

A Cat with Ureteral Obstruction Caused by A Calcium Oxalate Stone in Which A Sub System Was Installed and Long-Term Renal Function Was Evaluated

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シュウ酸カルシウム結石による尿管閉塞に SUB System を設置し、 長期にわたって腎機能評価を行った猫の 1 例

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SUMMARY : This case was an 8-year-old female cat (6.6 kg, altered) with renal failure caused by ureteral obstruction of the right kidney with calcium oxalate stones. The cat underwent 50-month evaluation of renal function after placement of a subcutaneous ureteral bypass (SUB) system. Pyelectasis and ureteral dilatation of the right kidney were confirmed, but it was difficult to identify the site of obstruction by stones because the kidney and urinary duct were buried in fat due to obesity. Thus, we chose to place a SUB system in the right kidney and the bladder. In addition, since there were stones in the renal pelvis and ureter, and an artifact was buried, there was a need to prevent obstruction of the catheter by stones and urinary tract infection; therefore, the SUB system catheter was cleaned on a regular basis. However, obstruction of the catheter progressed due to urinary calculus caused by long-term placement of the SUB system, and thus, the system was replaced. The subsequent prognosis was favorable, but peritoneal dialysis was performed because blood urea nitrogen (BUN) and plasma creatinine levels elevated again. Since there was a transient decrease of BUN and plasma creatinine levels, peritoneal dialysis for chronic renal failure was a stopgap treatment. BUN and plasma creatinine levels continued to be high, but the symptoms were stable when the plasma inorganic phosphorus level was low. However, plasma inorganic phosphorus gradually increased, despite the absence of large changes in BUN and plasma creatinine levels. The cat subsequently showed changes in physical conditions and died suddenly. This case suggests that inorganic phosphorus in blood plasma might affect prognosis more than the plasma creatinine level in the absence of an influence of muscle mass.

KEY WORDS : Plasma creatinine, plasma inorganic phosphorus, ureteral obstruction

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要約：本症例は、シュウ酸カルシウム結石による右側腎臓尿管閉塞を原因として腎不全に陥った8歳の猫症例(6.6Kg, 避妊雌)に対し、SUB Systemを設置し約50カ月にわたる腎機能評価を行った。症例は、右側腎臓腎盂の拡張および尿管の拡張が認められたものの肥満のため腎臓、尿管が脂肪に埋没しており結石による閉塞部位を特定することが困難と判断し、SUB Systemを右側腎臓および膀胱に設置する方法を選択実施した。また、腎盂、尿管に結石が存在していること、人工物を埋没していることなどからカテーテルの結石による閉塞および尿路感染に対し十分注意を払う必要があると考え、定期的なSUB Systemカテーテルの洗浄を行っていた。しかし、長期間のSUB System設置において尿石の沈着によるカテーテルの閉塞が進行し、SUB Systemの交換を行った。その後良好に推移していたが、再度BUNおよび血漿クレアチニン値が高値を示したことから腹膜透析を実施し、BUNおよび血漿クレアチニン値の一過性の低下しか認められなかったことから、慢性腎不全に対する腹膜透析は一時しのぎにし過ぎだった。その後BUNおよび血漿クレアチニン値は高値を示したが、血漿無機リン値が低値を示し安定していた。しかし、BUNおよび血漿クレアチニン値に大きな変化はみられなかったが、血漿無機リン値が徐々に上昇し、体調の変化が認められ突然死した。このことは、筋肉量の影響を受けない条件での血漿クレアチニン値に比較して血漿無機リン値が病態の予後に影響を与えたのではないかと推察された。

キーワード：血漿クレアチニン、血漿無機リン、尿管閉塞

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Introduction

Ureteral calculi causing ureteral obstruction are also important in feline acute kidney injury and chronic kidney disease (CKD), and therefore, these calculi are highly clinically significant. Surgery is used for ureteral obstruction, and artificial urinary tract devices for small animals, including a system for subcutaneous ureteral bypass (SUB), have been developed and used in practice [1, 2]. We installed a nephrostomy tube and a SUB system in a cat with hydronephrosis caused by ureteral obstruction due to ureteral calculi. We report laboratory findings for renal functional assessment for 1506 hospital days after the cat developed ureteral obstruction.

