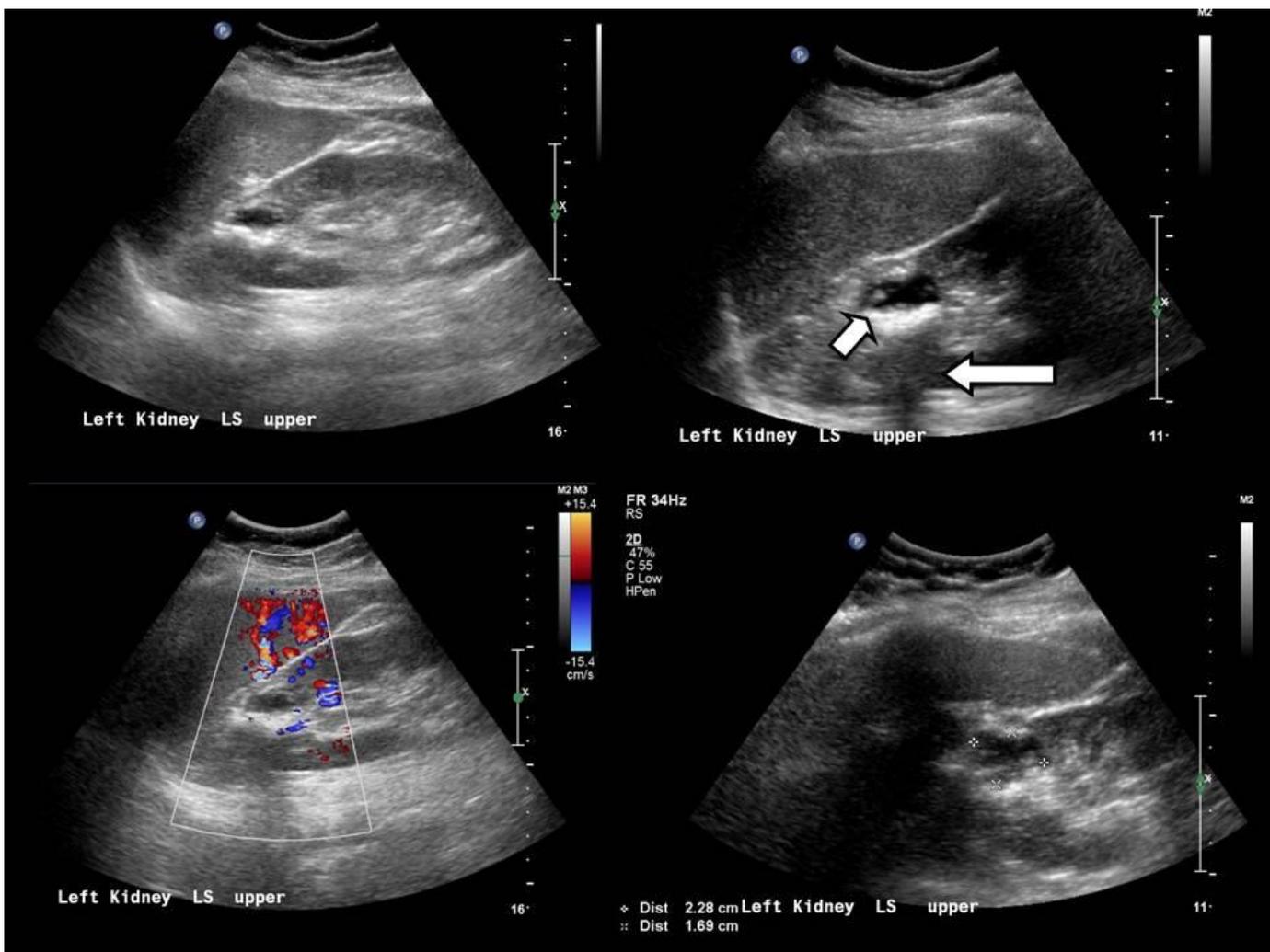
1. Gervais DA, Lee MJ, Papanicolaou N. Genitourinary Imaging. In: Primer of Diagnostic Imaging. 4th ed. Missouri; Mosby, 2007; 303. ISBN-10: 0323040683
2. Reynard J, Brewster S, Biers S. Oxford Handbook of Urology. Oxford; Oxford University Press, 2006; 328. ISBN-10: 0198530951
3. Leveillee RJ, Bird VG. Treatment of Caliceal Diverticula and Infundibular Stenosis. In: Smith AD, Badlani G, Bagley, D et al. Smith's Textbook of Endourology. 2nd ed. Ontario, BC Decker, 2007; 171-185. ISBN-10: 1550093657
4. Dahnert, W. Renal, Adrenal, Ureteral, Vesical and Scrotal Disorders In: Radiology Review Manual. 5th ed. Philadelphia, Lippincott Williams & Wilkins, 2003; 787. ISBN-10: 0781748224
5. Rathaus V, Konen O, Werner M, Shapiro Feinberg M, Grunebaum M, Zissin R. Pyelocalyceal diverticulum: the imaging spectrum with emphasis on the ultrasound features Br J Radiol. 2001;74(883):595-601. PMID: 11509394

