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Flexible ureterolithotripsy for the management of multiple gas-containing renal calculi: A case report and literature review

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ABSTRACT

Gas-containing renal stones (GCS) are rare urological entities. Current literature has suggested possible associations with premenopausal women, urinary tract infection, and metabolic diseases. We report the case of a 25-year-old young woman with no underlying co-morbidities who had multiple right GCS and suspected emphysematous pyelitis. Antibiotic therapy was initiated to control her urinary tract infection with *E. coli*. She then underwent elective right flexible ureteroscopy to relieve her ureteropelvic junction obstruction. Complete stone retrieval was achieved and she made an uneventful recovery with no stone recurrence during 1-year follow-up.

1. Introduction

Gas-containing renal stones (GCS) is so rare that its exact incidence is unknown but may increase as computed tomographic (CT) urography is becoming the primary imaging modality for the evaluation of haematuria.[1,2]

In this study, we report a young Chinese woman with no known co-morbidities with right renal GCS accompanied with hydronephrosis and emphysematous pyelitis (EP). Our report details the successful treatment with antibiotics and flexible ureterolithotripsy.

2. Case presentation

A 25-year-old female was admitted due to right flank pain, increased urinary frequency, dysuria, and haematuria for 6 days. Plain CT scan revealed multiple GCS in the right kidney with an approximately 10.0 × 8.3 mm calculus (max. 1548 HU) obstructing the right ureteropelvic junction (UPJ), resulting in stenosis, accompanied with hydronephrosis and EP (Fig. 1). Her vitals were stable upon admission and she was afebrile. She had no underlying co-morbidities. Biochemical results revealed an elevated white blood cell count (12.7×10^9/L) and raised C-reactive protein (8.3 mg/L). Urinalysis detected the presence of nitrate and bacteria. Urine culture yielded *E. coli*.

Antibiotic therapy with intravenous Augmentin was initiated upon admission. Preoperative CT urogram confirmed the presence of right multiple GCS with hydronephrosis. Obstruction at the right UPJ and EP resolved spontaneously (Fig. 2). Renal scintigraphy demonstrated a lower renal function (44.5% vs. 55.5%) and glomerular filtration rate (65.4 ml/min vs. 81.4 ml/min) of the right kidney than the left. Urine culture on the fifth day returned negative and she was scheduled for an elective ureterolithotripsy.

Under general anaesthesia, she was placed in lithotomy position. A F6/7.5 rigid ureteroscope was inserted into the bladder and detected no abnormalities. Under cystoscopic guidance, a guidewire was inserted to reach the right UPJ. A flexible ureteroscope (FURS; RedPine, Guangzhou, China) was introduced. There was no ureteral stenosis. However, the UPJ was slightly narrowed. Multiple solid and "mushy" calculi were seen (Fig. 2). Larger solid stones were retrieved with a stone basket and the remainder were flushed out. After confirming complete stone retrieval, a F5 double-J stent was retained in the right ureter. Total operative time was 90 minutes. Stone component analysis returned as calcium oxalate monohydrate and carbonated apatite. Stone culture was negative.

No postoperative complication was observed. She was discharged 2 post-operative days later with 3-day oral Augmentin continued with a 3-month oral nitrofurantoin (100 mg once daily) prophylaxis. The double-J stents were removed 42 days later when CT showed no residual stone. She remained well with no recurrent UTI and 1-year post-operative CT showed no stone recurrence or UPJ restenosis (Fig. 3).

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3. Discussion

Limited GCS cases have been documented. Zawaidah et al. reviewed 21 patients with GCS and concluded that its radiographic presence was often associated with UTI.[1] GCS has a high female prevalence (81.8%; n = 18/22). No similar case has been identified in the mainland China database, therefore the prevalence or association with ethnicity cannot be determined. To our best knowledge, this is the youngest patient documented to have GCS and the first case treated with flexible ureterolithotripsy.

There is no specific treatment for GCS due to its heterogenous presentation. Paterson et al. reported a 46-year-old male with staghorn GCS that underwent successful percutaneous nephrolithotomy (PCNL) and ultrasound lithotripsy.[2] Zawaidah et al. also reported a staghorn GCS in an 88-year-old woman who was treated conservatively due to urosepsis and multiple co-morbidities.[1] She died of unrelated causes. All stones were unilateral with similar solitary to multiple stones ratio. Manny et al. treated 4 patients with ureteral stent placement for urinary drainage prior PCNL.[3] One patient underwent robot-assisted *trans*--peritoneal pyelolithotomy. All were rendered stone free during a mean 3.4-month follow-up. PCNL was the main treatment method as most GCS were large (mean 26 ± 18 mm; range 6–65 mm). In our case, FURS was

Fig. 2. Intraoperative photos of (A) 'mushy' gas-containing stones and (B) solid stone fragments that were sent for component analysis.

