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A large renal pelvic diverticulum, presenting incomplete excretion during Tc-99m MAG-3 scintigraphy and tracer accumulation on Tc-99m DMSA scintigraphy; a case report

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This case report illustrates the dynamic and static renal scintigraphic images of a patient with an unusual large diverticulum of the renal pelvis. The initial diagnosis by intravenous pyelography (IVP) and ultrasonographic (US) examination was a renal pelvic diverticulum of the left kidney, and the patient was referred to the nuclear medicine department for exploration of the effect of the pelvic diverticulum on renal functions.

We performed dynamic renal scintigraphy with technetium-99m (Tc-99m) labeled mercaptoacetyl triglycine (MAG-3) and static renal scintigraphy with Tc-99m labeled dimercaptosuccinic acid (DMSA). In dynamic renal scintigraphy, bilaterally normal concentration function was observed. While right kidney excretion function was normal, an incomplete excretion pattern was seen on the left side. Complete urinary flow obstruction occurred approximately at the 10th minute of the acquisition, which did not seem to respond to the i.v. furosemide application. However, when only the renal cortex was included in the region of interest, the obstructive pattern disappeared. In static renal scintigraphy, a large renal pelvic diverticulum localized antero-medially was clearly visualized in the left-anterior oblique projection, most probably due to accumulation of radiopharmaceutical inside it.

This case showed that a renal pelvic diverticulum should be thought of when an incomplete excretion pattern is seen on dynamic renal scintigraphy. Using only a cortical region of interest may also help to distinguish other types of obstructive pattern from diverticulum. Additionally, Tc-99m DMSA scintigraphy may show diverticulum localization with antero-oblique projections in addition to routine projections.

Key words: renal, pelvic, diverticulum, scintigraphy, MAG-3, DMSA

INTRODUCTION

CALICEAL (or pyelocaliceal) diverticulums are cystic, urine containing intrarenal cavities lined with transitional cell epithelium that communicate through a narrow channel with the collecting system. They are congenital or acquired anatomical abnormalities of the collecting system.[1–3] Renal pelvic diverticulum, which is a urine filled cavity, is a rare disorder. Although there are numerous reports about various interventions, management techniques,[4] treatment procedures,[5–7] complications[2,8] and imaging findings[9,10] in patients with caliceal diverticulum, there are few reports on renal pelvic diverticulum. Moreover, we could not find any reports of Tc-99m MAG-3 dynamic renal scintigraphy or Tc-99m DMSA scintigraphy findings in association with renal pelvic diverticulum in the literature.

Dynamic and static renal scintigraphic techniques are useful, non-invasive and easily applicable methods that are used in the diagnosis of many renal diseases such as

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renal outflow obstructions, and cortical and renovascular dysfunction. Normal finding of dynamic renography excludes an obstructive disease, whereas loss of radionuclide elimination after stimulation with furosemide is characteristic for its diagnosis.

We present here a case report illustrating the IVP, US, dynamic and static renal scintigraphic findings of a patient with an unusual large diverticulum of the renal pelvis.

CASE REPORT

A 29-year-old male patient with an initial diagnosis of renal pelvic diverticulum on the left kidney was referred to the nuclear medicine department for exploration of the effect of pelvic diverticulum on intrarenal urinary flow by dynamic renal scintigraphy.

The patient had been suffering from pollakiuria, nocturia and polyuria for six years. He did not have a previous history of recurrent urinary tract infection, hematuria, symptomatic calculi, dysuria, pain or fever. The actual urine analysis was unremarkable. The blood tests showed the following results: glucose; 106 mg/d*l*, blood urea nitrogen; 17 mg/d*l*, urea; 36 mg/d*l*, plasma creatinine; 1.19 mg/d*l*, aspartate aminotransferase; 23 IU/*l*, alanine aminotransferase; 38 IU/*l*, sodium; 137 mEq/*l*, potassium; 3.5 mEq/*l*, chloride; 105 mEq/*l*.

Before the patient was referred to the nuclear medicine department, he had an initial diagnosis of renal pelvic diverticulum by IVP and US. Intravenous pyelography, obtained 7 minutes after injection of contrast medium showed opacities in the multiple dilated calices present in upper, lower poles and middle portion of the left kidney, while an additional opacity was observed in a large round pelvic diverticulum at the renal pelvic region on the delayed urogram, obtained 90 minutes after contrast medium injection. No sign of calculus was observed in either kidney. During the course of the IVP study, there was no contrast medium transition to the left ureter (Fig. 1).