6. Kaviani A, Hosseini J, Lotfi B, Valipour R, Sadeghian I. Disfiguring abdominal mass due to a huge extraordinary calyceal diverticulum. *Urol J.* 2010;7:284-6. PMID: 21170862
7. Dyer RB, Chen MYM, Zagoria RJ. Intravenous Urography: Technique and Interpretation1. *Radiographics.* 2001;21(4):799 -824. PMID: 11452054
8. Hoddick W, Jeffrey R, Goldberg H, Federle M, Laing F. CT and sonography of severe renal and perirenal infections. *AJR Am J Roentgenol.* 1983;140(3):517 -520. PMID: 6600545
9. Gayer G, Apter S, Heyman Z, Morag B. Pyelocalyceal diverticula containing milk of calcium-CT diagnosis. *Clin Radiol.* 1998;53:369-71 PMID: 9630277
10. Joffe SA, Servaes S, Okon S, Horowitz M. Multi-Detector Row CT Urography in the Evaluation of Hematuria1. *Radiographics.* 2003;1;23(6):1441 -1455. PMID: 14615555
11. Kawashima A, Sandler CM, Goldman SM, Raval BK, Fishman EK. CT of renal inflammatory disease. *Radiographics.* 1997;17(4):851 -866. PMID: 9225387
12. Auringer ST, Sumner TE. Calyceal diverticulum. Focal renal uptake on bone scan. *Clin Nucl Med.* 1992;17(2):142. PMID: 1563187
13. Kavanagh JJ, Gordon L, Curry NS, Ravenel JG. Calyceal diverticulum mimicking a renal tumor on FDG PET imaging. *Clin Nucl Med.* 2006; 31(5):277-279. PMID: 16622345

