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CURRENT TREATMENT OF UPPER THIRD URETERAL STONES

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ABSTRACT

Objective: To evaluate therapeutic strategies currently available for management of proximal ureteral stones.

Material and Methods: A review of the literature was performed. Clinical aspects of the natural history of proximal ureteral stones were reviewed, and the results of treatment with extracorporeal shock-wave lithotripsy (SWL), retrograde and antegrade ureteroscopy, laparoscopic stone extraction and open surgery were compared. The advantages and disadvantages of each therapeutic option were critically analyzed.

Results: Expectant management remains the treatment of choice for most upper third ureteral stones. Stones 5 mm or less in diameter have a high probability of spontaneous passage, and should be observed if symptoms are manageable and there is no upper tract infection or significant obstruction. Surgical intervention is required for most stones larger than 5 mm in diameter since their spontaneous passage is less predictable. Both SWL and retrograde ureteroscopy are acceptable choices for stones 1 cm or less. SWL treatment of stones measuring greater than 1 cm in diameter may require multiple sessions; retrograde ureteroscopy in combination with laser lithotripsy offers greater efficacy and lower overall morbidity. Antegrade (percutaneous) ureteroscopy is an attractive option for large and/or impacted stones. Surgical ureterolithotomy is very successful but is associated with greater immediate morbidity than the endoscopic alternatives. It is usually reserved for calculi that are refractory to endoscopic techniques. When available, the laparoscopic approach to ureterolithotomy offers reduced hospital stay and post-operative convalescence compared to the open surgical approach.

Conclusions: The majority of upper third ureteral stones that do not pass spontaneously can be addressed effectively by either SWL or retrograde ureteroscopy. The former is less invasive, and is the first line of treatment for most cases, but the latter offers a greater chance of complete stone removal in one setting. Antegrade ureteroscopy has application for large and/or impacted stones. Laparoscopic and open surgical ureterolithotomy should be reserved for special circumstances, such as anatomical abnormality requiring concomitant surgical intervention, when endoscopic management has failed, or if other options are not available. As endourological training becomes more widespread, upper third ureteral stones likely will be managed almost exclusively with minimally invasive techniques.

Key words: ureter; ureteral calculi; ureteroscopy; lithotripsy
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INTRODUCTION

Technological advances have changed profoundly the management of ureteral stones. Before 1980, open surgical ureterolithotomy and fluoroscopic basket extraction were the only options available for the treatment of upper third ureteral stones. Current minimally invasive options are so reliable and safe that open ureterolithotomy is rarely indicated for the treatment for upper urinary tract calculi, and fluoroscopic basket extraction is considered substandard care for proximal ureteral stones. Since its introduction in the 1980s (1), extracorporeal shock wave lithotripsy has been a mainstay of treatment of both renal

and ureteral stones. Almost concurrently, percutaneous nephrostolithotomy was introduced as an alternative treatment for renal stones, and the percutaneous approach (antegrade ureteroscopy) was soon used with success in the treatment of upper third ureteral stones. More recently, with the miniaturization of flexible ureteroscopes and development of laser lithotripsy, virtually every stone in the upper tract can be treated with retrograde ureteroscopy. Finally, laparoscopic ureterolithotomy can be used as a direct replacement for the open surgical procedure. Today, urologists have so many options with which to treat upper third ureteral stones, that to determine which modality suits best each case can be difficult.

The aim of this article is to review clinical aspects of upper ureteral stones and to analyze the outcomes of therapeutic modalities currently available for treating upper third ureteral calculi. We hope to provide urologists with the most up-to-date information regarding this topic, in order to facilitate knowledgeable treatment decisions regarding upper third ureteral stones.

