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ROUTINE POSTOPERATIVE IMAGING IS IMPORTANT AFTER URETEROSCOPIC STONE MANIPULATION

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ABSTRACT

Purpose: Improved fiber optics and advanced intracorporeal lithotripsy devices have significantly decreased the incidence of complications during ureteroscopic procedures. Despite recent reports suggesting that radiographic imaging may not be necessary in all individuals after routine ureteroscopy silent obstruction may develop in some, ultimately resulting in renal damage. We determined the incidence of postoperative silent obstruction at our institution and assessed the need for routine functional radiographic studies after ureteroscopy.

Materials and Methods: We retrospectively reviewed the charts of 320 patients who underwent a total of 459 ureteroscopic procedures for renal or ureteral calculi in a 3-year period. Complete followup with imaging was available for 241 patients (75%). Average patient age was 47.2 years. The variables of interest reviewed included preoperative pain, preoperative obstruction, targeted calculous site, stone-free rate, postoperative pain and postoperative obstruction. Mean followup was 5.4 months (range 2 to 43).

Results: A total of 241 patients with complete followup were identified in this analysis. Preoperative pain was present in 202 patients (84%) and 168 (70%) had preoperative obstruction. Overall targeted calculous clearance was successful in 73% of the patients and an additional 15.8% had residual fragments less than 4 mm. The renal, proximal or mid and distal ureteral stone-free rate was 32.1%, 81.9% and 90.5%, while in an additional 46.4%, 6.3% and 6.7% of cases, respectively, residual fragments were less than 4 mm. Of the 241 patients 30 (12.3%) had obstruction postoperatively due to residual stone in 25 (83.3%), stricture in 3 (10%), edema of the ureteral orifice in 1 (3.3%) and a retained encrusted stent in 1 (3.3%). Postoperatively obstruction correlated with postoperative pain in 23 of the 30 patients (76.7%). Pain was present postoperatively in 30 of the 211 patients (14%) without evidence of ureteral obstruction postoperatively. However, silent obstruction developed in 7 patients (23.3%) or 2.9% of the total cohort. All 7 patients underwent secondary ureteroscopy to alleviate obstruction. A single patient ultimately received chronic hemodialysis for renal failure, 1 was lost to followup and in 5 there was documented successful resolution of the cause of obstruction.

Conclusions: Our analysis suggests that silent obstruction remains a potentially significant complication after stone management. Relying on postoperative pain to determine the necessity of postoperative imaging places patients at risk for progressive renal failure due to unrecognized obstruction. Therefore, we recommend that imaging of the collecting system should be performed by excretory urography, spiral computerized tomography or ultrasound within 3 months after routine ureteroscopic stone treatment to avoid the potential complications of unrecognized ureteral obstruction.

KEY WORDS: ureter, ureteral obstruction, ureteroscopy, ureteral calculi, diagnostic imaging

Complications after ureteroscopy have dramatically decreased with the advent of smaller ureteroscopes, safer intracorporeal lithotriptors, and smaller graspers and baskets. Because ureteral obstruction or stricture after ureteroscopy may negatively impact renal function, most urologists routinely perform radiographic imaging in the postoperative period to ensure that these adverse events do not arise. However, routine imaging has recently been questioned due to the low complication and high success rates of ureteroscopic stone management. To assess better the need for routine postoperative imaging after ureteroscopy for ureteral and renal stone manipulation we retrospectively reviewed the results in patients who underwent ureteroscopy at our institution.

PATIENTS AND METHODS

We retrospectively reviewed the records of 320 patients who underwent a total of 459 ureteroscopic procedures from 1997 to 2000. Imaging studies capable of suggesting renal and ureteral obstruction included noncontrast abdominal computerized tomography (CT), renal ultrasound, excretory urography (IVP), renal scan and retrograde pyelography.

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Since plain x-ray of the abdomen was deemed insufficient for detecting obstruction, 20 patients who underwent only plain abdominal x-ray were excluded from analysis. We also excluded from analysis 59 patients for whom no postoperative radiographic studies were available. Similarly patients were excluded from analysis when the indication for ureteroscopy was the detection or treatment of upper tract transitional cell carcinoma (8), management of ureteropelvic junction obstruction (24) and ureteral stricture (9).