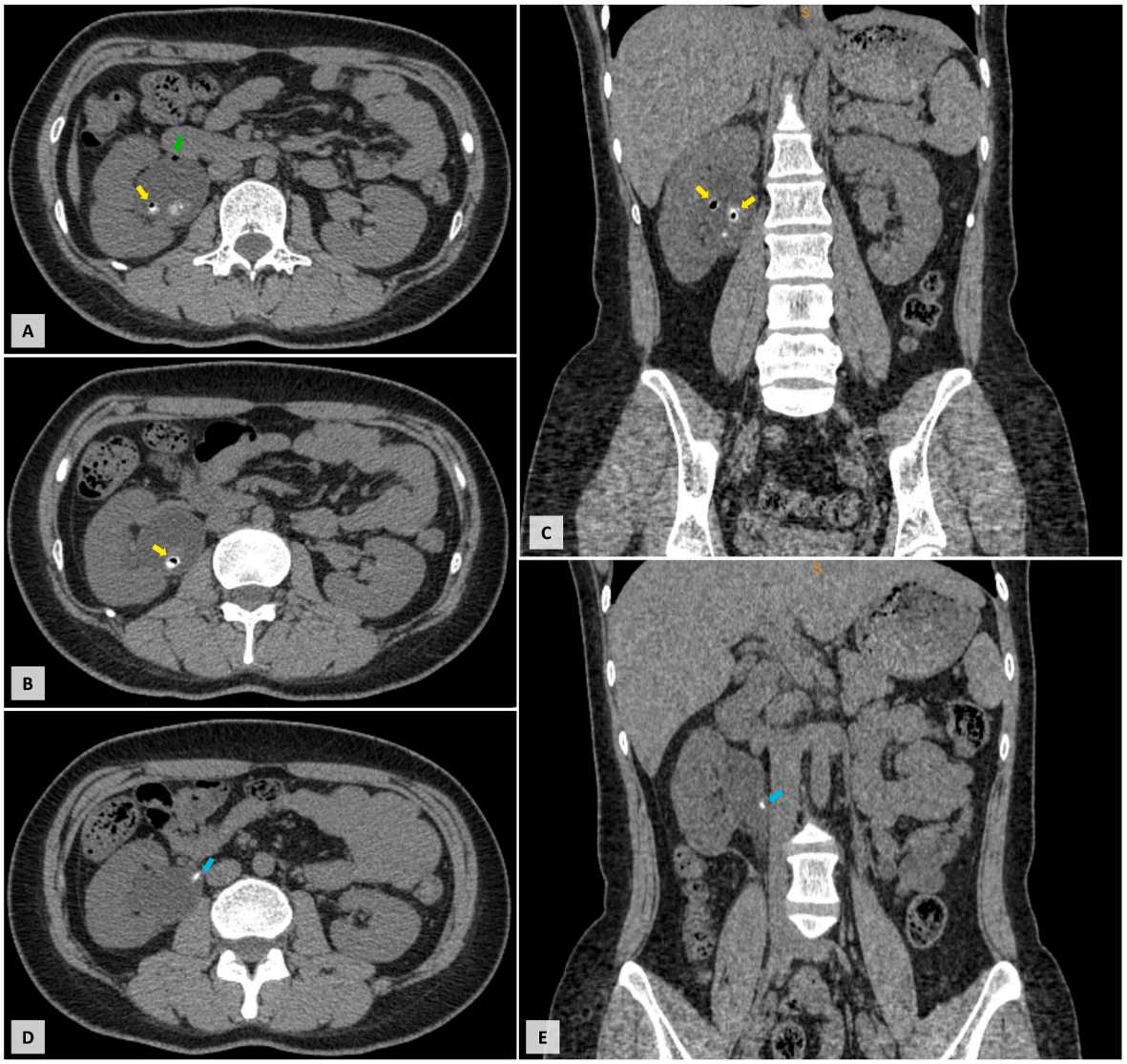

Fig. 1. Preoperative computed tomography revealing (A) suspected free gas (green arrow), (B) (C) gas-containing stones (yellow arrow), and (D) (E) ureteropelvic obstruction (blue arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Fig. 3. 1-year post-operative computed tomographic scans shows no recurrence of renal stones or hydronephrosis and no ureteropelvic junction restenosis.

performed as the UPJ obstruction resolved and was effective in retrieving multiple small GCS.

Schwaderer and Wolfe found that *Pseudomonas* was the dominant organism yielded by enhanced quantitative urine culture, followed by Enterobacteriaceae.[4] These pathogens were the most commonly isolated bacteria from stone cultures, especially calcium oxalate. The mechanism between concurrent renal stone and UTI is yet well-understood. The current hypothesis is that some bacteria selectively aggregate to certain crystal types and is associated with an increased number of crystal-crystal agglomerations. In most GCS cases, positive *E. coli* was cultured in urine (71.4%; $n = 15/21$). Certain *E. coli* strains can produce high levels of nitrogen, carbon dioxide, and hydrogen using necrotic tissue and glucose. Therefore, diabetic patients have higher risks of developing EP and, possibly, GCS. While our patient had *E. coli* UTI, she had no underlying metabolic disease. Hazouard et al. described that the presence of renal failure (creatinine >2.5 mg/dl) alone could advocate gas production by acting as a standard medium for fermentation.[5]

Subgroup analysis between UTI patients with and without GCS cannot be conducted given its rarity. Antibiotic therapy should be initiated upon GCS detection regardless of culture results although there is no consensus regarding its regimen. Infectious markers should be monitored and early stone retrieval may lead to a favourable prognosis. One GCS-related mortality occurred in a 60-year-old GCS female who succumbed to septic shock and renal failure despite prompt and appropriate antibiotic therapy.[1] Urosepsis is a relatively common complication in GCS patients (31.8%, $n = 7/22$). Conservative management has been reported in certain cases.[1] Our patient remained afebrile and elective surgery was performed after one-week antibiotic therapy. We recommended a 3-month prophylactic antibiotic therapy with nitrofurantoin to reduce the risk of recurrent UTI. Stone-free rate during follow-up was high in the reported literature, achieving 100% during a range of 1 month to 1 year with no stone or UTI recurrence.

4. Conclusion

We document a unique case of multiple small GCS in a young Chinese woman with no co-morbidities. Flexible ureterolithotripsy after adequate antibiotic treatment was a feasible method and can achieve complete stone retrieval. One-year prognosis was favourable.

Consent

The patient gave her written consent, and all medical data have been anonymized before writing this manuscript.

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Declaration of Generative AI and AI-assisted technologies in the writing process

Authors disclose that no use of generative AI and AI-assisted technologies have been used in the writing process.

Declaration of competing interest

None.

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