CONSERVATIVE MANAGEMENT OF UPPER THIRD URETERAL STONES

There are few absolute indications for surgical intervention for ureteral calculi: infection, severe ureteral obstruction with risk of renal damage, and intractable pain. With recent advances in minimally invasive techniques, urologists are tempted to recommend surgical interventions over conservative management (observation for spontaneous stone passage) in cases of upper third of ureteral stone even in the absence of absolute indications. It should be remembered that conservative management is attractive to patients as it may allow them avoid the discomfort and stress of surgery. Nevertheless, this approach has potential risks. Numerous complications associated to observation of upper ureteral stones have been reported, including kidney loss and death due to sepsis (2,3). The natural history of ureteral stone has been analyzed by several investigators, and variable rates of spontaneous upper ureteral stone passage have been reported (2,3). Most studies agree that stones with a diameter of 5 mm or less have a high probability of spontaneous passage. Rates ranging from 29 to 98% have been reported (2). The odds of spontaneous stone passage for stones larger than 5 mm are less favorable, and rates between 10 to 53% have been observed (2). The 2 main factors that influence spontaneous stone passage are size and location of the stone, assuming that there is no anatomical abnormality involving the ureter. The limitations of expectant management are the inability to determine for a specific patient whether or not the stone will pass, and the uncertainty of when stone passage will occur. In a recent article addressing the matter of time to stone passage, Miller & Kane. (3) followed a group of patients with upper ureteral stones with observation and verified that for stones with a diameter of 4 mm or less, spontaneous passage occurred in an average of 7 days (range of 2 to 15 days). It took much longer for stones with a diameter greater than 4 mm to pass, with an average time for spontaneous passage of 53 days (range 15 to 105 days). Surgical intervention increased from 4.8% with stones less than 2 mm to up to 50% with those larger than 4 mm. Not only are larger stones less likely to pass, but the time to passage tends to be longer and more variable.

Consequently, expectant management with periodic re-valuation is recommended as initial treatment for patients with a newly diagnosed upper ureteral stone of 5 mm or less in diameter. Most patients are comfortable with this approach and feel safe knowing that the odds of spontaneous stones passage are in their favor. Elective surgical management of small stones is reasonable, however, if the patient wishes to avoid the uncertainty associated with expectant management or has a desire to become stone free as soon as possible (airplane pilot, upcoming travel, etc.). Surgical intervention is recommended in situation such as intractable pain, high narcotic requirements, multiple trips to the emergency room, or stones that fail to progress after 3 to 4 weeks. Stones that are larger than 5 mm in diameter have a low probability of spontaneous passage. Over 50% of patients will require some type of surgical intervention, and they have a greater risk of complications. Patients with stones that have a low probability of spontaneous passage who wish to pursue this course should be informed about potential risks and advised to consider surgical treatments.

These general recommendations are applicable to patients with a new proximal ureteral stone that are not pregnant, and have a normal urinary tract with a solitary ureteral stone composed of material other than cystine or uric acid. Pregnancy entails an additional set of considerations, as does an anatomically abnormal urinary tract. Cystine stones may grow quickly, and they require close follow-up to avoid complications. Uric acid stones should be treated medically with urine alkalinization unless absolute indications for stone removal (noted above) are present.

SURGICAL MANAGEMENT OF UPPER THIRD URETERAL STONES

Surgical intervention should be instituted immediately in patients with intractable pain, severe obstruction, signs of infection, or failure of stones progression after 3 to 4 weeks. Even for small stones, if passage has not happened after this period, spontaneous passage is unlikely and therefore surgical intervention will likely be required.

Factors that concern patients with regards to urolithiasis are becoming stone free, re-treatment rate, degree of discomfort/pain during and after the procedure, work absence, and length of hospital stay. Consequently, for a patient to make an informed decision regarding which therapeutic modality to pursue, a careful discussion regarding risks and benefits of each reasonable and available modality is required.

Five modalities of treatment are currently available for management of upper third ureteral stones: extracorporeal shock wave lithotripsy, retrograde ureteroscopy, antegrade ureteroscopy (percutaneous), laparoscopic ureterolithotomy, and open surgical ureterolithotomy. All are reasonable alternatives for the management of proximal ureteral stones, and in the hands of well-trained urologists good results can be expected from all.