A total of 241 patients met the criteria for study inclusion. The charts were reviewed for age, gender, and medical and surgical history. Preoperative information obtained included pain, indwelling ureteral stent, stone size and location, and obstruction. Operative reports were reviewed for ureteroscope type and size, adjuncts used to facilitate the procedure, intracorporeal lithotripsy devices and placement of a ureteral stent. Complete followup with imaging was available in all 241 patients, including IVP in 185 (77%), spiral CT in 47 (19.5%), ultrasound in 8 (3%) and antegrade nephrostography in 1 (0.4%). Postoperative data were obtained from patient clinic records.

In 209 patients (86.7%) a ureteral stent was placed at the conclusion of ureteroscopy. Indications for stenting were ureteral edema secondary to an impacted calculus, iatrogenic ureteral trauma or a significant residual stone burden. The need for stent placement was determined by a staff surgeon (D. M. A. or G. M. P.) at the end of the procedure. The stent was removed 3 to 5 days after the procedure. All patients were scheduled for a 3-month followup visit that included IVP. However, those with significant symptoms, such as intractable pain, nausea or emesis that required emergency room visits, or earlier followup underwent imaging before 3 months.

Postoperative parameters recorded included evidence of obstruction on postoperative radiological imaging, cause of obstruction, concurrent pain, need for additional procedures, evidence of hematuria on urinalysis and stone composition when available. Patients were considered to have silent obstruction when there was evidence of obstruction on postoperative imaging without concurrent pain. The stone-free rate was determined for targeted stones, defined as any ureteral stone on the symptomatic side or a renal calculus suspected of contributing to patient complaints despite concurrent ipsilateral renal calculi. Statistical analysis was performed using standard computer software with the chi-square and Fisher exact tests with $p < 0.05$ considered statistically significant.

RESULTS

Of 320 patients 241 (75%) who underwent a total of 278 procedures and for whom complete followup was available were considered in this review. Table 1 lists patient demographics. Average patient age was 47.2 years (range 6 to 80) and mean followup was 5.4 months (range 2 to 43). The male-to-female ratio was 2.1:1. There was a history of surgical treatment for calculous disease in 89 patients (36.9%), including percutaneous nephrolithotripsy in 9, ureteroscopy in 18, shock wave lithotripsy in 54 and open stone removal in 8. In most patients stones were greater than 5 mm., including 159 (66%) with stones 5 to 10 mm. and 57 (23.7%) with stones greater than 10 mm. Only 25 patients (10.3%) had stones 5 mm. or less. Aggregate stone size was 3 × 3 to 20 × 35 mm.

The overall stone-free rate for targeted calculi was 73.4% and in 16.6% of cases residual fragments were less than 4 mm. The renal, proximal or mid ureteral and distal ureteral stone-free rate was 32.1%, 81.9% and 91.9%, and an additional 46.4%, 8.1% and 6.7% of patients, respectively, had residual fragments less than 4 mm. the stone-free rate was 80% in patients with stones less than 5 mm., 79.1% in those with stones 5 to 10 mm. and 58% in those with stones greater than 10 mm. (table 2). Stone site correlated statistically with complete stone clearance since ureteral calculous removal was associated with a higher success rate than renal calculous removal ($p < 0.001$) However, stone size did not appear to portend complete stone clearance ($p > 0.05$).

Independent predictors of a successful stone free outcome included stone site within the ureter and preoperative obstruction (table 3). Of 111 patients 91 (81.9%) with proximal or mid ureteral stones were stone-free on followup imaging, as were 68 of 74 (91.9%) with distal calculi. Moreover, postoperative pain statistically forecasted complete stone clearance ($p < 0.001$).