Abdominal US was performed with a SDU-450XL (Shimadzu Diagnostic Ultrasound, Shimadzu Corporation, Japan) scanner equipped with a 2–5.5 MHz transducer. The dimensions of the right and left kidney were 65 × 130 mm and 75 × 170 mm, respectively. Transverse and longitudinal US images revealed caliceal dilatations in the upper as well as in the lower poles and in the middle portion of the left kidney. Renal pelvis was seen extrarenally and was connected to the large renal pelvic diverticulum, measured as 80 × 100 mm (Fig. 2). Additionally, no stenosis at the uretero-pelvic junction, and no stone were observed by US.

The dynamic renal scintigraphy with Tc-99m labeled MAG-3 and static renal scintigraphy with Tc-99m labeled DMSA were performed for both the evaluation of renal functions and exploration of the effect of the pelvic diverticulum on intrarenal urinary flow.

For dynamic renal scintigraphy, 185 MBq (5 mCi) of Tc-99m labeled MAG-3 (Technescan® MAG-3, Mallinckrodt Medical B.V., Holland) was injected intravenously to the patient in the supine position. Posterior dynamic images [64 × 64 matrix, zoom: 1.2, 30 frame (2 sec/frame) for perfusion phase and 29 frame (1 min/frame) for parenchymal and excretory phases] were ob-

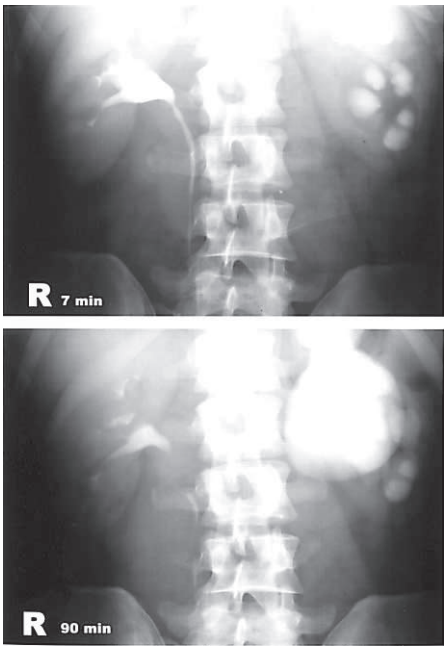

Fig. 1 Intravenous pyelographic images of the patient obtained at 7 and 90 minutes. R; right.

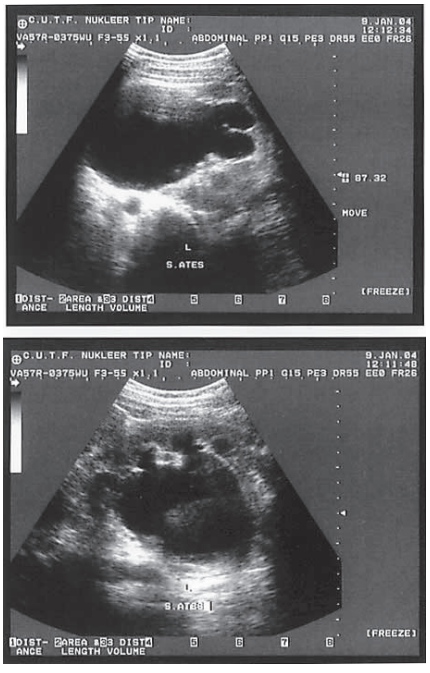

Fig. 2 Transaxial and longitudinal ultrasonographic images of the patient show large renal pelvic diverticulum and dilated calices in the left kidney.