Case Description

The subject was an 8-year-old female contraceptive Japanese cat of weight 6.6 kg with slight loss of energy, anorexia and vomiting for one month. The cat was brought to our hospital for work-up and treatment (hospital day 1). Biochemical tests performed by the attending physician indicated blood urea nitrogen (BUN) of 18.8 mg/dl, plasma creatinine of 3.2 mg/dl, and plasma potassium of 3.7 mmol/l. Similar tests on hospital day 53 showed higher levels of these parameters of 106.8 mg/dl, 10.8 mg/dl, and 5.9 mmol/l, respectively, and the plasma inorganic phosphorus level was elevated to 8.2 mg/dl. Kidney stones were detected in the right kidney, and ureteral stones were found in the right and left urinary ducts on radiography (Fig. 1A). Hydronephrosis of right kidney was confirmed by ultrasonography (Fig. 1B).

A. Radiography



B. Ultrasonography



Enlargement of the right renal pelvis

Kidney stones

Fig. 1 Radiography and ultrasonography image on hospital day 53

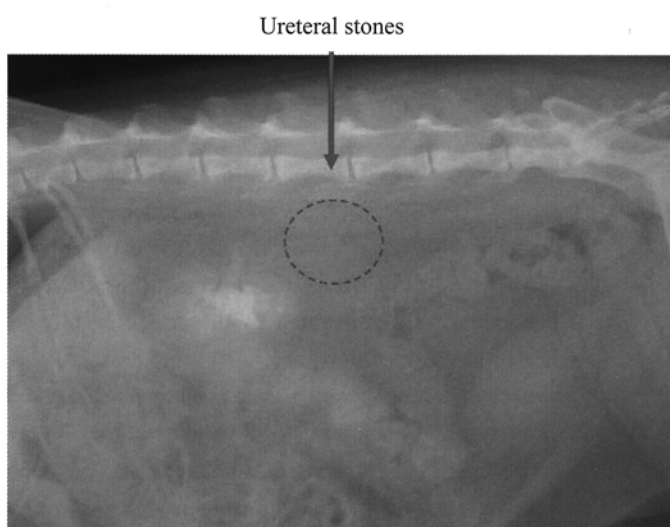
On hospital day 55, nephrostomy was performed using a 6-F tube in the right kidney. On hospital day 60, azotemia was improved, based on BUN of 32.8 mg/dl, plasma creatinine of 2.9 mg/dl, and plasma potassium of 3.9 mmol/l, and ureteral obstruction was resolved on contrast radiography. Based on these findings, the nephrostomy tube was removed.

On hospital day 110, slight pyelectasis was present, but renal function parameters were not high compared with those on hospital day 53. Medical treatment was started and the animal was only followed up for 2 days because renal function recovered. However, renal function parameters increased again due to stones obstructing the ureter, and on

hospital day 303 we decided to install a SUB System in the cat.

The course after tube removal was good; however, hydronephrosis occurred in the right kidney due to ureteral obstruction caused by ureteral calculi on hospital day 304 (Fig. 2). Blood tests showed BUN of 78.9 mg/dl, plasma creatinine of 5.1 mg/dl, and plasma potassium of 5.0 mmol/dl. After obtaining informed consent from the owner, a SUB system was installed in the right kidney on hospital day 311 (Fig. 3). After placement of the SUB system, the systemic conditions were good. The SUB system was rinsed once a month, but on hospital day 542, BUN had increased to

A. Radiography



B. Ultrasonography



Enlargement of the right renal pelvis

Fig. 2 Radiography and ultrasonography image on hospital day 304



Fig. 3 Radiography image after SUB system surgery

90.9 mg/dl and plasma creatinine to 6.8 mg/dl, suggesting partial obstruction in the SUB system. Urine was cloudy and *Enterococcus faecalis* and *Enterococcus faecium* were detected in bacteriological tests, with a bacterial load of 1.0×10^6 CFU/ml. The catheter was rinsed with injectable fosfomycin sodium (Nichi-Iko Pharmaceutical Co., Ltd.) using a coreless needle from the SUB system port for 7 days. On hospital day 549, there were improvements to BUN of 37.0 mg/dl, plasma creatinine of 3.7 mg/dl, plasma potassium of 4.5 mmol/l, and plasma inorganic phosphorus of 6.0 mg/dl.

