4th Edition of the Clinical Cases Contest related to the non-surgical clinical management of non-surgical clinical management of renal lithiasis

Official template

Title: Extracorporeal shock wave lithotripsy on a calcified renal graft ureteral catheter in a patient with pulmonary tuberculosis

Keywords (3 to 6): extracorporeal lithotripsy, calcified ureteral catheter, renal graft, pulmonary tuberculosis, apathetic calcium phosphate.

1. Abstract

The most common complication of prolonged ureteral catheter use is calcification. There are multiple associated risk factors, with time being the determining factor for its development. The pathophysiology of calcification is unclear due to a large number of variables present in its development. We report a case of a 43-year-old male kidney transplant recipient with pulmonary tuberculosis, an indwelling ureteral catheter and two episodes of calcification treated by extracorporeal shock wave lithotripsy, a first-line non-invasive treatment for the management of ureteral catheter calcification.

2. Introduction

The function of ureteral catheters is urinary diversion from the kidney to the bladder, which may be required due to lithiasic, oncological or iatrogenic pathology, with the possibility of temporary or definitive indications. It is known that after placement there is an obstruction of the ureteral calibre, but due to its adaptability, the ureters are able to dilate to allow an extraluminal flow, allowing adequate descent of urine to the bladder[1]. Unfortunately there are up to 13% of chronic catheter patients who have "forgotten" catheters[2], with a higher chance of developing complications from chronic use, with catheter calcification being one of the most frequent and difficult to manage. The mechanism by which this calcification occurs is currently unknown, but there are theories that include variations in urinary pH, different ionic strengths of minerals present in urine and hydrophobic properties of the catheter biomaterial[3]. However, there is no doubt that the length of time the catheter remains in the urinary tract is the determining factor in the development of catheter calcification. The following is a clinical case of a renal transplant patient with multiple episodes of graft ureteral catheter calcification and the medical-surgical management to achieve its replacement.

3. Description of the clinical case:

a. Relevant background

43-year-old male with a history of stage 5D chronic kidney disease secondary to chronic glomerulonephritis. First renal transplant in June 2000. Second renal transplant in October 2021 complicated with venous thrombosis and transplantectomy. Third renal transplant in December 2021 with torpid postoperative period, requiring multiple surgical reinterventions. Carrier of permanent ureteral catheter due to ureteral stenosis secondary to ischaemic lesion, with periodic replacements every 6 months. In January 2023 a pulmonary nodule suspicious for malignancy was found, with subsequent atypical resection by Thoracic Surgery, and intraoperative diagnosis of necrotising granuloma compatible with infection by Mycobacterium tuberculosis. Mycobacterium tuberculosis infection. Anti-tuberculosis treatment was started with Isoniazid/Pyridoxine + Etambutol + Moxifloxacin. In March 2023 an unsuccessful attempt was made to replace the ureteral catheter due to calcification of the proximal end of the catheter which prevented its removal.

b. Diagnostic support studies and results

- Blood tests: creatinine 3.5mg/dL, CKD-EPI 20mL/min/m2 , urate 7.5mg/dL.
- Abnormal and urine sediment: pH 6.0.
- X-ray (figure 1): proximal end of ureteral catheter impossible to remove.

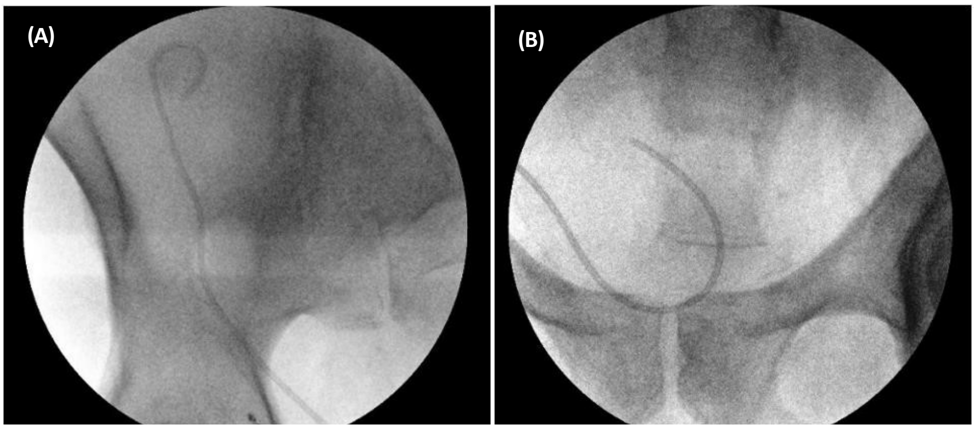

Figure 1. (A) Proximal end of calcified ureteral catheter in renal graft pelvis. (B) Distal end of ureteral catheter without bladder "J" (cut for attempted passage).