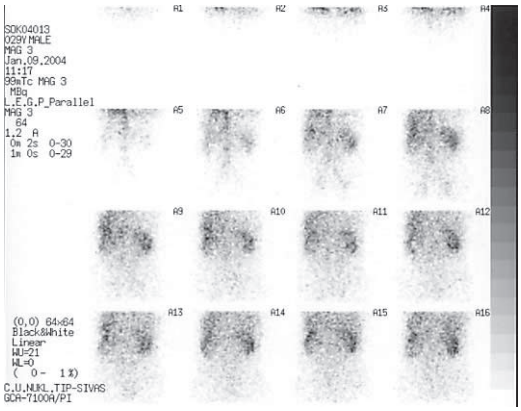

Fig. 3 Images of perfusion phase [64 × 64 matrix, zoom: 1.2, 30 frame (2 sec/frame)] obtained with Tc-99m MAG-3 showing normal symmetric perfusion in both kidneys.

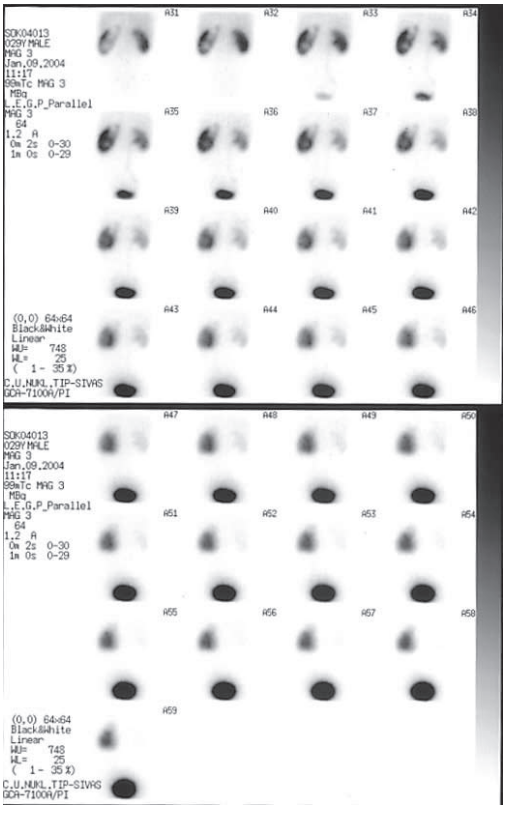

Fig. 4 Dynamic renal scintigraphic images [64 × 64 matrix, zoom: 1.2, 29 frame (1 min/frame) for parenchymal and excretory phases] obtained with Tc-99m MAG-3 showing incomplete excretion pattern in the left kidney.

tained using a gamma camera (E-Cam, Toshiba, Japan) equipped with low energy general-purpose collimators and connected to a dedicated computer system for acquisition (GMS-5500A, Toshiba, Japan).

Normal perfusion appearance was observed in both kidneys in dynamic images (Fig. 3). The expected con-

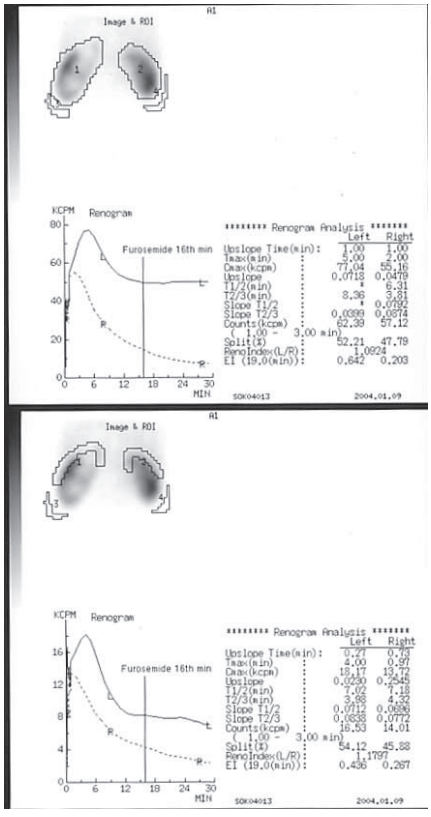

Fig. 5 While normal concentration and excretion functions were observed in right kidney, heterogeneous but good radiopharmaceutical concentration and complete stasis were observed approx, after the 10th minute of the acquisition in left kidney. Furthermore, there seemed to be no response to the i.v. 30 mg furosemide stimulation (*Top*). When regions of interest were drawn from the upper pole and lateral renal cortical area on the kidneys, nearly normal excretion was observed on renogram curve in left kidney (*Bottom*).

