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Research Article

THE MANAGEMENT OF RENAL MATRIX CALCULI: A SINGLE INSTITUTE EXPERIENCE

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A B S T R A C T

Introduction: Renal matrix stones are also known as fibrinomas, colloid calculi or albumin calculi. Renal matrix stones are uncommon form of urinary stones. In contrast to the normally brittle calcium stones, they are soft, pliable and amorphous. The objective of my study was to define incidence of renal matrix calculi in patients undergoing PCNL and to describe clinical, laboratory and radiological features. We also assessed efficacy of PCNL in treating matrix stones.

Materials and Methods: We retrospectively reviewed records of 800 PCNLs performed at our institute from June 2011 to May 2016, to identify patients having matrix calculi. PCNL was planned for the treatment of large renal calculi. All patients with normal serum creatinine levels had taken CECT KUB for the functional evaluation and to provide anatomical information for surgery. All PCNLs were performed with the patient under general anesthesia. The patients' clinical, laboratory and radiological features were assessed, and the perioperative outcome and follow-up data analysed.

Results: The mean age group was 44.3 years. 6 patients were male and 10 were female patients.6 patients had stone on right side and 10 patients had stone on left side. Mean stone size was 2.2 cm (1.2 to 3.5). Mean hounsfield unit was 550 HU. 4 renal units needed multiple access tract. No patients required intra or postoperative blood transfusion. One patient developed sepsis and needed an ICU care for 3 days.

Conclusion: Matrix calculi occurred in 1.2% in our study. Although radiolucent, radiopaque shadow was seen in 11 Patients.PCNL was considered as safe and effective in treatment of matrix stone. In future, prospective multicentre studies are necessary to provide insights into the etiopathogenesis of this rare entity.

INTRODUCTION

Renal matrix stones are also known as fibrinomas, colloid calculi or albumin calculi. Renal matrix stones are uncommon form of urinary stones [1]. In contrast to the normally brittle calcium stones, they are soft, pliable and amorphous [2], since the matrix component accounts for approximately 65% of their dry weight instead of 2.5%; accordingly, matrix stones appear radiolucent or weakly radiopaque due to their very low content of mineral components.

In most cases, conventional radiological techniques are unable to make a correct diagnosis of renal matrix stones. Intravenous urography does not always help distinguish between matrix stones and other filling defects. Computed tomography (CT) is more reliable in diagnosing this matrix calculi. Only during surgery unquestionable diagnosis can be done.

The objective of my study was to define incidence of renal matrix calculi in patients undergoing PCNL and to describe clinical, laboratory and radiological features. We also assessed efficacy of PCNL in treating matrix stones.

MATERIALS AND METHODS

We retrospectively reviewed records of 800 PCNLs performed at our institute from June 2011 to May 2016, to identify patients having matrix calculi. PCNL was planned for the treatment of large renal calculi. All patients with normal serum creatinine levels had taken CECT KUB for the functional evaluation and to provide anatomical information for surgery. Noncontrast CT were used to diagnose the calculi in two patients on haemodialysis. All patients had serum calcium, phosphorus, uric acid levels, serum parathormone levels estimated, in addition to other routine biochemical investigations like complete blood count, renal function tests.Urine samples were analysed and cultured in all patients before PCNL. All patients were given culture-speci c antibiotics for more than 3 days before the procedure.

All PCNLs were performed with the patient under general anesthesia. A 5 Fr ureteric catheter was placed transurethrally with the patient in the lithotomy position. A retrograde pyelogram usually revealed a lling defect in the pelvicalyceal system suggestive of a radiolucent stone component. Then patient turned to prone position.The

nephrostomy tract was dilated with telescoping metal dilators, amplatz sheath kept. Using 22 frnephroscope, matrix calculi were diagnosed during nephroscopy. The calculus was disintegrated using pneumatic lithotripsy, and manually evacuated usingtriprong grasping forceps. A gentle wash with normal saline was given through the Amplatz sheath which helps in removing small matrix material. Additional tracts were made when necessary, with the aim of complete stone clearance; a 5 Fr JJ stent was placed antegradely. In all patients needing a supracostal access tract, chest uoroscopy was used to con rm the integrity of the costophrenic angle. On completing the procedure, a 28 F nephrostomy tube was placed for drainage and a Foley catheter was left in the bladder.

Haemoglobin levels were estimated on the rst day after PCNL in all patients. Patients with supracostal access received intensive chest physiotherapy and spirometry. They also had chest radiography on the rst day. Patients received tramadol hydrochloride for pain management. A plain X-ray KUB and nephrostogram were taken in all patients on the second day, once the urine cleared. After confirmation of no residual stones, the nephrostomy tube was then removed 48 hours after surgery. The Foley catheter was removed 72 hours after surgery once the leakage from the nephrostomy tract stopped.