Extracorporeal Shock Wave Lithotripsy

Because of its non-invasiveness, efficacy, and safety, extracorporeal shock wave lithotripsy (SWL) quickly established itself as a mainstay for treatment of urinary calculi. With experience, it became clear that this modality of treatment had limitations. The efficacy of SWL for staghorn calculi was the first application to be questioned. Soon after, investigators started to question the role of SWL in the treatment of ureteral stones, and several studies were conducted to establish patterns of SWL failure. In a retrospective study (5), Grasso et al. evaluated reasons for SWL failure in a series of patients with upper urinary tract calculi (renal and ureteral) referred to a tertiary hospital for endoscopic management of stones after they had failed SWL treatment. Causes of failure were classified as: failure to fragment stones, failure to clear fragments, inability to localize stone, and failure due to anatomical obstruction of the urinary tract. In addition, the authors evaluated such variables as different types of lithotriptors, number of SWL sessions and shocks, and calculus composition. The mean number of SWL treatment in that series was less than 2 (range of 1 to 7). Upper ureteral calculi that failed to fragment had a mean pre-SWL diameter of 12.5 mm, and the mean stone diameter of those that failed to clear fragments was 10.3 mm. Stones composed of calcium oxalate monohydrate or brushite offered the highest index of resistance for both fragmentation and passage. Impacted stones and ureteral obstruction were common causes of treatment failure. Localization of stones was particularly problematic among obese patients, and failure in this setting of patients was not infrequent. Inadequate pre-SWL imaging failed to define anatomic abnormalities such as ureteral strictures in a significant number of patients that precluded successful SWL. The authors also noted that second and third generation lithotriptors were less effective than first generation lithotriptors. The lower level of energy and narrower focal zones generated by these devices have made anesthesia-free treatment possible, but at the expense of efficacy. The authors concluded that large stones, especially those composed of calcium monohydrate, frequently fail SWL, but SWL should remain as the treatment of choice for uncomplicated and moderately sized upper third ureteral stones.

A guidelines panel convened by the AUA to review treatment outcomes on methods available to treat ureteral stones (2) also recommended SWL as the first line treatment for patients with uncomplicated, proximal ureteral stones of 1 cm or less.

After reviewing 20 years of literature regarding treatment of ureteral calculi they concluded that stones of 1 cm or less in diameter tend to respond well to SWL, and close to 85% of the patients will be stone free after 1 treatment. According to the panel's review, ureteral stent placement did not improve stone fragmentation or clearance after SWL treatment, and that routine placement of ureteral stents prior to SWL treatment for 1 cm upper third ureteral stones was not necessary. Stenting was recommended only in situations such as management of symptoms associated with the passage of stone fragments. Studies have not revealed any advantage to pushing upper ureteral stones back to the renal pelvis prior to SWL. If the stone can be well localized under fluoroscopic guidance it should be treated it in situ. The overall rate of significant complications after SWL of upper proximal ureteral stones is less than 3%. The incidence of complication tends to increase with high number of shock waves, higher energy levels, and after multiple treatments.

Results of SWL treatment for stones in the upper third ureter larger than 1 cm are less promising. Larger stones usually require multiple treatments, which increases both cost and the risk of complications. Patients that opt for SWL treatment should be warned that treatment may require multiple SWL sessions, and sometimes a secondary modality of treatment may be necessary to render them stone free.

Because of its the non-invasiveness, SWL will continuo to be common choice of treatment for most upper third ureteral stones. Although capable of providing excellent results for stones less than 1 cm in diameter, the same efficacy should not be expected when treating stones larger than 1 cm in diameter. For larger stones, especially impacted ones, other lines of treatment should be considered.

Retrograde Ureteroscopy

Retrograde ureteroscopy has the inherent advantage over the remaining intracorporeal techniques of being performed through the existing urinary tract. The ureteroscope is introduced through the urethra and advanced alongside or over a guide wire into the ureteral orifice under direct vision or under fluoroscopic guidance. This approach requires facility with the equipment, but in the hands of a well-trained urologist is very effective and safe. Both rigid and flexible ureteroscopes can be used. Rigid ureteroscopes are more durable and less expensive than flexible ones. The working channels system of these scopes have a wide diameter, which allows more choices for intracorporeal lithotripsy and maintains excellent visibility by providing rapid inflow of irrigant fluid. Rigid lithotrites and graspers, which are usually more efficient than their flexible counterparts, can be used in ureteroscopes with an offset lens. The advantages of rigid ureteroscopes are offset by their inability to access the upper third ureter in many patients (usually men), and by the greater degree of ureteral manipulation that may be required. Nonetheless, if an upper third ureteral stone can be approached with a rigid rather than flexible ureteroscope, the stone extraction is greatly facilitated.

