Upper tract imaging after ureteroscopic holmium:YAG laser lithotripsy: when is it necessary?

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Introduction/objective: *Advances in ureteroscope design and refinements of ancillary instrumentation have resulted in an expanded role for ureteroscopy in the management of urinary calculi. Technological enhancements coupled with improved endourologic skills have also been associated with a reduction in procedural-related complications. Historically, postoperative imaging with ultrasound (U/S) or intravenous pyelogram (IVP) had been advocated to rule out persistent obstruction due to retained stone fragments or ureteral stricture. The purposes of this study were to evaluate the incidence of postoperative ureteral obstruction in a contemporary series of patients undergoing ureteroscopic holmium:YAG laser lithotripsy without basket extraction of fragments and to identify patient, stone and operative factors predictive of which patients will benefit from postoperative imaging.*

Materials and methods: *The charts and imaging studies of 89 consecutive patients undergoing a total of 94 holmium:YAG ureteroscopic lithotripsy procedures between December 1998 and December 2000 were retrospectively reviewed. Preoperative, intraoperative and postoperative data were collected and analyzed. The primary outcome measure was the incidence of postoperative ureteral obstruction documented on upper tract imaging. Secondary outcome measures included interventions required for postoperative obstruction and other nonobstructive postoperative complications.*

Results: *Twenty-eight females and 61 males were studied, with a mean patient age of 54 (range 13 - 80) years. Fifty-five percent of patients underwent related procedures prior to referral to our tertiary endourology centre. Complete clinical and radiological follow-up is available for 68 of 89 (76.4%) patients, with a mean follow-up duration of 24.2 weeks. Overall stone-free rate was 97%. Six patients had evidence of urinary tract obstruction on follow-up radiological assessment, two from residual stone fragments and four from ureteral stricture. Each of these four patients had at least one preoperative risk factor for ureteral stricture.*

Conclusions: *Routine postoperative upper tract imaging is not necessary in all patients undergoing uncomplicated ureteroscopic holmium:YAG laser lithotripsy. Indications for upper tract imaging include chronic stone impaction, significant ureteral trauma, pre-existing renal function impairment, endoscopic evidence of stricture and postoperative flank pain or fever.*

Key Words: imaging, urolithiasis, ureteral stricture, ureteroscopy, holmium laser lithotripsy

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Introduction

Ureteroscopy emerged in the late 1970's and early 1980's as a diagnostic tool,[1-3] and has evolved into an essential minimally invasive diagnostic and therapeutic modality for a variety of upper urinary tract disorders. With improvements in ureteroscope design, the widespread implementation of holmium:yttrium-aluminum-garnet (YAG) laser lithotripsy and refined endourologic technique, treatment-related complications, in particular the risk of postoperative ureteral stricture, have decreased. Nonetheless, postoperative ureteral obstruction from ureteral edema, retained stone fragments or ureteral stricture is a well documented complication of ureteroscopy.[4-10] There is no contemporary consensus, however regarding the required radiological follow-up of patients undergoing ureteroscopic procedures. Current urological practice ranges from no routine postoperative imaging to extensive follow-up imaging with plain x-ray of kidneys-ureters-bladder (KUB), ultrasound (U/S), intravenous pyelogram (IVP) or computed tomography (CT) scan. The purposes of this study were two-fold: first, to determine if routine postoperative upper tract imaging is required for patients who have undergone uncomplicated ureteroscopic lithotripsy using the holmium:YAG laser without basket extraction of fragments; second, to identify preoperative features, intraoperative findings and postoperative presentations predictive of post-ureteroscopy ureteral obstruction.

Patients and methods

The charts and imaging studies of 89 consecutive patients undergoing ureteroscopy and holmium:YAG laser lithotripsy procedures between December 1998 and December 2000 were retrospectively reviewed. A total of 94 ureteroscopic procedures were carried out on this cohort as several patients required simultaneous bilateral ureteroscopy. In 55% of patients, manipulations including stent insertion, blind basket manipulation or ureteroscopy had been attempted or performed prior to referral to our centre.