c. Diagnosis

Suspicion of hyperuricaemia secondary to treatment with ethambutol led to serial analytical control of urate levels, with mild hyperuricaemia (7.5mg/dL) without alteration of urinary pH (pH 6.0).

d. Treatment

In April 2023, extracorporeal shock wave lithotripsy (ESWL) was performed on the proximal end of the ureteral catheter allowing removal of the catheter and passage of flexible cystoscope guidance through the ureteral neomeat, and placement of a new ureteral catheter (figure 2).

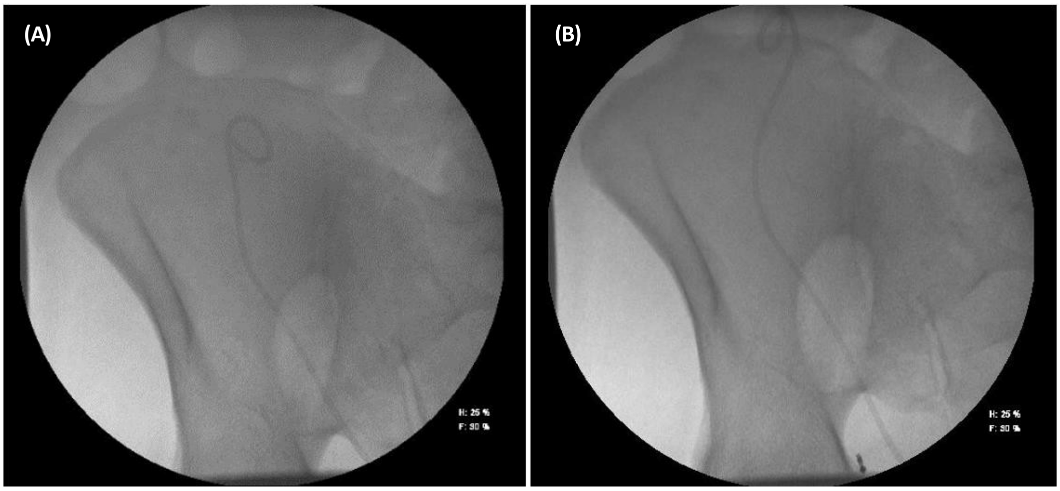

Figure 2. (A) Ureteral catheter after ESWL session. (B) New ureteral catheter after removal of calcified catheter.

At the same time, medical treatment was started with Lit-Control® pH Up to alkalinise the urine as a preventive measure against calcification of the ureteral catheter in the context of hyperuricaemia secondary to treatment with Ethambutol.

e. Evolution and follow-up

In October 2023, an unsuccessful attempt was made to replace the ureteral catheter due to calcification of both ends of the ureteral catheter. A new session of ESWL was decided on the proximal and distal end of the ureteral catheter, with removal of the catheter. Multiple attempts were made to pass the guidewire (flexible cystoscope, semi-rigid ureteroscope and flexible ureterorenoscope), with the impossibility of tutoring the neomeat, with subsequent placement of the ureteral catheter via the antegrade route (figure 3).

