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Diagnostic imaging features of calyceal diverticulum in a cat

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A seven-year-old, castrated male, Korean domestic shorthair cat was referred because of a kidney abnormality. Radiography revealed left renal agenesis and right kidney enlargement. Ultrasonography and computed tomography (CT) showed amorphous calcified materials in a cyst-like lesion of the right kidney. In the excretory phase of the CT images, the lesion was opacified with contrast materials, indicating communication with the collecting system. Based on these findings, the cat was diagnosed with a calyceal diverticulum. A calyceal diverticulum may cause various clinical symptoms related to the urinary system. The excretory phase of CT is useful for diagnosing a calyceal diverticulum.

Keywords: cat; kidney; diverticulum; ultrasonography; contrast media

A calyceal diverticulum is a urine-filled cystic lesion lined with transitional epithelium, which develops as the outpouching into the renal parenchyma and communicates with the upper collecting system via a narrow channel [1-5]. The etiology of a calyceal diverticulum is unclear [1,2]. The most common theory is a congenital factor of an embryologic origin, even though it may develop due to obstruction, infection, or trauma [1-3,5]. This condition rarely occurs in humans and is primarily an incidental finding without symptoms [1,2,5]. On the other hand, it can be associated with symptoms, such as flank pain, hematuria, recurrent urinary tract infection, decreased renal function, and vomiting, which may require therapeutic intervention [2,3,5]. Malignancy in a calyceal diverticulum has been reported in humans [1,4,5]. Only one case report describing the pathology of feline calyceal diverticulum can be found in the veterinary literature [6]. This report describes the radiographic, ultrasonographic, and computed tomography (CT) features of a calyceal diverticulum in a cat.

A seven-year-old, castrated male, Korean domestic shorthair cat presented with anorexia, vomiting, and weight loss at a local hospital two weeks earlier. The cat was tentatively diagnosed with chronic renal disease, and the clinical signs were improved after fluid therapy and symptomatic treatment. Abdominal radiography suggested right renomegaly and left renal agenesis, and he was referred to Chungnam National University Veterinary Teaching Hospital for an accurate diagnosis.

The physical examination revealed mild dehydration. Serum biochemical analysis revealed only mild azotemia (creatinine, 2.5 mg/dL; reference interval [RI], 1-2 mg/dL; blood urea nitrogen, 20.5 mg/dL; RI, 18-33 mg/dL; symmetric dimethylarginine, 19 μg/dL; RI, 0-14 μg/dL). The urine had a specific gravity of 1.025 (RI, 1.035-1.065), and 30 mg/dL of protein was found by dipstick analysis. A microscopic examination of urine revealed a few hyaline casts per low power field. A urine protein/creatinine ratio test was not performed.

On abdominal radiography, the right renal length was 6.5 cm (RI, 3.0-4.3 cm) and 3.25 times (RI, 2.4-3.0 times) the length of the second lumbar vertebra, indicating severe enlargement of the right kidney. The outline of the right kidney was slightly irregular, and the right pelvic calculi were also shown; The left kidney was not visible. On abdominal ultrasonography, an 11 × 8 mm poly-lobulated cystic lesion was observed on the mid-portion of the right renal parenchyma, adjacent to the renal pelvis. Unlike a true cyst, this anechoic cavity contained solid echogenic materials without acoustic shadowing (Fig. 1A, C, and D). These solid materials were settled on the cyst, depending on gravity. Color Doppler analysis did not identify any blood flow in this lesion (Fig. 1B). Although a connection with the pelvis was suspected, it was ambiguous on ultrasonography. The external renal contour around the lesion appeared to be distorted. In addition, mild pelvic dilation of 2.9 mm in the right kidney and pelvic calculi were found.

For a differential diagnosis of the renal cystic lesion, the cat underwent CT scanning using a 32-row multidetector CT (Alexion™; Toshiba, Japan), performed under general anesthesia using 4 mg/kg of propofol (Provive® inj; Myungmoon Pharm. Co., Korea) intravenously for induction and isoflurane (Ifran®; Hana Pharm. Co., Korea) for maintenance. The scanning parameters were 150 kVp, 120 mAs, and 2 mm slice thickness. For contrast studies, iohexol (300 mg iodine/mL, Omnipaque®; GE Healthcare, Ireland) of 600 mg iodine/kg was administrated intravenously using a power injector (2 mL/sec). Pre-contrast, portal phase, and delayed phases (2, 5, and 10 minutes post-injection) were acquired.