All patients received broad-spectrum perioperative prophylactic antibiotics and all procedures were performed under general anesthesia, in the lithotomy position. Our technique of ureteroscopy has been previously described.[11] Briefly, a 14.5F flexible cystoscope was used to pass a safety guidewire under fluoroscopic guidance into the renal collecting system. Among this series several patients had complex stone problems requiring the use of hydrophilic guidewires and a variety of catheter configurations in order to bypass impacted stones. Balloon dilation was not routinely employed. An 8F/10F coaxial dilator system was used to allow placement of a second guidewire if flexible ureteroscopy was planned. Ureteral access sheaths were not employed in any patient in this series. Depending on stone size and location, a 6.9F semi-rigid or 7.5F flexible ureteroscope was used. Gravity-weighted irrigation was used initially in all cases. If visibility was unsatisfactory, hand-held irrigation was then employed.

Intracorporeal lithotripsy was performed with the holmium: YAG laser using either a 200 or 365 μm fibre until stone fragments were sufficiently small (2 mm or less) to pass spontaneously. No other energy source or method of intracorporeal lithotripsy was utilized. Basket extraction of fragments was not performed in any case. A double J ureteral stent was placed after ureteroscopy in 93 of the 94 procedures. All patients were treated on an outpatient basis, and prophylactic oral antibiotics were administered.

Stone impaction was defined as follows: patients who were diagnosed with pre-operative stone impaction were those who had a stone in the same ureteral location (unchanged, based on imaging studies) for a period of 4 weeks or more; intraoperative findings that resulted in a diagnosis of impaction included difficulty in passing a guidewire beyond the stone or endoscopic evidence of a stone that was stuck at a fixed position against or into the ureteral wall.

Postoperative clinical and radiographic follow-up was performed by the referring urologist or at our centre. All patients had a KUB to confirm adequate stone fragmentation prior to ureteral stent removal. Further upper tract imaging consisting of U/S, IVP or helical CT scan was recommended 4 - 6 weeks after stent removal to search for upper tract dilation or evidence of obstruction.

Preoperative (patient demographics, history of ureteral stricture, prior shock wave lithotripsy {SWL}, prior ureteral surgery or ureteroscopy, presence or absence of ureteral stent, renal function, stone size and stone location), intraoperative (stone impaction, ureteral edema, evidence of ureteral stricture, type of ureteroscope used, need for balloon dilation, mucosal trauma, ureteral perforation and any other complications) and postoperative (flank pain, fever, other complications, imaging studies) data were collected.

Results

Of the 89 patients, 28 were female and 61 were male. Mean patient age was 54 (range 13 - 80) years.

TABLE 1. **Related procedures prior to treatment at our centre**

Procedure	**# of patients (%)**
Ureteral stent insertion alone	13 (14.6%)
Unsuccessful ESWL with stent insertion	20 (22.5%)
Attempted ureteroscopy with basket or EHL	11 (12.4%)
Attempted blind stone basket manipulation	3 (3.4%)
Failed stent insertion	1 (1.1%)
Failed stent insertion, percutaneous nephrostomy insertion	1 (1.1%)
Total manipulations	**49 (55.0%)**

Interventions conducted prior to referral to our centre are shown in Table 1. Stone sizes and locations are shown in Table 2. Pre-operative features identified as potential factors predicting post-operative obstruction are shown in Table 3a and 3b.

A 6.9F semi-rigid ureteroscope and a 7.5F flexible ureteroscope were used in 55 (59%) and 39 (41%) of the 94 cases, respectively. Ureteral balloon dilation was performed in 12 of the 94 (12.8%) cases. Intraoperative findings are shown in Table 4, with the risk of developing postoperative ureteral obstruction for each intraoperative finding. There were no ureteral perforations related to ureteroscope passage or the use of the laser. In one patient with an impacted stone, it was noted that the guide wire had taken a submucosal course for 2- 3 cm at the site of impaction, but without full thickness perforation, evidenced by the absence of contrast extravasation by retrograde pyelography. There were no cases of ureteral avulsion.