In 30 patients (12%) obstruction was noted after ureteroscopy (fig. 1). Causes of obstruction included ureteral calculus in 25 patients (83%), stricture in 3 (10%), edema at the ureteral orifice in 1 (3%) and an encrusted ureteral stent in 1 (3%). The overall incidence of stricture in this cohort was 1.2%. Stricture etiology was related to 2 separate previous ureteroscopic procedures in 1 individual and impacted stones requiring multiple endoscopic procedures in 2. All strictures developed in the distal ureter and all were subsequently managed successfully by ureteroscopic laser incision. Followup IVP 3 to 6 months after incision was normal. Of the 30 patients with obstruction 26 (86.6%) underwent secondary procedures to manage the remaining stone fragments or stricture, including 24 via the retrograde and 2 via the antegrade approach. In 2 patients who were hospitalized for parenteral analgesia and intravenous fluids ureteral obstruction resolved without any additional procedures. Another 2 patients refused further treatment, including 1 with end stage lung cancer. In 22 of 25 patients (88%) obstruction was completely resolved on subsequent followup imaging. There was no further documented radiographic followup at our institution in 5 patients. Ultimately 233 patients (96.7%) who underwent followup imaging had no evidence of obstruction after primary or secondary treatment.

Figure 2 shows patient outcome based on postoperative pain. Of the 53 patients experiencing pain after ureteroscopy 23 (43.4%) had obstruction and 30 (56.6%) had no signs of

TABLE 1. *Characteristics of 241 patients who underwent ureteroscopic stone manipulation*

Av. age	47.2
No. men (%) No. women (%)	164 (68)/77 (32)
No. previous stone surgery (%):	89 (37)
Percutaneous nephrolithotripsy	9 (3.7)
Shock wave lithotripsy	54 (22.4)
Ureteroscopy	18 (7.5)
Open	8 (3.3)
No. stone site (%):	
Kidney	56 (23.2)
Proximal, mid ureter	111 (46)
Distal ureter	74 (30.8)
No. mm. stone size (%):	
Less than 5	25 (10.3)
5–10	159 (66)
Greater than 10	57 (23.7)

TABLE 2. *Stone-free rate based on size and location*

	No. Stone-Free (%)	No. Stone Fragment 4 Mm. or Less
Overall	177 (73.4)	40 (16.6)
Stone mm. ($p > 0.05$):		
Less than 5	12 (80)	3 (20)
5–10	110 (79.1)	18 (12.9)
Greater than 10	29 (58)	14 (28)
Unknown	26 (70.3)	5 (13.5)
Stone site ($p < 0.001$):		
Renal kidney	18 (32.1)	26 (46.4)
Proximal, mid ureter	91 (81.9)	9 (8.1)
Distal ureter	68 (91.9)	5 (6.7)

TABLE 3. *Predictive factors for preoperative and postoperative obstruction, and stone-free success*

	Preop. Obstruction p Value	Postop. Obstruction p Value	Stone-Free p Value
H/O previous shock wave lithotripsy	Not significant	0.014	Not significant
Gender	Not significant	Not significant	Not significant
Preop. pain	Not significant	Not significant	Not significant
Preop. stent	Not significant	Not significant	Not significant
Ureteral stone site	<0.001	Not significant	<0.001
Renal stone site	Not significant	Not significant	Not significant
Preop. obstruction	Not applicable	Not significant	0.001
Ureteral access sheath	Not applicable	Not significant	Not significant
Balloon dilation	Not applicable	Not significant	Not significant
Lithoclast fragmentation	Not applicable	Not significant	Not significant
Grasper/basket extraction	Not applicable	Not significant	Not significant
Laser fragmentation	Not applicable	Not significant	Not significant
Postop. hematuria	Not applicable	Not significant	Not significant
Postop. pain	Not applicable	<0.001	<0.001