All patients had an indwelling ureteric stent and were given antibiotics for 4–6 weeks after surgery. A Xray KUB and ultrasonography were done before stent removal to document stone-free status. CT was not used during the follow-up for economic reasons. The stones were analysed in 11 patients. The patients' clinical, laboratory and radiological features were assessed, and the perioperative outcome and follow-up data analysed.

RESULTS

The mean age group was 44.3 years. 6 patients were male and 10 were female patients.6 patients had stone on right side and 10 patients had stone on left side. Also, six patients had previous surgical procedures for stone disease, of whom stone analysis was available in two patients, and showed calcium oxalate stones in those patients. None of these patients were known to have matrix calculi previously. The serum calcium, phosphorous and uric acid, serum parathormone levels were normal in all the 16 patients.

A plain abdominal X-ray was normal in 5 patients, suggesting the presence of pure radiolucent calculi in only few patients. Noncontrast CT urography diagnosed calculi in two patients on haemodialysis. Mean stone size was 2.2 cm (1.2 to 3.5).Mean hounsfield unit was 550 HU.4 renal units needed multiple access tract. Access was supracostal in 2 patients. The mean (range) duration of surgery was 52.6 (27–94) min. The initial procedure was abandoned in four patients due to pyonephrosis. The mean duration between initial percutaneous nephrostomy and de nitive PCNL in these patients was 18.6 (12–33) days. The mean duration of urethral catheterization was 3.8 (3–10) days. The mean hospital stay was 4.2 (3–16) days. Decrease inhaemoglobin after PCNL was 1.17 (0.4–1.9) g/dL. The commonest complication after PCNL was fever, seen in four patients. Two patients had a persistent urine leak from the nephrostomy site for > 24 h; both had a nephrostomy tube for pyonephrosis before PCNL. They responded to re-insertion of an indwelling urethral catheter for 48 h, and bladder relaxants. No patients required intra or postoperative blood transfusion. One patient developed sepsis and needed an ICU care for 3 days. Of 11 stones analysed, two were composed entirely of proteins and the remaining nine patients had crystalline components in their stones. At a mean follow-up of 12.2 months, 2 patients had recurrence of stones.

DISCUSSION

Matrix calculi are an uncommon form of urinary tract concretion [3]. Of 800 patients who had PCNL from June 2011 to May 2016 at our centre, 16 patients (1.2%) had matrix calculi. The mean matrix component of these calculi is around 65 (42–84)%, compared with 2.5% of the dry weight in calcigerous calculi. The matrix is composed of 64% protein, 9% free sugars, 5% glucosamines, 10% water and 12% inorganic ash [4].

Bommer *et al*. [5] analysed matrix stones formed in patients with proteinuria and on haemodialysis. With transmission electron microscopy, they identified matrix calculi to consist of micro brils. The proteinaceous material differed from brin or TammHorsfall protein, as indicated by ultrastructure, carbohydrate analysis, and amino-acid analysis. On X-ray diffraction and scanning electron microscopy, they noted the presence of small amounts of calcium oxalate monohydrate and/or uric acid in some specimens. Histological examination of these calculi shows laminar concentric rings of organized matrix with an orderly, layered deposition of minerals.

Boyce and Garvey [6] found that the matrix substance in crystalline calculi is closely related to the matrix substance found in matrix calculi. This matrix might serve as an architectural template, with secondary deposition of crystals, or act as a co-precipitate in a mineralogical process. The reason for the failure of calci cation in matrix calculi is not known.

Matrix calculi are more common in females; Stoller *et al*. [2] found that they were three times more common in females. They also have tendency to occur in patients who are stone-formers, especially if they have previously had surgery for stone disease. In the present series eight patients were known stone-formers and six had undergone previous surgery for stone disease. None of them were known to have matrix calculi in the past.

UTI, usually with Proteus species or Escherichia coli, is a known predisposing factor for developing matrix calculi. Although only ve of the present 16 patients had a history of symptomatic recurrent UTI, urine analysis showed pyuria in 14 patients and urine culture showed signi cant growth in 12 patients. The bacteria isolated were E. coli (eight patients), Klebsiella (one), Pseudomonas aeruginosa (one) and Proteus mirabilis (two).

Proteinuric patients with glomerulonephritis on dialysis are also at high risk of developing matrix calculi. Seven such patients with considerable persistent proteinuria are reported [5]. In present series, two patients had chronic renal failure, on maintenance haemodialysis. However, both these patients also had a positive urine culture suggesting an associated UTI. It isdif cult to differentiate whether UTI is a cause or effect of matrix calculi in these patients. Similarly Branten *et al*. [9]

described a case of matrix calculi in a non-dialysed patient with chronic renal failure.