Complete clinical and radiological follow-up is available for 68 of the 89 (76.4%) patients and 72 of the 94 (76.6%) cases. Ureteral stents were normally left indwelling for 1-2 weeks, but in select cases, were removed as early as 3 days (severe stent symptoms) and as late as 6 weeks (high risk of ureteral stricture) following ureteroscopy. Mean interval to postoperative upper tract imaging was 12.6 weeks (range 4.4 - 46.3 weeks) and ultrasound, IVP and CT scan were performed in 58, 12 and 2 cases, respectively. Mean duration of clinical follow-up was 24.2 weeks (range 4.6 - 53.0 weeks). A stone-free status was established for 70 of 72 procedures and 66 of 68 patients for an overall stone free rate of 97%. Six of the 72 (8.3%) patients with postoperative imaging were found to have upper tract dilation. Two of these six patients were symptomatic with ipsilateral flank pain and had small residual distal ureteral stones that eventually passed spontaneously without intervention. The remaining four patients had persistent dilation without residual stones and were asymptomatic. In each of these four cases, pre and intra-operative findings as a result of significant stone impaction were harbingers of potential ureteral stricture development. Two of these patients had undergone an attempt at stent insertion prior to referral, at which time guidewire perforations occurred. Another patient suffered ureteral injury as a result of blind basket manipulation. At the time of ureteroscopy at our centre, three patients had endoscopic evidence of stricture at the site of stone impaction and the fourth patient had significant ureteral wall edema. Imaging with either retrograde pyelography or post-operative IVP confirmed ureteral stricture formation in these patients. In one patient who suffered a proximal ureteral perforation during previous attempted stent insertion, a stricture developed at that site. The other three patients developed distal ureteral strictures.

One elderly patient who developed a distal stricture and who was prone to recurrent urinary tract infections, underwent Ho:YAG endoureterotomy without success and is now managed with regular stent changes. The remaining three patients are being managed conservatively as they remain asymptomatic with stable renal function.

TABLE 2. **Size and location of stones treated**

	# of cases (%)
Size of stone	
0-5 mm	14 (14.9%)
6-10 mm	54 (57.4%)
>10 mm	26 (27.7%)
mean stone size = 9.1 (range 3-20) mm	
Location of stone	
Renal	11 (11.7%)
Proximal ureter	24 (25.5%)
Middle ureter	15 (16.0%)
Distal ureter	44 (46.8%)

TABLE 3a. **Pre-operative risk factors, with the risk of subsequent postoperative obstruction**

Preoperative factors	# of cases	# obstructed/# of cases with that preoperative finding (%)
Grade IV hydronephrosis and parenchymal thinning	1	1/1 (100%)
17% differential renal function on radionuclear renogram	1	1/1 (100%)
Blind basket stone manipulation	1	1/1 (100%)
Proximal ureteral perforation	1	1/1 (100%)
Stone impaction	4	4/4 (100%)

TABLE 3b. **Intraoperative findings, with the risk of subsequent postoperative obstruction**

Intraoperative findings	# of cases (%)	# obstructed/# of cases with that preoperative finding (%)
Normal ureter	54 (57.4%)	0/54 (0%)
Ureteral edema	24 (25.5%)	6/24 (25%)
Stone impaction	19 (20.2%)	4/19 (21%)
Changes suspicious for stricture	9 (9.6%)	3/9 (33%)

All of the remaining 66 nonobstructed patients were asymptomatic. None of these patients had suffered ureteral injury from prior manipulations. There were no intraoperative findings of concern at the time of ureteroscopy at our centre either. The postoperative course and follow-up of the 94 procedures is shown in Figure 1.