BUN increased again from hospital day 862 and plasma creatinine also increased from hospital day 873. Peritoneal dialysis was started on hospital day 878 due to BUN of 85.2 mg/dl, plasma creatinine of 7.38 mg/dl and plasma potassium of 5.5 mmol/l. Urine volume gradually increased and the respective levels on hospital day 885 had improved to 38.5 mg/dl, 4.92 mg/dl and 3.5 mmol/l. However, the levels

on hospital day 889, three days after dialysis withdrawal, were higher, at 62.2 mg/dl, 5.30 mg/dl and 4.4 mmol/l, respectively.

On hospital day 1188, BUN was 95.4 mg/dl, plasma creatinine was 5.40 mg/dl, plasma potassium was 4.4 mmol/l, and plasma inorganic phosphorus was 7.6 mg/dl. However, on hospital day 1486, these levels had increased to BUN of 139.2 mg/dl, plasma creatinine of 7.01 mg/dl and plasma inorganic phosphorus of 14.9 mg/dl. The plasma inorganic phosphorus level was above 15.0 mg/dl on hospital day 1497, resulting in sudden death. The treatment course and test data are shown in Fig. 4.

Discussion

Ureteral obstruction in cats under treatment for renal failure is generally caused by calculi and many cases have recurrent ureteritis. Surgical procedures are required for cats that are poorly responsive to drug treatment; however, it should be noted that recurrent ureteral obstruction and obstruction in the opposite ureter can occur in CKD after obstruction removal. In the current case, ureteral obstruction was caused by calcium oxalate stones, and large stones prevented urine flow and caused acute kidney injury (AKI) associated with hydronephrosis and hydroureter. Medical

treatment including infusion was performed to transfer stones along with urine flow into the bladder and improve renal impairment. However, a nephrostomy tube had to be used due to poor responsiveness, but placement of a SUB system permitted survival until hospital day 1497.

Kulendra et al. reported median survival of 530 days (273–787 days) in cats with plasma creatinine ≥ 5.0 mg/dl [3], which indicates that the outcome in our subject exceeded those that are typically observed. The SUB system includes a urine test and culture, with urine routinely collected from the port, and this permits provision of prompt treatment corresponding to bacterial sensitivity to antibiotics at onset. In addition, weekly urine and blood tests facilitated early detection of partial obstruction and urinary tract infection caused by the SUB system. This shows the importance of implementation of urine and blood tests and rinsing of the SUB system port at certain intervals.

In addition to oliguria and anuric AKI, azotemia due to serious uremia and anuria unresponsive to standard fluid therapy are included in indications for peritoneal dialysis [4, 5]. Our subject had significant azotemia and fatal electrolyte abnormality, and was unresponsive to infusion and diuretics for three days, resulting in anuria from oliguria, which was considered to be an indication for renal replacement therapy. Cats that undergo peritoneal dialysis