The pre-contrast images showed an irregular, hyperdense lesion of 76 Hounsfield unit in the right renal cortex ventral to the pelvis (Fig. 2A), which was suspected as being a complicated cyst containing echogenic material on ultrasound. Two pelvic calculi were detected separately. After contrast injection, the hyperdense lesion was not enhanced on the portal phase and the 2 minute-delayed images (Fig. 2B and C). In the excretory phase images (5- and 10-minute-delayed images), however, this area was filled with contrast material similar to the excretory system, including the renal pelvis, ureter, and urinary bladder (Figs. 2D-F and 3A). The curved planar reformatted image (Fig. 3A) and maximum intensity projection (Fig. 3B) were also performed to demonstrate the narrow connection between the area and the pelvis and visualized the direct connection. Therefore, a calyceal diverticulum connected to the pelvis was confirmed.

The left kidney was not identified by CT as on the radiographic images. Furthermore, CT revealed the absence of the left renal artery, vein, and ureter. There was no history of a nephrectomy. Based on these examination results, a calyceal diverticulum containing calcified materials of the right kidney and left renal agenesis was definitively diagnosed in this cat.

After imaging diagnosis, the cat was returned to the local hospital for further treatment. Intermittent vomiting symptoms were noted at one-month follow-up, but no elevated kidney enzyme level was observed on the laboratory examination.

Calyceal diverticulum in humans can be divided into two types: type 1, the more common form that communicates with the minor calyx, and type 2, the less common form that communicates directly with the major calyx or renal pelvis, which is also known as pyelocalyceal diverticulum [1-5]. A type 2 diverticulum is mostly larger, symptomatic, and located in the middle region of the kidney [1-5]. Unlike multi-papillate kidneys in humans and pigs, the uni-papillate kidneys of dogs, cats, and several animals have different renal structures. The human kidney has a pelvis, 2 to 3 major calyces, and 7 to 13 minor calyces. In comparison, a uni-papillate kidney has no calyx that communicates with the pelvis, even though the pelvis itself is often re-

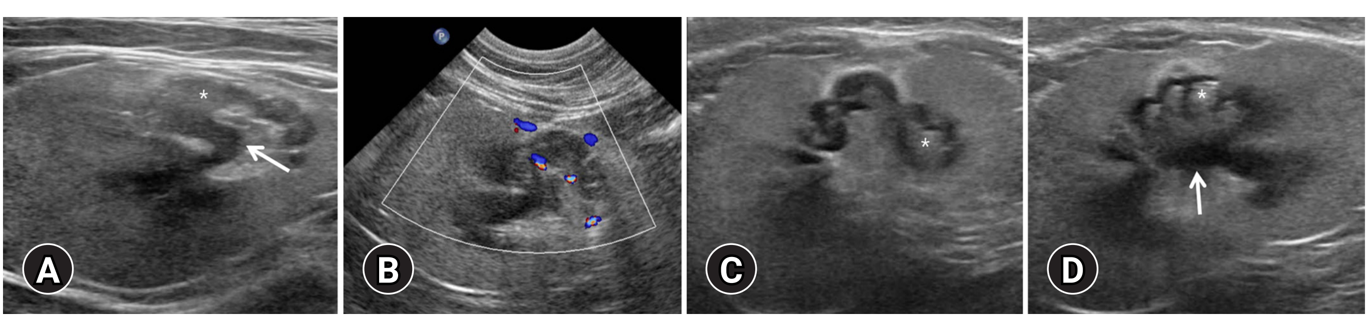

Fig. 1. Transverse (A, B), sagittal (C), and dorsal (D) ultrasonography of the right kidney. The calyceal diverticulum appeared as poly-lobulated cystic cavities, including their echogenic contents (asterisks) near the renal pelvis. This lesion (arrows) was suspected of being connected to the renal pelvis. Blood flow was not detected with a color Doppler examination (B). The renal contour near the cystic lesion was distorted.