The technical capabilities of flexible ureteroscopes continue to advance, with improvements in optical quality, degree of active deflection, and durability. The entire collecting system can be visualized, with the only typical limitation being access to the lower pole calyces in some patients. Access to the upper third ureter is not hampered by urinary tract anatomy, even in muscular men with large prostates. Despite the improvements in flexible ureteroscopes, the disadvantages of inability to use rigid instrumentation, smaller working channel diameter, and decreased durability compared to rigid ureteroscopes persist – albeit less so than with models from years past. The small working channel (currently ~ 3F in most flexible ureteroscopes) limits irrigant inflow to the point that any upper tract hemorrhage can be problematic. Durability is a significant problem, especially in training programs. At our institution, a repair is needed an average of every 25 uses of the flexible ureteroscope.

The efficacy of retrograde ureteroscopy for treatment of upper third ureteral calculi is well documented in the literature. Stone-free rates after a single therapeutic session between 95 to 97% have been reported (6-8). A recent study compared the results of SWL and ureteroscopy in 54 patients with upper third ureteral stones (6). Of those, 27 underwent ureteroscopic stone removal and 27 were treated with SWL. Mean

diameter of the stones was approximately 10 mm for both groups. Twenty-five of 27 patients (95%) were stone-free 1 month after ureteroscopic treatment, and 26 (97%) were free of stones 3 months after the treatment. Only 1 patient returned with a 4 mm fragment requiring a second procedure. Of those that underwent SWL, only 10 (45%) were stone-free 1 month after treatment, and 16 (62%) were stone-free 3 months after surgery. The SWL patients not only had a much higher re-treatment rate, but they also required more post-operative visits and imaging studies. Operative treatment costs were similar for both therapy, but the retreatment rate and number of additional procedures and office visits made treatment with SWL two-fold more expensive than ureteroscopy. Another study evaluated the efficacy of retrograde ureteroscopy and Holmium:YAG laser lithotripsy as treatment for upper third ureteral stones that were considered too large for SWL treatment (2 cm in diameter or larger)(8). In 20 of 21 patients (95%), complete ureteroscopic stone fragmentation was obtained after a single session, and 1 patient was clear of stones after the second ureteroscopic session. There were no significant intraoperative or post-operative complications in this setting.

At our institution over the past few years, we have used almost exclusively a 6.9F flexible ureteroscope in combination with Holmium:YAG laser lithotripsy for treatment of upper third ureteral stones. We disfavor the rigid ureteroscope for upper third ureteral stones because of the potential for ureteral trauma. For 81 of these stones (including middle third ureteral stones), treated consecutively between January 1, 1997 and September 30, 1999, the stone free rate with the initial procedure was 78%, improving to 88% after a second ureteroscopy in 7 patients. There were 6 ureteral perforations, all managed without consequence by ureteral stenting, and 8 post-procedure emergency room visits or re-admissions for pain.

Antegrade Ureteroscopy

Antegrade flexible ureteroscopy is a melding of the techniques of percutaneous nephrostolithotomy and ureteroscopy. The technique combines the stability of access of the percutaneous procedure with the minimal trauma afforded by the small caliber ureteroscope. For large stones impacted in the upper third ureter, the retrograde ureteroscopic approach can be very challenging. The same stone can often be managed much more effectively with a ureteroscope "going down" on the stone, rather than "pushing up" on it as with retrograde ureteroscopy. Flexible lithotrites (laser, electrohydraulic) are used. The goal of the lithotripsy is only to fragment stones into manageable pieces, since fragments can be pushed out into the bladder. This aspect of the antegrade approach markedly enhances efficiency compared to the retrograde approach, where the entire stone burden must be converted into fragments of less than 1 to 2 mm in diameter.