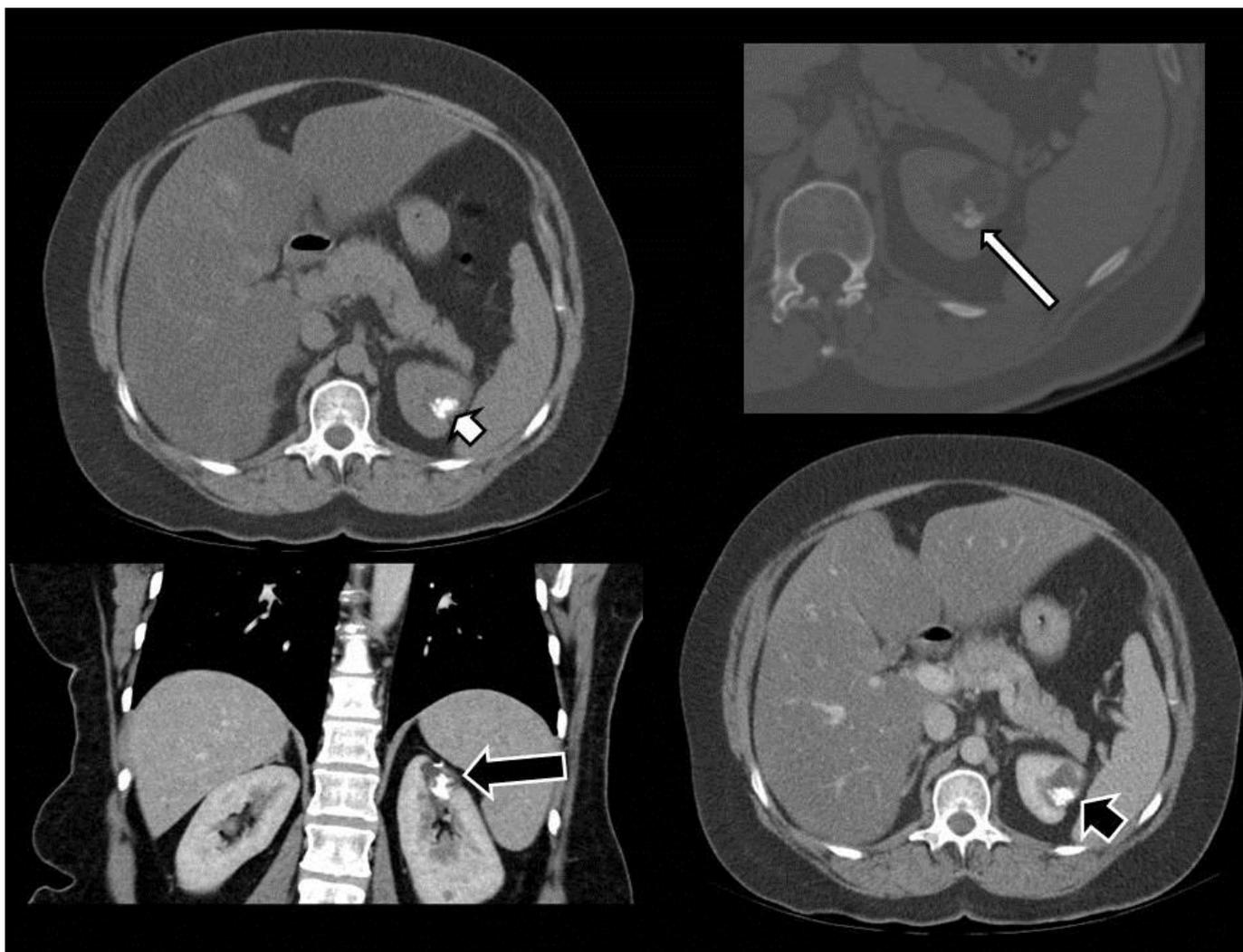
## FIGURES



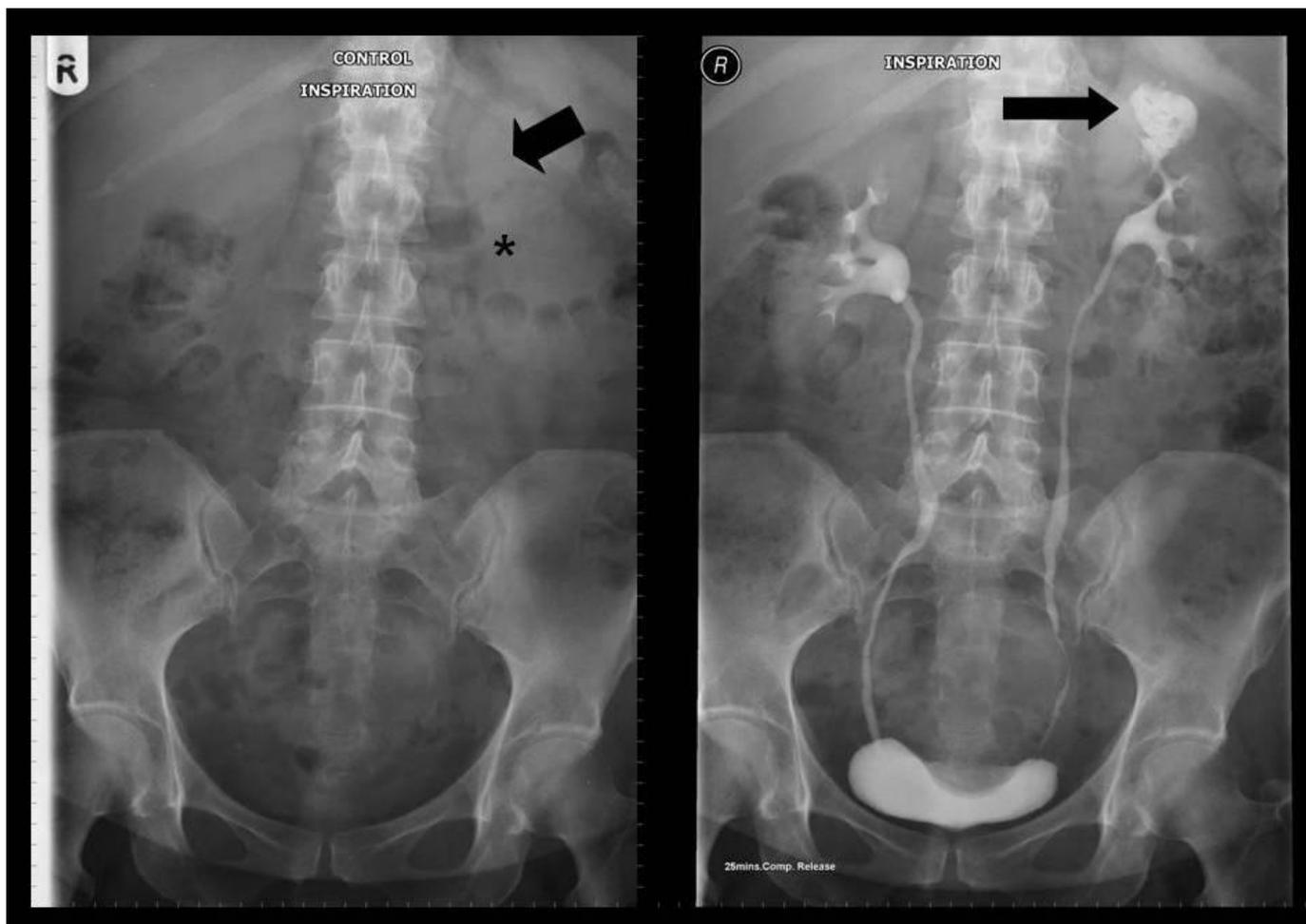
**Figure 1:** 58 year old female with previous breast cancer presenting with thoracic back pain. Whole body bone scan, with anterior and posterior views, demonstrates a small area of focal intense uptake in the region of the upper pole of the left kidney (anterior view, long arrow), proved to be a calyceal diverticulum. The left renal outline is demonstrated (posterior view, short arrow). (Protocol: 600MBq Tc99mMDP whole body planar bone scan with images acquired at 3 hours post injection of radiopharmaceutical).