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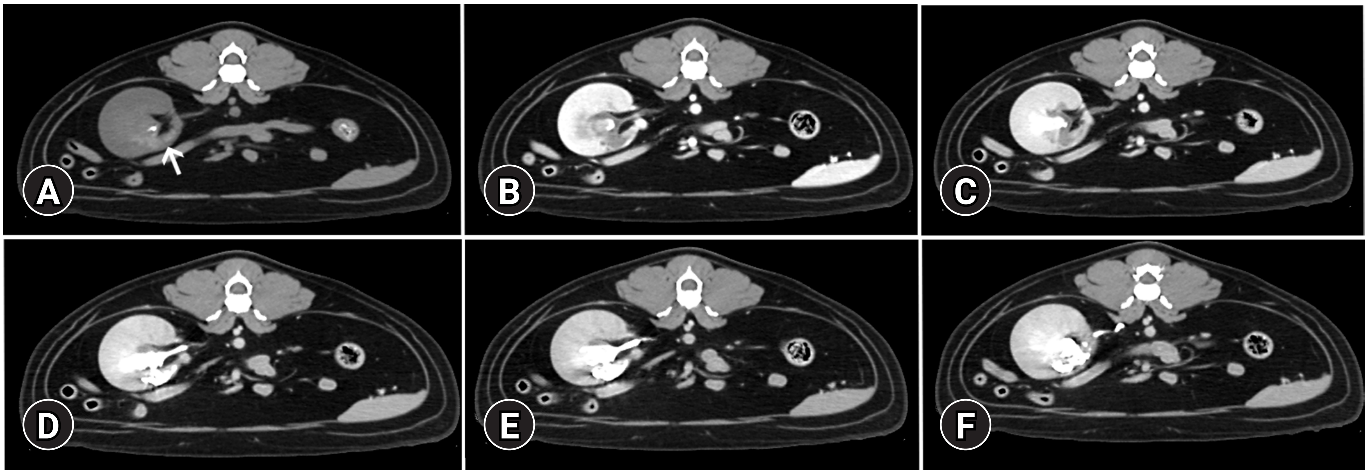

Fig. 2. Abdominal transverse pre-contrast (A), post-contrast nephrogenic phases (B: portal phase; C: 2 minutes delayed phase), and excretory phases (D: 5 minutes; E, F: 10 minutes) of computed tomographic soft-tissue window images. These images except (F) showed how the calyceal diverticulum lesion changed over time in the same cross-section. (F) It shows the following computed tomography image to (E). The pre-contrast image (A) showed hyperattenuated pelvic calculi and calcified materials (arrow) at the ventral part of the right renal cortex. After contrast injection, this lesion was not enhanced on the portal phase (B) and 2-minute-delayed images (C), and was filled up by contrast medium with a similar density to that of the collecting system in the 5- and 10-minute-delayed images (D–F). The diverticulum necks were shown on 10-minute-delayed images (E, F).