centration and excretion functions were also observed in the normal-sized right kidney by dynamic renal scintigraphy (Fig. 4). The left kidney was bigger than the right kidney. During the concentration phase, left kidney had a good, but heterogeneous radiopharmaceutical concentration and an activity defect was seen at the upper pole. An abnormal excretion pattern was observed in the left kidney. Although, spontaneous excretion was seen in the beginning of the excretion phase in relating renogram, complete stasis was observed approximately after the 10th minute of the acquisition. Thirty mg furosemide was injected intravenously to the patient at the 16th minute. However, there seemed to be no response to the i.v. furosemide stimulation (Fig. 4 and Fig. 5-top). Static image obtained at the end of the study showed no change in the urine stasis in the left renal pelvic region. However, the split renal functions, measured between 1 to 3 min intervals were symmetrical, namely 48% on the right kidney and 52% on the left kidney. Additionally, excretory indexes at the 19th minute (EI-19 min) (EI is the ratio

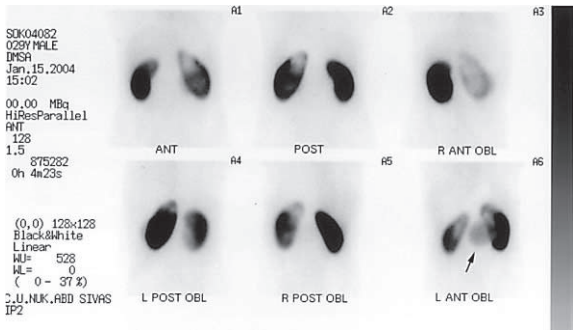

Fig. 6 Static renal scintigraphic projections obtained with Tc-99m DMSA at 4th hour. Renal pelvic diverticulum apparently visualized at anterior of the left kidney in the left-anterior oblique projection (*arrow*).

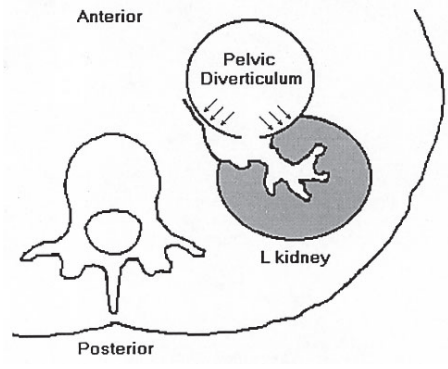

Fig. 7 Schematic (transaxial plane) representation according to US findings of the renal pelvic diverticulum in the presented case.

of kidney activity at 19th min to maximum activity) were calculated as 0.20 on the right kidney and 0.64 on the left kidney. When the analysis was repeated by using a region of interest, comprising only the renal cortical areas, a nearly normal excretion pattern was observed on the left kidney renogram curve. EI was diminished to 0.43 on this side (Fig. 5).

For the renal cortical scintigraphy, 185 MBq (5 mCi) Tc-99m labeled DMSA (Technescan® DMSA, Mallincrodt Medical B.V., Holland) was injected intravenously to the patient on a separate day. At the 4th hour after injection, anterior, posterior, posterior and anterior oblique projection images (128 × 128 matrix, zoom: 1.5) were obtained using a double head gamma camera (E-Cam, Toshiba Corporation, Japan) equipped with low energy high resolution collimators. In the left-anterior oblique projection, a large renal pelvic diverticulum localized antero-medially was clearly visualized at the left renal pelvic region accumulating radiopharmaceutical inside it (Fig. 6). Decreased cortical activity at the upper pole of the left kidney was also seen during Tc-99m DMSA scintigraphy. Split renal uptakes, calculated as the geometrical mean of the anterior and posterior projections, performed as a routine procedure in our department, were 55% on the right kidney and 45% on the left kidney.

The decision of the urological surgeon of the patient was removal of the lesion by surgery. The patient was operated on, and a pelvic diverticulum was surgically removed by an open surgical approach.