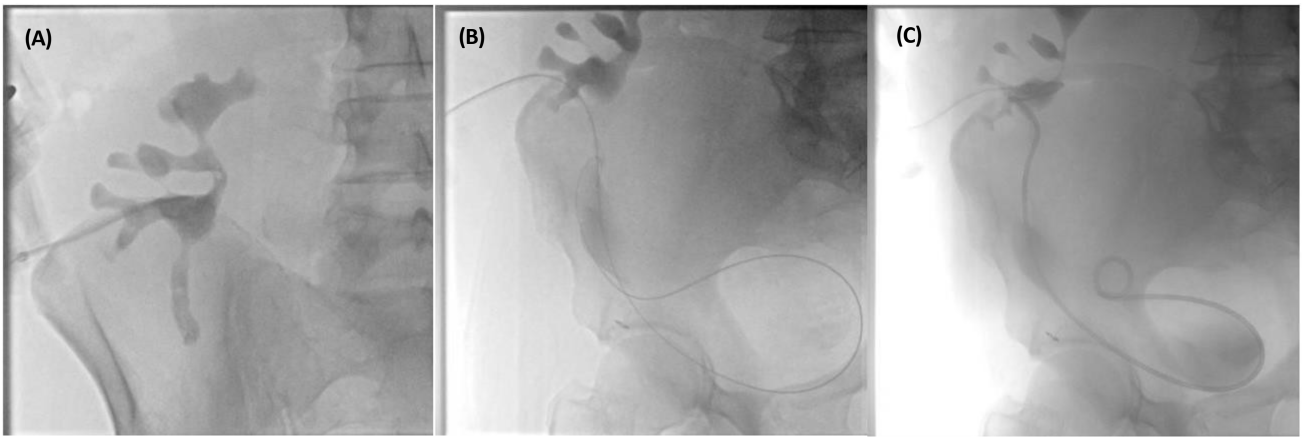

Figure 3. (A) Nephrostomy catheter in renal graft with antegrade pyelogram. (B) Passage of guidewire via the antegrade route. (C) Placement of ureteral catheter via the antegrade route with adequate descent of contrast to the bladder.

Following an increase in the degree of calcification of the ureteral catheter despite the use of Lit-Control® pH Up, a new analytical study was performed, which highlighted an increase in hyperuricaemia (9.4mg/dL) and slight urinary alkalinisation (pH 7.5), together with an analysis of the calcification of the catheter with the result of apathetic calcium phosphate (apatite). Due to the need for anti-tuberculosis treatment with Ethambutol and the finding of apatitic calcium phosphate calcification, medical treatment with Lit-Control® pH Balance® was started.

f. Clinical results

After 46 months since the last renal transplant, a slight improvement in the graft's renal function was observed (creatinine 4.4mg/dL and CKD-EPI 16mL/min/m2 in December 2021, creatinine 2.9mg/dL and CKD-EPI 25mL/min/m2 in October 2023). After the introduction of medical treatment with Lit-Control® pH Balance he maintains a urinary pH in the safe range for lithiasis formation (pH 6.5). She is being closely monitored by Nephrology and Urology, pending analytical and urinary re-evaluation. Throughout the course of urological management, anti-tuberculosis treatment was maintained (Isoniazid/Pyridoxine + Ethambutol + Moxifloxacin) with good tolerance.

4. Discussion

Ureteral catheter calcification is a complex and multifactorial process. Risk factors include bacterial colonisation, urinary composition (hypercalciuria, hypermagnesiuria, hyperuricosuria, pH variations, etc.) and patient-specific factors (diabetes mellitus, chronic kidney disease, lithiasis disease, malabsorptive syndromes, pregnancy, etc.). However, the key risk factor in this phenomenon is the time of exposure of the patient to the catheter2,4. They are generally considered a late complication (>4 months), but studies have shown calcification rates of 9.2% for use less than 6 weeks, 47.5% for use 6-12 weeks and 76.3% for use greater than 12 weeks[1].

After placement, an inflammatory reaction of the ureteral mucosa occurs, inducing epithelial hyperplasia and dysplasia, together with mucosal oedema1. Simultaneously, the catheter becomes coated with a thin layer of glycoproteins specific to each patient, depending on the characteristics of the ureteral mucosa and urinary composition2. These molecular and cellular alterations may go clinically unnoticed in the short term, but may be a key factor to be taken into account due to the high rate of calcification in chronic patients.

There are theories that argue that bacterial colonisation facilitates calcification through the creation of a biofilm, and theories that argue the opposite, that calcification acts as a focus for bacterial anchorage. A study by Tunney et. al. found that 90% of calcified catheters had bacterial colonisation and 55% had a biofilm[5]. Although these results do not allow causality to be determined, they do allow us to ascertain the relevance of bacterial colonisation in ureteral catheter calcification. There is no evidence regarding the mechanism by which mineral deposition develops, nor the type of bacteria that increase the risk of calcification. However, Kawahara et al. comment that ureteral catheter staining may be related to possible bacterial colonisation or even infection. Escherichia coli and Klebsiella pneumoniae are bacteria frequently associated with urinary tract infections, producing hydrogen sulphide, which when in contact with iron (present in ureteral catheters, giving them radiopacity) produces iron sulphide, a black component that adheres to the surface of the ureteral catheter. Their results indicate that the degree of ureteral catheter staining is significantly related to the degree of calcification and that the presence of a black ureteral catheter indicates the possibility of urinary tract infection, with Escherichia coli or Klebsiella pneumoniae being suspected as possible associated pathogens.[6]