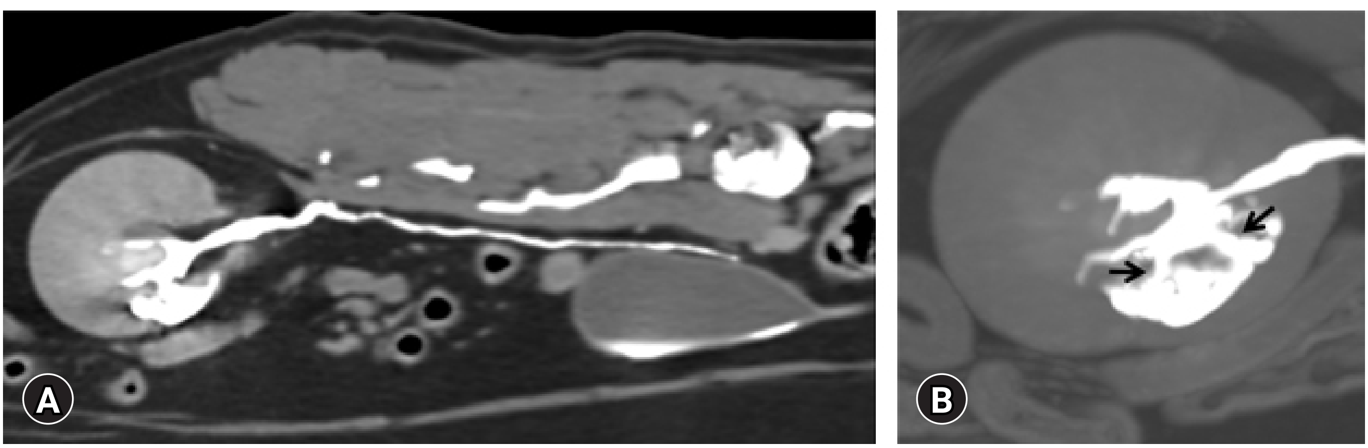

Fig. 3. Curved planar reformatted image (A) and the maximum intensity projection (MIP) reconstruction image (B) of the right kidney on the excretory phase. The reformatted image (A) definitely revealed communication between the calyceal diverticulum and the collecting system. This also showed a urine pathway, including the calyceal diverticulum, pelvis, ureter, and urinary bladder. Two main diverticulum necks (arrows) were evident on the MIP image.

ferred to as a major calyx by some researchers [7]. In this case, this diverticulum had direct communication with the renal pelvis (also called the major calyx in a cat), was located in the middle region of the kidney, and reduced the kidney function. These characteristics were similar to a type 2 calyceal diverticulum in humans.

The calyceal diverticulum should be differentiated from other renal cystic diseases, such as hydrocalyx, simple renal cyst, parapelvic cyst, and cystic renal tumors [2,3]. Human cases of calyceal diverticulum have mainly been reported as non-specific findings on radiography, ultrasonography, or the non-enhanced and nephrogenic phase of CT [2-5]. To date, a calyceal diverticulum mimics other renal cystic diseases, which leads to a misdiagnosis [1,2,5]. On the other hand, other diseases do not involve direct communication with the collecting system [3]. The ultrasonographic findings only raise the suspicion of a lesion being a calyceal diverticulum if a diverticulum neck is found, if the cyst contains calculi or milk calcium—liquid, or semisolid calcified materials of the calyceal diverticulum in human medical terms [1-3,5,6,8,9]. A confirmed diagnosis of calyceal diver-

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ticulum requires the excretory phase images of CT and magnetic resonance imaging in humans [1,2,4,5]. The excretory phase of CT shows filling of the renal cystic cavity with contrast indicating a connection with the collecting system [1-5].

In this case, plain radiography and the non-contrast nephrogenic phase of CT revealed non-specific findings. Ultrasonography showed the cystic cavities, including calcified materials, which suggested a connection of the diverticulum with the pelvis. The CT study showed specific features only on the excretory phase, as observed in humans. As an excretory phase scan of CT is not performed routinely, the true prevalence of calyceal diverticulum could be higher owing to its misinterpretation as a simple renal cyst in a small animal, such as a cat.

In humans, 50% of calyceal diverticulum cases are complicated by calculi and milk calcium, which are usually faintly radiopaque or radiolucent in radiographs, but only hyperdense on non-contrast CT [1,4,5,7,9]. This complication is likely due to a combination of urinary stasis and repeated infection in the calyceal diverticulum [3-5]. In this case, the calcified materials within the calyceal diverticulum were similar to milk calcium observed in humans.

Calyceal diverticulum and renal agenesis are both congenital conditions, and a calyceal diverticulum with contralateral renal agenesis has been reported in humans [10]. Embryogenically, these two diseases arise due to a failure of ureteric bud development. Therefore, calyceal diverticulum and renal agenesis were also suspected to be congenital conditions in this case.

This case report describes the radiographic, ultrasonographic, and CT features of a right renal calyceal diverticulum with left renal agenesis in a cat. Calyceal diverticulum resembles other renal cystic diseases on ultrasonography and the non-enhanced and nephrogenic phase of CT, which could result in a misdiagnosis. On the other hand, calyceal diverticulum can be diagnosed definitively on excretory phase CT imaging. The reformatted CT images could also provide more important diagnostic information on the calyceal diverticulum by demonstrating its anatomical position and communication with the collecting system.

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