**Figure 2:** 58 year old female with a history of breast cancer and incidental focal uptake in kidney on bone scan, undergoing ultrasound scan for further characterisation. Longitudinal images from ultrasound scan of the renal tract demonstrate a cystic lesion in the upper pole of the left kidney, measuring 2.3 x 1.7cm. The mass contains areas of hyperechogenicity (short arrow) with posterior acoustic shadowing (long arrow) suggestive of calcification. There was no increased Doppler flow. This proved to be a calyceal diverticulum. (Technique: Ultrasound renal tract performed with 5-2MHz curvilinear probe).



**Figure 3:** 58 year old female with known breast cancer undergoing investigation of cystic mass in the upper pole of the left kidney. CT scan confirmed ultrasound findings of a cystic area in the upper pole of the left kidney. Precontrast axial image demonstrates focal area of internal calcification (short white arrow). Using bone windowing, this calcification is demonstrated to be made up of multiple small calcifications, rather than one mass (thin white arrow). This is confirmed to be in the upper pole on coronal reformatted image (long black arrow - coronal reformatted image from a later CT scan performed 3 years after initial scan). Post contrast the mass demonstrates no enhancement (short black arrow). This proved to be a calyceal diverticulum. (Technique: CT scan of the upper abdomen. Performed on GE single slice CT scanner, 300mAs, 120kVp, 5mm slice thickness. Unenhanced scan (superior images) followed by post contrast images (inferior images) taken in portal venous phase following administration of 97mls of Optiray300).



**Figure 4:** 58 year old female with known breast cancer undergoing investigation of cystic lesion in the upper pole of the left kidney. Selected images from IVU series - pre contrast image and image 25 minutes post IV contrast - demonstrating normal left renal outline (asterix) with faint calcification in the left kidney upper pole (short arrow). Post contrast, there is infilling of the previously identified mass (long arrow) in keeping with a calyceal diverticulum. (Technique: IVU with frontal films before administration of contrast and 25 minutes following intravenous injection of 100mls Optiray300)

<b>Etiology</b>	Developmental or acquired secondary to reflux, infection
<b>Incidence</b>	Uncommon. Reported as 0.21-0.6% of patients undergoing renal imaging
<b>Gender ratio</b>	No specific gender predilection noted
<b>Age predilection</b>	Seen from childhood upwards. No specific age predilection.
<b>Risk factors</b>	Developmental – unknown Acquired - reflux, urinary tract infection, renal cysts
<b>Treatment</b>	Asymptomatic – no treatment required Symptomatic treatment includes antibiotics if infection present, shock wave lithotripsy, ureteroscopic lithotripsy/removal, percutaneous nephrolithotomy, or laparoscopy
<b>Prognosis</b>	Many uncomplicated and asymptomatic. May develop recurrent infection. May cause mass effect on adjacent pelvicaliceal system if large
<b>Findings on imaging</b>	Urine containing outpouching, usually from upper pole calyx. Many contain stones or milk of calcium which is mobile. On contrast enhanced studies, diverticulum may demonstrate delayed filling with prolonged opacification as compared with the adjacent pelvicaliceal system.