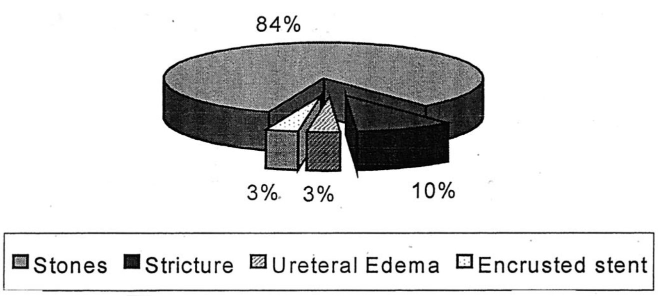

FIG. 1. Etiology of postoperative obstruction

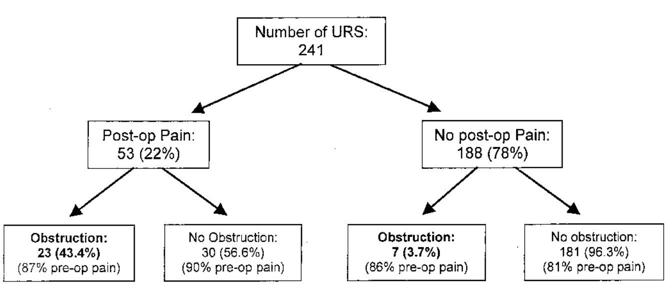

FIG. 2. Incidence of ureteral obstruction based on postoperative (*Post-op*) pain. *URS*, ureteroscopies. *pre-op*, preoperative.

obstruction. However, 7 of the 188 patients (3.7%) with no pain after ureteroscopy had evidence of obstruction on postoperative imaging for an overall 2.9% incidence of silent obstruction. This incidence of silent obstruction equates to 12.3% of all patients in whom obstruction developed postoperatively. The etiology of obstruction in these 7 patients was retained stone fragment in 6 and ureteral stricture in 1. Six of these 7 patients (86%) had pain preoperatively, 5 had obstruction on imaging preoperatively and 5 had a proximal or mid ureteral stone. These patients underwent stenting postoperatively. Obstruction was detected a mean of 3.4 months (range 0.5 to 9) after stent removal.

After silent obstruction was identified all patients underwent secondary ureteroscopy (table 4). Patient 3, who initially presented with renal failure due to bilateral silent obstruction, was ultimately rendered stone-free. However, he continued to require hemodialysis despite improved renal function, as indicated by a change in creatinine from 35.7 to 6.5 mg./dl. Patient 5 failed to return for repeat postoperative imaging. In 3 of the remaining 5 patients dilatation of the intrarenal collecting system persisted, although they were

TABLE 4. *Treatment and outcome in 7 patients with silent obstruction*

Pt. No.	Preop. Study/Results	Stone Site	Stone Size (mm.)	Ureteroscopy Side	Postop. Study/Results	Mos. Followup	Secondary Procedure	Secondary Followup Imaging/Results
1	IVP/mild obstruction	Lt. mid ureter	5 × 5, 12 × 7	Lt.	IVP/moderate distal obstruction, 5 × 5 stone	5	Lt. ureteroscopy side	IVP/no stones or obstruction
2	IVP/moderate obstruction	Lt. proximal ureter	15 × 10	Lt.	IVP/moderate mid ureteral obstruction, 8 × 4 stone	9	Lt. ureteroscopy side	IVP/residual dilatation, no obstruction
3	CT/bilat. severe obstruction, flank pain, acute renal failure	Bilat. proximal ureter	10 × 10 Rt., 12 × 8 lt.	Bilat.	CT/improved lt. dilatation, persistent severe rt. dilatation steinstrasse	0.5	Rt. ureteroscopy side	CT/no stones, renal failure, dialysis
4	Plain x-ray of kidneys, bladder, ureters, renal scan/no obstruction, differential function 58% lt., 42% rt.	Rt. mid ureter	10 × 6	Rt.	IVP, renal scan/no stone, distal stones, differential function 58% lt., 42% rt., half-time 33 mins.	3	Rt. ureteroscopy side, stone incision	IVP/normal, no obstruction
5	Spiral CT/mild–moderate obstruction	Rt. distal ureter	5 × 5, 12 × 7	Rt.	CT/improved lt. dilatation, persistent severe rt. dilatation, steinstrasse	2	Rt. ureteroscopy side	Lost to followup
6	IVP/no lt. ureteral obstruction	Lt. lower kidney pole	7 × 6	Lt.	IVP/moderate obstruction to lt. mid ureter, 3 × 3 stone, no pain	3.5	Lt. ureteroscopy side	IVP/Stone-free, no obstruction
7	IVP/severe obstruction, no pain, normal IVP 12 mos. before	Lt. mid ureter	9 × 5, 6 × 6, 3 × 4	Lt.	IVP/severe obstruction to lt. mid distal ureter, multiple stones	1	Lt. ureteroscopy side	IVP/Stone-free, persistent caliceal clubbing, no obstruction

considered stone-free or stricture-free with resolved obstruction.