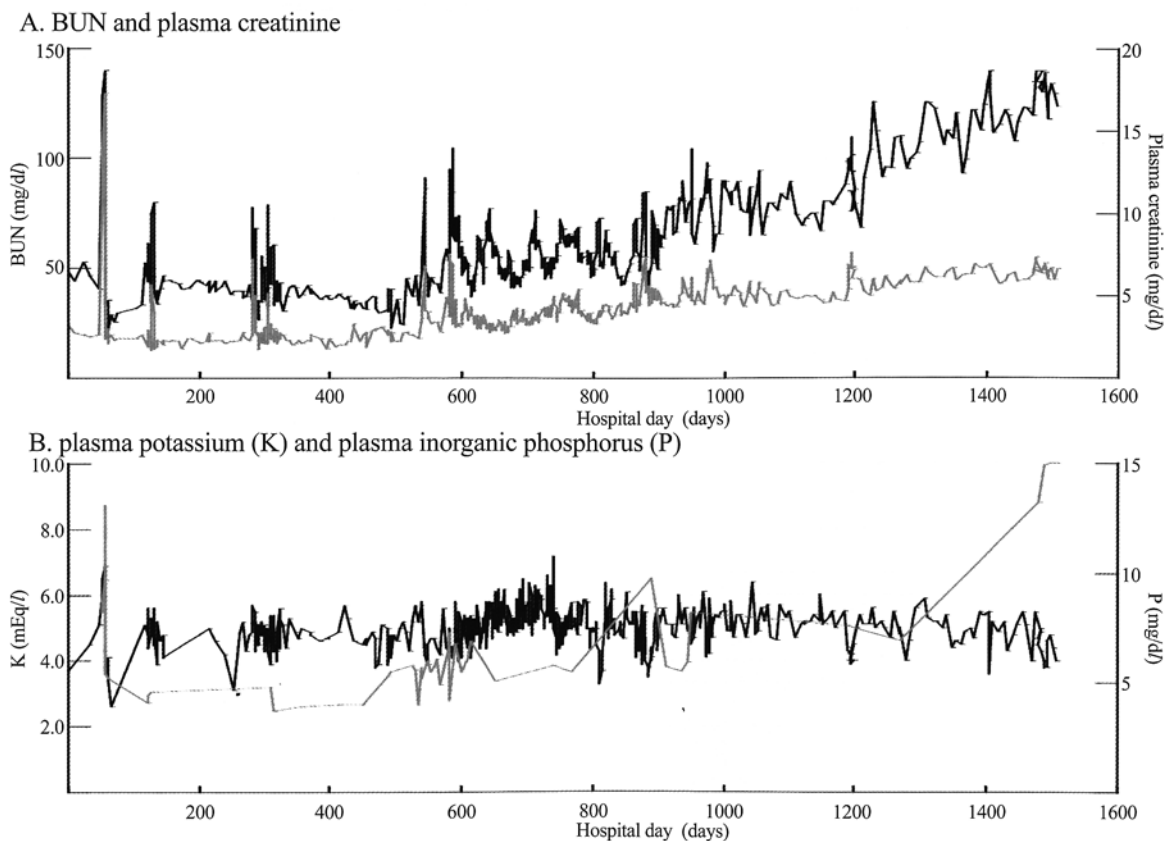


Fig. 4 Blood test data

have various prognoses. Crisp et al. found a 27% survival rate for cats with acute/chronic renal failure that were treated with peritoneal dialysis [6]. Our subject survived the transition from an oliguric to diuretic status well with peritoneal dialysis. BUN and plasma creatinine increased by about 62% and 8%, respectively, three days after completion of dialysis, but dialysis was still considered to be effective for the transition from an oliguric to diuretic status.

BUN, plasma creatinine, potassium and phosphorus are general markers for renal function, and plasma creatinine is also used in the IRIS classification [7]. Plasma creatinine in our subject did not exceed 6.0 mg/dl and body weight did not change significantly. Therefore, plasma creatinine was not influenced by muscle mass, but reflected renal function due to a decreased glomerular filtration rate. High plasma phosphorus is related to a poor renal prognosis and cardiovascular events [8, 9], but is increased in end-stage renal disease and does not predict prognosis in patients with early CKD. The phosphorus load increases the incidence of cardiovascular disease directly by calcific sclerosis and vascular endothelial dysfunction, and indirectly through increased FGF23 and PTH, which are phosphorus diuretic hormones related to cardiovascular disease and prognosis [10, 11].

Sudden death in this subject was thought to be caused by cardiovascular disease associated with hyperphosphatemia due to renal failure. However, this is a matter of speculation because autopsy was not performed. Plasma creatinine is a general marker for chronic renal failure, but in this subject, plasma phosphorus was a better prognostic factor than plasma creatinine.

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