The Impact of Proximal Stone Burden on the Management of Encrusted and Retained Ureteral Stents

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Abbreviations and Acronyms

BTGH = Ben Taub General Hospital

CT = computerized tomography

ESWL® = extracorporeal shock wave lithotripsy

KUB = plain x-ray of the kidneys, ureters and bladder

PCNL = percutaneous nephrolithotomy

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Supplementary material for this article can be obtained by e-mailing weedin@bcm.edu.

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See Editorial on page 387.

Editor's Note: This article is the third of 5 published in this issue for which category 1 CME credits can be earned. Instructions for obtaining credits are given with the questions on pages 758 and 759.

Purpose: Managing the encrusted and retained ureteral stent is a potentially complex challenge. To improve surgical planning, we hypothesized that proximal stone burden is the most important factor associated with complicated removal, and that computerized tomography more accurately estimates stone burden than plain film x-ray of the kidneys, ureters and bladder.

Materials and Methods: Records were reviewed of patients undergoing surgical removal of an encrusted and retained ureteral stent or nephrostomy at Ben Taub General Hospital from 2007 to 2009. Preoperative imaging consisted of a plain x-ray of the kidneys, ureters and bladder and/or computerized tomography of the abdomen/pelvis. Each encrusted tube was assessed using the FECal (forgotten, encrusted, calcified) grading system and associated stone burden was calculated. Univariate and multivariate analyses were performed to determine factors associated with the need for multiple surgeries.

Results: A total of 55 encrusted and retained ureteral stents and 1 nephrostomy were removed from 52 patients. Mean tube duration was 24.9 months. Most tubes were removed endoscopically (94.2%). Of the patients 21.2% required multiple surgical procedures to remove each tube. Computerized tomography graded stone burden more accurately than plain x-ray of the kidneys, ureters and bladder (94.9% vs 64.4%, $p = 0.01$). Plain x-ray of the kidneys, ureters and bladder underestimated proximal stone burden in 44.4% of patients who underwent multiple surgeries. When dividing stone burden into 3 categories (0 to 100, 101 to 400 and greater than 401 mm^2) only proximal stone burden correlated with multiple surgeries and surgical complications ($p = 0.01$ for both). On multivariate analysis only proximal stone burden was associated with multiple surgeries to remove each tube (OR 12.1, 95% CI 1.5–95.9, $p = 0.02$ for 101 to 400 mm^2 and OR 18.1, 95% CI 1.7–192.8, $p = 0.02$ for greater than 401 mm^2).

Conclusions: In patients with encrusted and retained ureteral stents accurate determination of the proximal stone burden, preferably by computerized tomography, is important for surgical counseling and planning.

Key Words: stents; ureter; nephrolithiasis; endoscopy; nephrostomy, percutaneous

Ureteral stents have an integral role in managing upper urinary tract obstruction. Current indications for ureteral stent placement include nephrolithiasis, ureteral stricture, malignancy and retroperitoneal fibrosis. Ureteral stents are temporary, requiring removal or exchange within 3 to 12 months. Despite widespread use indwelling ureteral stents are associated with complications such as pain, lower urinary tract symptoms, hematuria,

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urinary incontinence, bacterial colonization/infection, migration, stent fragmentation and encrustation/stone formation.[1,2] Alternate methods of managing upper urinary tract obstruction include percutaneous nephrostomies and nephroureteral stents, which have similar potential complications.

Ureteral stent encrustation and stone formation typically begin with bacterial adhesion, colonization and biofilm formation. The biofilm protects bacteria from the host immune system and antibiotics.[2,3] As the biofilm grows stent occlusion and encrustation with stones can lead to urinary tract obstruction and stasis. Resulting infections are difficult to treat unless the foreign body is removed.[4] Encrustation can occur in sterile or infected urine due to a combination of urinary constituents, urine pH, bacterial enzymes and stent biomaterial.[5]

The encrusted and retained ureteral stent represents the most challenging complication associated with ureteral stents. After ureteral stent placement encrustation/stone formation can occur at varying rates.[6] The stent biomaterial such as silicon, polyurethane, polyethylene and metal may affect the rate of encrustation.[3] If not removed before encrustation occurs, complications such as irritative voiding symptoms, urinary tract obstruction, loss of renal function, severe infection and death have been reported.[7] Severe encrustation can hinder simple office endoscopic removal, necessitating operative removal and treatment of associated encrustation/stones.