A single patient was referred from elsewhere with a history of shock wave lithotripsy for renal calculi in 1995. This patient was lost to followup with no imaging available for 5 years but remained asymptomatic. During evaluation for microscopic hematuria IVP revealed right distal ureteral calculi with renal atrophy and high grade obstruction. Ureteroscopic stone fragmentation and removal were successful. However, followup renal scan demonstrated only 12% function on the obstructed side. The patient subsequently underwent right laparoscopic nephrectomy.

Of the variables investigated only previous shock wave lithotripsy and postoperative pain were significantly related to postoperative obstruction (table 3). A proximal or mid ureteral calculus trended toward predicting postoperative obstruction compared with distal stones, although this factor was not statistically significant ($p = 0.079$). Interestingly preoperative pain, preoperative obstruction and postoperative hematuria did not correlate with the risk of postoperative obstruction ($p > 0.05$). As expected, patients in whom ureteral calculi were identified were more likely to have obstruction than those exclusively with renal calculi on preoperative radiography ($p < 0.001$). Nevertheless, the site of the stone within the ureter had no impact on the development of obstruction ($p > 0.05$).

DISCUSSION

Improvement in endourological devices have expanded the indications and success of ureteroscopic procedures, while decreasing associated complications.[1–3] Major complication rates have decreased to less than 2% in published series. In addition, the incidence of ureteral stricture is less than 0.5%, questioning the need for routine imaging after ureteroscopic procedures.[3–5] Despite the decreasing likelihood of morbidity associated with flexible and semirigid ureteroscopy many urologists customarily continue to perform imaging after ureteroscopy, not only to determine the efficacy of the procedure, but also to assess silent obstruction, which could negatively impact patient renal function.

However, recent reports question the necessity of routine documentation in select individuals. It was suggested that patients without symptoms in the postoperative period uniformly have no evidence of obstruction on imaging and functional imaging should only be performed in those with pain after ureteroscopy, except when intraoperative complications may predispose to stricture. It was been suggested that limiting postoperative imaging would save patient time and money as well as avoid the associated risks of intravenous contrast material.[5]

When reviewing the results of our large series, except for postoperative pain clinical parameters were not helpful for identifying patients at risk for postoperative obstruction. Patients with pain after ureteroscopy were statistically more likely to have obstruction than those without pain. Conversely no parameters confidently predicted silent obstruction. Surprisingly preoperative pain, preoperative obstruction, type of intracorporeal lithotripsy device, access sheath or balloon dilation were not related to postoperative obstruction. Moreover, gross or microscopic hematuria at followup was equally as prevalent in patients with obstruction who did and did not have pain. The 3 patients with stricture had associated risk factors predisposing them to stricture formation. Multiple manipulations and impacted calculi may induce a fibrotic or inflammatory response. Strictures were successfully managed by endoscopy in all cases with no further difficulty at the latest followup. Although the 3% incidence of silent obstruction in our group was not statistically significant, it appeared to be clinically significant since it placed patients at risk for chronic renal damage, as in previous studies.[5–11]

Notably patients undergoing shock wave lithotripsy before ureteroscopy were statistically more likely to experience postoperative obstruction than those who did not undergo shock wave lithotripsy. Furthermore, 3 of the 7 patients with silent obstruction in our series underwent shock wave lithotripsy before ureteroscopy. The risks of post-shock wave lithotripsy steinstrasse are well known, again placing patients at risk for renal damage.[12, 13] These patients may represent a unique group that requires diligent followup because of the associated risk of silent obstruction. In our patient with silent obstruction and a nonfunctioning kidney 5 years after shock wave lithotripsy significant complications were associated with unrecognized silent obstruction, namely progressive renal damage and loss of the affected kidney.

We define silent obstruction as radiographic evidence of obstruction without concurrent pain. Silent obstruction is a well documented occurrence after shock wave lithotripsy. It is believed that shock wave lithotripsy decreases renal parenchymal blood flow, resulting in decreased urine production. The decreased volume of urine in an obstructed system may result in decreased ureteral distension and consequently less pain. Although ureteroscopy has not been proved to decrease renal blood flow, this series of events may be at the root of silent obstruction after ureteroscopy. Other potential causes of silent obstruction may include partial or intermittent ureteral obstruction, which does not result in significant ureteral distention.