DISCUSSION

Pyelocaliceal diverticula can develop anteriorly or posteriorly from the kidney collecting system although they occur more frequently posteriorly. They are frequently associated with stone formation and infections because of urinary stasis.[3,6] Many are asymptomatic and are often discovered as an incidental finding on IVP or other imaging modalities (e.g. renal US, computed tomography scanning, magnetic resonance imaging, retrograde pyelography). The differential diagnosis should be made from some other lesions like communicating cyst, renal cortical abscess, pseudodiverticulum and tuberculosis. In IVP, radiographic contrast material fills diverticula in a retrograde fashion, and so delayed visualization is a common finding.[1,10] This rare anatomical abnormality occurs in 0.21%–0.6% of the population and often contains calculi.[1–3,6,7,11]

The anatomy of the kidney, calices, and ureter can be imaged, and also pelvic diverticulum and caliceal dilatation can be diagnosed by US, but the use of US may be sometimes insufficient for accurate diagnosis. Because diverticula have a thicker outer wall than most benign cysts, the ultrasonographic appearance may also mimic a malignant or infected cyst.[10] The dynamics of the fluid in the diverticulum or caliceal dilatations can also be evaluated by IVP.[9] However, the effects of this condition on the kidney functions should be evaluated by dynamic renal scintigraphy, which is a non-invasive imaging technique.

Only two old reports were found related to diverticula of the renal pelvis and scintigraphy in our literature survey.[12,13]

Renal scintigraphies with Tc-99m MAG-3 and Tc-99m DMSA are known as reliable, suitable and safe approaches to evaluate renal functions. Tc-99m labeled MAG-3 is the radiopharmaceutical agent that allows simultaneous investigation of renal perfusion, functional parenchyma and collecting system. Split-total renal function and other quantitative parameters of renal function can be determined from time-activity curves obtained from MAG-3 dynamic renal scintigraphic images.

In the present case, bilaterally normal concentration function was observed in dynamic renal scintigraphy. While, right kidney excretion function was normal, incomplete excretion was seen in left kidney. Complete urinary flow obstruction occurred approximately at the 10th minute of the acquisition, which did not respond to the i.v. furosemide application. Two reasons can be

considered;

a) Positional transient obstruction; The situation was probably due to the patient's position and mechanical obstruction produced by the pressure of the anterior and middle portion-lower pole placed pelvic diverticulum on the uretero-pelvic junction during excretion (Fig. 7). Indeed, no stenosis or stone was observed in US examination, and the split renal function was symmetrical. It was thought that because both the renal pelvises were located extrarenally and the pelvic diverticulum produced positional transient obstruction, renal functions were preserved. However, the pressure effect of the diverticulum by positional transient obstruction was most probably the reason for the patient's symptoms of pollakiuria, nocturia and polyuria.

b) Technical reason; Incomplete excretion was due to the superposition of the pelvic diverticulum with the left renal ROI. In dynamic renal scintigraphy, to test the effect of superposition on the renogram, Tc-99m MAG-3 dynamic images were re-processed. When the region of interest was drawn from upper pole and lateral renal cortical area on the left kidney, nearly normal excretion was observed on the renogram curve (Fig. 5). This situation showed that a real obstruction was not present, suggesting that this was due to the superposition of the pelvic diverticulum with the left renal ROI.

Static renal scintigraphy, performed with Tc-99m DMSA, which is a renal cortical imaging agent, is used for obtaining information about the overall morphology of the functioning renal units, split renal function and to detect parenchymal abnormalities. It is a useful imaging technique for detecting renal cortical defects and scars. Tc-99m DMSA localizes to the renal cortex by binding to sulfhydryl groups in proximal renal tubules. Renal uptake of Tc-99m DMSA gives an index for the evaluation of the functional renal cortical mass, which depends on the renal blood flow and proximal tubular cellular membrane transport function. The renal collecting system, other than the nephron unit, is usually not visualized with this agent, since the imaging time is usually 3–4 hours post injection when most of the tracer has been eliminated from the urinary tract. However, renal pelvic diverticulum was clearly visualized in the present case because of delayed elimination of urine from the diverticulum. Additionally, decreased cortical activity at the upper pole of the left kidney was evaluated as secondary to caliceal dilatation which was quite obvious in the IVP.

In conclusion, this case showed that renal pelvic diverticulum should be thought of when an incomplete excretion pattern is seen in dynamic renal scintigraphy. Using only a cortical region of interest may also help to distinguish other types of obstructive pattern from diverticulum. Additionally, Tc-99m DMSA scintigraphy may show the diverticulum localization with antero-oblique projections in addition to routine projections.

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