TABLE 4. **Recommended guidelines for imaging following ureteroscopy**

Preoperative factors

Chronic stone impaction
Complete ureteral obstruction preoperatively
Diminished renal function
Known ipsilateral ureteral stricture
Patient enrolled in clinical trial
Secondary ureteroscopy
Radiolucent stone

Intraoperative findings

Significant ureteral edema
Stone impaction
Incomplete stone fragmentation
Changes suspicious for stricture
Ureteral perforation
Ureteral balloon dilation performed

Postoperative symptoms

Ipsilateral flank pain
Termperature >38.5°C

Discussion

Ureteroscopy has revolutionized the management of upper urinary tract disorders, and in particular urinary lithiasis. Postoperative ureteral obstruction, most commonly due to ureteral edema, retained stone fragments or ureteral stricture, remains a complication of ureteroscopy. Although ureteral stricture is a well-established complication of ureteroscopic procedures, its incidence has decreased

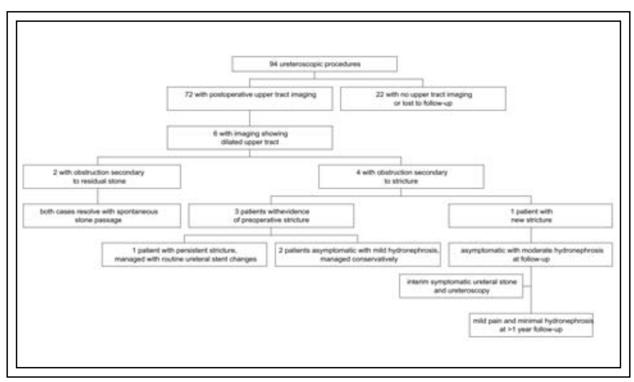

Figure 1. The outcome of 94 cases of ureteroscopic holmium laser lithotripsy.

dramatically in recent years.[10] This can be attributed to many technological advances, including miniaturization of endoscopes and introduction of flexible ureteroscopes reducing the need for routine ureteral dilation. Similarly, the development of intracorporeal lithotripsy devices such as the Ho:YAG laser with its greater safety profile has decreased the rates of inadvertent ureteral wall injury.[12-14]

Regardless of these advances however, there remains a lack of agreement among urologists regarding the role of and indications for postoperative imaging in patients undergoing ureteroscopic procedures. To date, there have been three studies addressing this issue, with differing results and views on the role of postoperative imaging after ureteroscopy. Karod et al. demonstrated that, in a group of 131 patients, none of the asymptomatic patients displayed obstruction on follow-up imaging and 13 of 21 (62%) patients with flank pain had radiographic evidence of obstruction.[15] They concluded that routine postoperative radiologic studies are unnecessary in an asymptomatic patient, and only patients with flank pain or intraoperative ureteral perforation require radiologic follow-up postoperatively. In another study, 118 patients undergoing a total of 134 ureteroscopic procedures were retrospectively analyzed, assessing the role for follow-up imaging of the upper urinary tracts after diagnostic or therapeutic ureteroscopy.[16] The authors concluded that upper tract imaging was indicated in patients who present for ureteroscopy with obstruction or patients who report flank pain during follow-up. More recently, Weizer et al. reported radiologic follow-up after ureteroscopy on 241 patients and found that 30 (12%) were obstructed.[17] Flank pain was present in 23 of the 30 patients postoperatively. More concerning was the finding of silent obstruction in 7 of the 241 patients (2.9%). These results prompted the authors to advocate imaging of the collecting system within 3 months of ureteroscopic lithotripsy.[17]

In our study, a significant number of patients had undergone some form of intervention prior to definitive ureteroscopic treatment at our institution making this patient population unique from the previously reported series. Multiple manipulations might potentially increase the risk of post-operative stricture formation particularly if associated with stone impaction or iatrogenic injury. Singal et al. have previously shown that secondary ureteroscopy although technically more complex, can be performed with excellent stone free rates and low complication rates.[18] Regardless, we feel that postoperative upper tract imaging is indicated for secondary ureteroscopy.