Another important, and in many cases variable, factor is the composition of the ureteral catheter itself. There is a wide range of materials used and catheters with non-stick or hydrophilic coatings that facilitate catheter placement. These variables add a degree of difficulty in elucidating the pathophysiological mechanism of ureteral catheter calcification. In cases of anti-adherent coating, unfortunately contact with the various urinary components (minerals, bacteria, etc.) alters the chemical properties of these substances, reducing their in-vivo success rate[2,4]. In 1996, a study published its results after analysing five different types of catheters, concluding that silicone was the material with the lowest rate of calcification compared to the rest, with 69% of the surface covered by microcalcifications after 10 weeks of use compared to 100% coverage in other materials, together with 20% less presence of biofilms[5]. However, there is evidence for the superiority of the new generation polymer-based catheters, but time continued to be the determining factor in all types of catheters[2]. Due to the wide variety of ureteral catheters on offer, coupled with the wide variability in the characteristics of each patient's urine, it is not possible to establish the ideal material for each patient. Although the perfect catheter does not exist, technological advances have allowed for an increasing range of catheters to be available, with indications of possible material and sheath preferences for a given type of patient[7].

The urological management of a calcified ureteral catheter is a challenge because there are no validated clinical guidelines, with a lack of consensus on the determination of the degree of calcification, diagnostic and therapeutic approach[7]. A fundamental aspect for adequate management is the diagnosis of certainty in cases of suspected ureteral catheter calcification, which can be made by simple abdominal radiography or by evaluation of the urinary tract by ultrasound or computed tomography, especially in cases of calcification due to radiolucent substances such as uric acid, or secondary to treatment with Indinavir[4]. Due to its difficult management, in cases of large and complex calcifications, a detailed study of renal function could be chosen, especially by means of nuclear medicine techniques (diuretic renogram) to determine the contribution of renal function of the involved kidney, evaluating a possible nephrectomy as therapeutic management[4]. The group of Arenas et. al. developed what they call KUB-Score, a clinical scale based on the degree of calcification of the different portions of the urinary tract, allowing the identification of calcified ureteral catheters that are difficult to manage. Taking into account the maximum thickness of calcification and maximum length of the calcified path, scores of 1-5 are assigned for each of the main portions of the ureteral catheter (K=kidney, U=ureter, B=bladder). Their results indicate that a KUB- Score greater than or equal to 9 points is significantly associated with prolonged operative times (> 180 minutes), the need for multiple interventions and a lower rate of total absence of lithiasic remnants[8]. According to the definition used by Acosta-Miranda et. al. which considers a calcified ureteral catheter to be one that cannot be removed by flexible urethrocystoscopy after a first attempt and requires auxiliary or surgical procedures, they developed a classification called FECal (forgotten, encrusted, calcified) establishing 5 degrees of calcification depending on size and location, making it possible to establish a basis on which to plan the therapeutic approach[7].

In 2015 Irkilata et. al. published the results of a study of the management of 44 patients with calcified ureteral catheters, of which 30 were treated by ESWL, with successful removal without complications in 21 patients with 1 session, 8 patients with 2 sessions and 1 patient with 3 sessions, with an overall success rate of almost 70%[3]. These results are consistent with our experience in the case presented, since on both occasions it was possible to fragment the ureteral catheter calcification in a single session. They also allow us to establish ESWL as first-line non-invasive treatment after a single attempt at removal by flexible urethrocystoscopy, knowing that even in cases where ESWL may not be sufficient (up to 30%), the use of ESWL on the calcified catheter increases the success rate of other more invasive treatments, reducing their duration[3,4]. Other less invasive management possibilities include the use of chemolytic agents directly in the urinary tract through a nephrostomy catheter, but the general recommendation is to reserve these treatments for extreme cases due to the inflammatory reaction on the urinary tract and possible hydroelectrolytic alterations due to their systemic absorption[4] .

In our case, treatment with chemolytics via nephrostomy was initially ruled out due to the history of renal transplantation and prevention of possible hydroelectrolytic alterations that could deteriorate renal graft function. A 2021 review by Tomer et al. attempted to integrate the clinical applicability of the FECal therapeutic algorithm with the KUB-Score classification, resulting in a new diagnostic and therapeutic algorithm2 (Figure 4).