Flank pain and UTI are the most common presentations of matrix calculi, but these calculi can conform to the shape of the ureter and cause urinary tract obstruction. In our study, 15 patients had flank pain and 5 patients had recurrent UTI symptoms. Singh *et al*. [10] and Matthews and Spirnak [11] described cases of bilateral ureteric obstruction and acute renal failure secondary to bilateral matrix calculi. Patients can also rarely develop emphysematous pyelonephritis [12].

A high degree of suspicion is necessary for the diagnosis of matrix lithiasis, as it lacks the usual clinical picture of a renal stone [1]. The diagnosis is usually made at surgery, but some preoperative radiographic ndings might be suggestive [2]. Although matrix calculi are usually considered radiolucent, a plain X-ray detected a small radio-opaque calculi or faint laminated calci cations in 11 of the present 16 patients. The presence of a radio-opaque component was also noted by other authors [8]. The diagnosis of non-opaque calculi can be dif cult on IVU [13]. CT can usually identify a non-opaque calculus and distinguish it from other causes of radiolucent lling defects in the collecting system. The appearance of radiolucent calculus on unenhanced CT is similar to that of calcigerous calculi, despite their low mineral content [2]. The crystalline component, frequently a calcium salt, results in a relatively high attenuation on CT. These stones can also be identi ed on ultrasonography but there might or might not be acoustic shadowing, depending on the amount of mineralization. Kim *et al*. [8] described a case of a stone lacking acoustic shadowing on ultrasonography. There is also a report of a matrix calculus with no mineral content and soft-tissue attenuation on CT [14]. Such cases might need diagnostic ureteroscopy for con rmation. On MRI matrix stones show a hypointense signal in T1-weighted images and a slight hyper-intense signal in T2-weighted images. No obvious contrast enhancement was found after gadolinium administration in T1-weighted images [15].

The important drawback of all these radiological studies is that they cannot differentiate a matrix from a uric acid calculus [11]. Measuring the urinary pH and serum uric acid levels might help to differentiate amongst common radiolucent calculi. A patient presenting with a radiolucent calculus and having alkaline urine and normal serum uric acid levels will possibly have infectious calculi, including a matrix calculus. By contrast, the same patient with acidic urine and/or raised uric acid levels will probably have a uric acid calculus.

The successful management of urinary matrix calculi depends on a high index of suspicion [2]. They are best treated by percutaneous or surgical extraction, sterilization of the urine and maintenance of dilute urine. ESWL is unsuccessful because of the gelatinous nature of the stone and lack of a crystalline structure. LaBerge and Sheff [16] described a case of renal obstruction resulting from retained struvite stone matrix after ESWL. The authors concluded that shock waves used to destroy these stones during ESWL might affect the inorganic and organic components of the stone differently.
Open surgery was the method of choice for treating these patients in the past [2]. Due to the soft consistency, methods like milking the proteinaceous material from the ureter into the bladder, or using a bottle brush to clear the pelvicalyceal system were used during open surgery [11,17]. But recently open surgery was replaced by endourological intervention. These ndings were con rmed in the present series of 16 patients. A rare patient with multiple nephroureteric matrix calculi can be successfully treated by a combination of ureterorenoscopy and PCNL [18]. Prophylactic chemolysis with Nacetylcysteine was also reported [16].

These stones have a very low recurrence rate once the stone is completely cleared. In a large series of 40 patients with infection stones, with a mean follow-up of 7 years, the recurrence rate was only 2.5% (one patient) [19]. Those authors concluded that the negligible recurrence rate emphasizes that these stones are caused by urea-splitting bacteria, rather than metabolic disorders. None of the ve patients described by BaniHani *et al*. [1], who had a metabolic evaluation for stone, had any detectable metabolic abnormality. A child with matrix calculus treated by pyelolithotomy had no relapse after a 20-year follow-up [20]. 2 patients developed recurrence in our study.The main limitation of our study is the lack of a long-term follow-up.

Table 1 (Operative and postop details)

Variable	Number
Access Tract	
Single	12
Multiple	4
Supracostal access	2
Duration of surgery	52.6 (27–94) min
Pyonephrosis (Procedure Abandoned)	4
Duration between PCN and PCNL	18.6 (12-33) days
Fall in Hb after PCNL	1.17 (0.4–1.9) g/Dl
Duration of catheterisation	3.8 (2–10) days
Hospital Stay	4.2 (3–16) days

Table 2 (Complications)

Complication	Number
Fever	4
Bleeding requiring blood transfusion	Nil
Urine leak	2
Sepsis	1

CONCLUSION

Matrix calculi occurred in 1.2% in our study. Although radiolucent, radiopaque shadow was seen in 11 Patients.PCNL was considered as safe and effective in treatment of matrix stone. In future, prospective multicentre studies are necessary to provide insights into the etiopathogenesis of this rare entity.

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