There were four cases of silent obstruction in our series. These four patients had pre and intraoperative findings that predicted potential risk of ureteral stricture development mandating postoperative upper tract imaging. Severe hydronephrosis, ureteral wall edema and chronic stone impaction were present in all four patients who developed strictures. Intuitively, the longer the duration of stone impaction the greater the risk of stricture occurrence. Roberts et al. demonstrated that a 24% incidence of ureteral stricture occurred when stone impaction was present for more than 2 months.[19] Ureteral edema may be of concern, but based on this study we are unable to conclude that the finding of ureteral edema alone is predictive of post-operative obstruction. In our study, all patients with post-operative obstruction had one or more factor present other than ureteral wall edema.

The findings in our study must be interpreted with the following caveats. As this is a retrospective series, there exist the usual potential biases related to such a study population. Furthermore, 21 of the 89 (23.6%) patients in our study were lost to follow-up. Data collection was problematic in that many of the patients were discharged to the referring health care centres for postoperative follow up. It could be argued that the follow-up period might have been extended longer, however, we would contend that most patients at risk for ureteral obstruction due to retained stones or stricture formation would become apparent during the period of time encompassed by our postoperative observation interval.

Given the paucity of published reports on follow-up imaging studies after ureteroscopy, and the conflicting results of the very few published series, perhaps it should be no surprise that there are currently no published consensus guidelines regarding indications for postoperative imaging following ureteroscopic procedures. In all likelihood, many urologists order a KUB and U/S or IVP on most patients following ureteroscopy. We agree that this practice is certainly appropriate in any patient with preoperative factors or intra-operative findings that would predispose to ureteral stricture formation or non-passage of stone fragments. Although not specifically identified as a risk factor for stricture formation in this study, balloon dilation has been mentioned by some as another indication for follow-up imaging.[20] Furthermore, we feel that the presence of postoperative symptoms, especially flank pain with or without fever, should also be an indication for postoperative imaging after ureteroscopy, even if the procedure itself was uncomplicated. Additionally, for patients with radiolucent calculi, postoperative imaging should be performed because of the inability to assess stone fragmentation and passage on KUB x-ray. However, based on our experience, we believe that routine postoperative imaging is unnecessary in patients undergoing uncomplicated ureteroscopic lithotripsy using the holmium:YAG laser. With the intent to fragment stones no larger than 2 mm - 3 mm, stone basket extraction is unnecessary. We routinely use this approach at our institution, allowing the tiny fragments to spontaneously pass.

One issue not addressed in this series is the method of follow up of patients who are not stented after uncomplicated ureteroscopy. Recent randomized series indicate routine stenting is not necessary in all patients.[21] Whether this population of patients should be routinely imaged is unanswered by this series. Our recommended guidelines for imaging following ureteroscopy are shown in Table 4. A second issue not addressed in this study is cost. Unfortunately, there is currently no data that suggests there is a cost saving related to limiting post-operative imaging to high risk patients. However, Bugg et al. noted that the cost to detect a single case of obstruction or residual stone would be between $3750 U.S. dollars (if intravenous pyelography was used) and $16 250 U.S. dollars (if CT scans were used).[16]

Conclusions

In the absence of preoperative risk factors, intraoperative findings or postoperative symptoms, routine upper urinary tract imaging is unnecessary after uncomplicated ureteroscopic lithotripsy using the holmium:YAG laser. Based on our study, indications for postoperative upper tract imaging include chronic stone impaction, radiolucent calculus, secondary ureteroscopy, ureteral perforation, endoscopic evidence of ureteral stricture and postoperative flank pain. Ideally, the exact role for postoperative imaging following ureteroscopic holmium:YAG laser lithotripsy would be best settled by a prospective randomized clinical trial. □

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