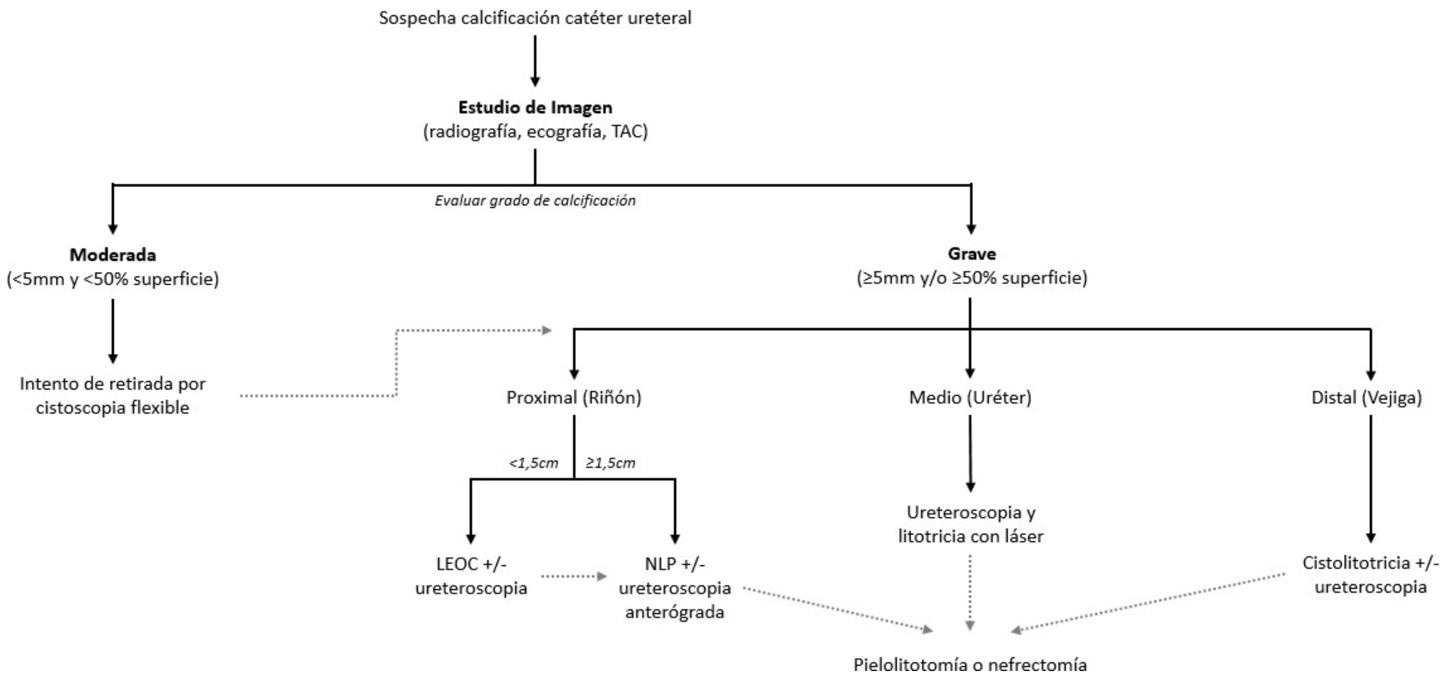

Figure 4. Diagnostic and therapeutic algorithm for the management of calcified ureteral catheters; adapted from Tomer et al. (2021). ESWL, extracorporeal shock wave lithotripsy. PCNL, percutaneous nephrolithotomy.

5. **Conclusions and recommendations**

We find more and more patients with temporary or permanent ureteral catheters. Despite their great usefulness, there are associated risks, especially in indwelling catheters. Ureteral catheter calcification is a complication whose exact pathophysiology is not known, being influenced by a large number of variables, some of which may fluctuate in the same patient over time. Associated risk factors are known, the determining factor being the time of contact with urine. The management of a calcified ureteral catheter is complex, requiring an adequate assessment of the degree and location of calcification prior to removal or replacement. Equally important is an assessment of possible modifiable factors, such as urinary pH and/or presence of bacteriuria, which can propagate catheter calcification.

6. **Bibliographical references (*of special interest, **of extraordinary interest)**

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