While postoperative pain was significantly associated with postoperative obstruction, relying on this clinical indicator alone would have caused us to miss 7 cases of silent obstruction, which were easily managed by current minimally invasive applications. Although all 7 patients underwent secondary ureteroscopy with correction of the cause of obstruction, 3 of 6 (50%) with secondary followup functional radiography available were noted to have persistent intrarenal collecting system dilatation. However, none had ureteral obstruction at the last followup. One can only speculate on the ultimate outcome if this silent obstruction had gone unidentified, including progressive renal damage.

Despite the difficulty of comparing the calculated monetary savings associated with fewer imaging studies with the impact of lost renal function we believe that the risk of renal impairment is too great to ignore. In addition, none of the other clinical parameters investigated improved our ability to identify patients with silent obstruction. Until such a parameter is established we recommend that routine IVP, plain x-ray of the kidneys, ureters and bladder with ultrasonography or furosemide renal scan, or noncontrast CT of the abdomen and pelvis should be performed after ureteroscopy. When CT is equivocal or renal ultrasound reveals dilatation, renal scan or IVP should then be performed.

We do not recommend plain x-ray of the kidneys, ureters and bladder alone as a screening tool for determining which patients need further evaluation. In another series plain abdominal x-ray performed after shock wave lithotripsy missed a third of renal or ureteral calculi.[14] In certain circumstances stones can be obscured by bowel gas or stool despite bowel preparation before radiography. Although bowel preparation is routinely administered before IVP, this procedure is seldom done before plain x-ray of the kidneys, ureters and bladder. In our series 65 patients (27%) had residual stones or stone fragments. As a result, relying on plain x-ray of the kidneys, ureters and bladder alone may have missed 21 patients with stones, excluding 3 with stricture, potentially impacting renal function. Moreover, patients in whom plain x-ray identified residual calculi would likely require further imaging, thereby, exposing them to more radiation, costs and time away from work. Although ultrasound, CT and IVP have limitations as functional imaging studies, their ability to detect hydronephrosis, accurately identify stone location (CT and IVP) and suggest function (CT and IVP) make them more appropriate studies than plain x-ray for routine evaluation after ureteroscopy.[15]

Stone-free rates in the current study were low compared with several modern series, in which outcomes were successful in as high as 80% to 95% of cases when ureteral stones were managed by endoscopy.[1, 4, 16–20] However, some reports of success greater than 85% included patients with small residual fragments or dust in the successful outcomes group.[21, 22] Until recently our practice was to fragment calculi in situ into fragments less than 3 mm. and yet not include these patients in the absolute stone-free cohort if residual calcification existed on followup imaging. Statistically calculi less than 5 mm. pass spontaneously 95% of the time.[23, 24] Currently we manage renal and proximal ureteral stones by Ho laser fragmentation with nitinol basket and/or grasper extraction facilitated by the ureteral access sheath.[25, 26] Although the true impact of these adjuncts on retrograde endoscopic management of upper tract calculi remains to be determined, it appears that an improved stone-free rate can be achieved, especially for lower pole renal calculi and proximal ureteral stones.

The savings associated with restricting postoperative imaging to only symptomatic patients must be weighed against the risk of missing renal obstruction and its subsequent impact on renal function. Furthermore, the cost of treating patients with decreased renal function is difficult to calculate but it could include the cost of dialysis, nephrology consultation, exacerbation of underlying cardiac disease, increased susceptibility to infection, worsening hypertension, and the potential morbidity and cost of nephrectomy. Therefore, jeopardizing the renal function of 3% of patients undergoing ureteroscopy for ureteral or renal lithiasis seems to be an unnecessary risk that is easily avoided.

CONCLUSIONS

Although they are effective for renal and ureteral calculi, endourological treatments carry the risk of significant potential morbidity in the postoperative period. Ensuring radiographic followup in patients who undergo ureteroscopic stone manipulation is imperative not only for monitoring stone free status, but also for identifying the location of residual calculi and decreasing the prospect of missed silent obstruction and associated sequelae.

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