Multiple investigators have reported their experience managing encrusted and retained ureteral stents and nephrostomies. Preferred management includes treating associated bacteriuria and endoscopic removal. Although some algorithms suggest that proximal stone burden should guide surgical management, no study to our knowledge has provided objective statistical evidence demonstrating the value of this approach. We hypothesized that proximal stone burden is a risk factor for complicated ureteral stent removal by examining patients treated at Ben Taub General Hospital, which is a major indigent care center, primary referral site of Harris County Hospital District, and hospital affiliate with Baylor College of Medicine.

METHODS

After receipt of institutional review board approval a retrospective review of all patients undergoing surgery at BTGH from 2007 to 2009 was conducted. Patients were included in analysis if they underwent surgical removal of an encrusted and retained ureteral stent or nephrostomy, and the tube could not be removed endoscopically in the clinic or without the patient being under anesthesia. Patients were excluded from study if preoperative imaging was not available.

Preoperative evaluation included serum creatinine and urine culture with sensitivity, and imaging consisting of KUB and/or noncontrast spiral CT of the abdomen and pelvis. In 8 patients preoperative nuclear renography was obtained if severely depressed renal function was suspected on the ipsilateral side of the encrusted tube to assist with surgical decision making. One patient with less than 5% ipsilateral renal function and significant proximal stone burden underwent laparoscopic nephrectomy instead of renal preserving surgery to remove the encrusted tube and all associated stone burden. Imaging was reviewed by a staff radiologist and urologist. Only encrustation/stones immediately adjacent to the encrusted tube were used to calculate stone burden with the formula, stone burden = length × width of stone on plain x-ray.[8]

The stone burden was considered mild if less than 100 mm^2, moderate if 101 to 400 mm^2 or severe if greater than 401 mm^2.[9] Encrustation was considered proximal if superior to the pelvic brim and distal if inferior to the pelvic brim. Each tube was assigned a grade intraoperatively, and by KUB and CT according to the FECal scale proposed by Acosta-Miranda et al (see figure).[1] This grading system was used to describe the location and quantity of the stone burden, with grade 1—mild encrustation lining the proximal or distal end of the tube, grade 2—significant encrustation involving the proximal or distal end without ureteral involvement, grade 3—significant encrustation involving the proximal or distal end with adjacent ureteral involvement, grade 4—significant encrustation involving both ends of the stent without ureteral involvement and grade 5—significant encrustation involving both ends of the stent with ureteral involvement.

Before surgery patients with a positive urine culture were treated with culture specific antibiotics. The results of preoperative urine cultures of patients with encrusted ureteral stents were compared to those with nonencrusted ureteral stents undergoing urological surgery during the same interval.

The treating urologist determined surgical management in each patient. Endoscopic management consisted of cystolithotripsy with holmium laser, ureteroscopy with holmium laser lithotripsy and PCNL with ultrasonic or pneumatic lithotripsy. ESWL was performed with the LithoTron (Healthtronics, Atlanta, Georgia) consisting of 2,500 voltage-gated shocks to the affected tube. If extensive ureteral manipulation occurred intraoperatively, another double-J ureteral stent was placed and removed 1 week later. In 5 patients from whom the encrusted ureteral stent could not be removed during the initial surgery, an additional double-J ureteral stent was placed in the ipsilateral ureter to passively dilate the ureter before definitive removal at a later date. Postoperatively patients underwent KUB to assess residual stone burden, and renal ultrasound or abdominal CT to monitor for postoperative hydronephrosis. Patients were considered stone-free if no stones greater than 2 mm were identified on postoperative imaging.

Statistical analysis was performed using SPSS® version 16.0. Univariate analysis included Pearson's chi-square test for categorical variables, independent t test for parametric continuous variables, Wilcoxon rank sum test

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