**Table 1:** Summary table for calyceal diverticulum

Differential Diagnosis	Ultrasound	Contrast enhanced CT	Bone scintigraphy	FDG PET-CT
<b>Calyceal diverticulum</b>	<ul style="list-style-type: none"> <li>Fluid filled structure with thin wall. Many contain mobile calcifications.</li> <li>No Doppler flow.</li> </ul>	<ul style="list-style-type: none"> <li>Thin walled fluid filled structure which may contain calcifications.</li> <li>Delayed phase imaging demonstrates infilling of the diverticulum, later than the pelvicalyceal system.</li> </ul>	<ul style="list-style-type: none"> <li>May not be seen. If seen, a focal area of increased uptake in the region of the kidney.</li> </ul>	<ul style="list-style-type: none"> <li>May not be seen. If seen, a focal area of increased uptake in the region of the kidney.</li> <li>On CT component this corresponds to a fluid filled structure which may contain calcification.</li> </ul>
<b>Complex renal cyst</b>	<ul style="list-style-type: none"> <li>Cystic structure with no communication with the pelvicalyceal system containing immobile solid or calcified components</li> </ul>	<ul style="list-style-type: none"> <li>Cystic structure with no communication with the pelvicalyceal system containing immobile solid or calcified components.</li> <li>Solid components may enhance.</li> </ul>	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>Cystic structure on CT component. Unless solid component present, should not uptake FDG</li> </ul>
<b>Renal tumour</b>	<ul style="list-style-type: none"> <li>Solid mass in the kidney.</li> <li>May demonstrate hypervascularity on Doppler.</li> </ul>	<ul style="list-style-type: none"> <li>Solid, enhancing mass in the kidney</li> </ul>	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>Focal area of increased tracer uptake within the kidney, corresponding to a solid structure on CT component</li> </ul>
<b>Renal abscess</b>	<ul style="list-style-type: none"> <li>Renal mass with thick wall and fluid filled centrally.</li> <li>May demonstrate peripheral Doppler flow in the wall or surrounding renal parenchyma.</li> </ul>	<ul style="list-style-type: none"> <li>Thick enhancing wall around central fluid filled structure</li> </ul>	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>Focal area of rim-like increased tracer uptake within the kidney, corresponding to a fluid filled walled structure on CT component</li> </ul>
<b>Hydrocalyx secondary to obstruction</b>	<ul style="list-style-type: none"> <li>Cause of obstruction may be seen e.g. calcified stone, crossing vessel, carcinoma</li> </ul>	<ul style="list-style-type: none"> <li>Cause of obstruction may be seen e.g. calcified stone, crossing vessel, carcinoma</li> </ul>	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>Cause of obstruction may be seen e.g. calcified stone, crossing vessel, carcinoma</li> </ul>
<b>Rib metastasis or fracture</b>	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>Focal area of increased uptake. Should be located in the region of a rib.</li> </ul>	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>

**Table 2:** Differential diagnosis table for calyceal diverticulum

**ABBREVIATIONS**

CT = Computed tomography  
 IV = Intravenous  
 IVU = Intravenous urography

**KEYWORDS**

Calyceal; diverticulum; renal calyx; IVU; intravenous urogram

**Online access**

This publication is online available at:  
[www.radiologycases.com/index.php/radiologycases/article/view/1123](http://www.radiologycases.com/index.php/radiologycases/article/view/1123)

**Peer discussion**

Discuss this manuscript in our protected discussion forum at:  
[www.radiopolis.com/forums/JRCR](http://www.radiopolis.com/forums/JRCR)

**Interactivity**

This publication is available as an interactive article with scroll, window/level, magnify and more features.  
 Available online at [www.RadiologyCases.com](http://www.RadiologyCases.com)

Published by EduRad



[www.EduRad.org](http://www.EduRad.org)