After obtaining routine percutaneous access (middle or upper posterior calyces are preferred to allow better access the ureter), the tract to the kidney needs to be dilated to only the diameter of a sheath that will accept the ureteroscope. As we prefer to use a 6.9F ureteroscope, a 10 or 12F biliary sheath is more than adequate. A common situation to which antegrade ureteroscopy is well applied is the management of large impacted upper third ureteral calculi that have resulted in pyonephrosis necessitating emergent percutaneous nephrostomy tube placement. After the track has matured for only a few days, the small flexible ureteroscopes can be passed over a wire directly into the skin without requiring any additional dilation. With either acute dilation, or use of an established tract, the nephrostomy tube can usually be removed at the conclusion of the procedure, although placement of a ureteral stent is often prudent. Some urologists have had good success with antegrade use of rigid ureteroscopes or nephroscopes for upper third ureteral stones. Although we also have used this technique on occasion, usually in the setting of extreme dilation of the proximal ureter, in general we prefer flexible ureteroscopes for the same reasons that we prefer the flexible instrument for retrograde ureteroscopy of the upper third ureter – for the reduction of trauma to the ureter.

Few studies have compared the efficacy of the antegrade and retrograde approaches to ureteroscopy (9,10). Maheshwari et al.,(9) evaluated 43 patients with large impacted upper ureteral stones (larger than

1.5 cm) treated ureteroscopically. Of those, 20 were treated with retrograde ureteroscopy and 23 via antegrade ureteroscopy. Four patients in the retrograde group and 10 patients in the antegrade group had associated lower-caliceal stones. Retrograde ureteroscopy was performed with an 8.5F rigid ureteroscope and antegrade ureteroscopy was performed with a rigid nephroscope or ureteroscope. Ultrasonic and pneumatic lithotriptors were used in both situations. The average operative time for antegrade approach was slightly longer (75 to 185, average 90 min) than that for the retrograde approach (25 to 90, average 65 min), mainly because of the time required for percutaneous access. Complete stone clearance was achieved in all patients with antegrade ureteroscopy and in 11 patients (55%) who underwent retrograde ureteroscopy (including clearance of the secondary renal stones). In the remaining 9 patients in the retrograde group partial stone clearance was possible and the residual fragments were pushed back into the pelvis for treatment with SWL. Two patients who underwent antegrade ureteroscopy required blood transfusion. No other major complications were noticed with either approach. Similar results were reported by Kahn (10). It should be noted that these studies likely underestimate the utility of the retrograde ureteroscopic approach since flexible ureteroscopes were not used.

In situations where flexible ureteroscopy is not widely available, antegrade ureteroscopy is an excellent choice for the treatment of upper third ureteral stones that are too large to be effectively managed with ESWL. For large and/or impacted upper third ureteral stones the antegrade approach might be preferable in any setting. Contraindications to the antegrade approach include bleeding diatheses, inability to tolerate prone position in the operative table, and inability to achieve safe access to the collecting system (anatomic abnormality, dysmorphic body shape, etc.).

Open Surgical Ureterolithotomy

With the advent of minimally invasive techniques, open surgery has assumed a distant role in the management of urolithiasis. Endoscopic techniques combined with powerful lithotriptors are capable of treating calculi in all portions of the renal collecting system so effectively, that in most tertiary centers, they have reduced the need for open surgery for treatment for urinary stones to less than 4% of the cases (12,19). Open ureterolithotomy is associated with a longer hospital stay and an even longer post-operative convalescence compared to endoscopic ureteral stone surgery. When the full spectrum of minimally invasive options are available, patients for whom open surgical ureterolithotomy should be considered are those who have failed endoscopic therapy or who require concomitant surgical repair (pyeloplasty, ureteroplasty for stricture, etc). Of course, if the minimally invasive options are not available, then there is no choice but to perform ureterolithotomy. A number of conditions, such as pregnancy, bleeding diathesis, poor medical condition, and morbidly obesity, may contraindicate SWL or antegrade ureteroscopy, but retrograde ureteroscopy can usually be applied in even these complicated patients if the possibility of re-treatment is acceptable (11).

Laparoscopic Ureterolithotomy

Laparoscopy was first used as an adjunct in the treatment of urinary calculi when Lee & Smith used laparoscopic instruments to assist the percutaneous endoscopic removal of a stone in a pelvic kidney (13). Since than, several authors have reported laparoscopic stone removal of both ureteral and renal calculi (14-17). Theoretically, anytime that there is an indication for open surgery to remove a stone, laparoscopy could be attempted. It may be especially useful when treating patients with concomitant upper urinary tract problems, such as ureteral strictures or UPJ obstruction, which need simultaneous surgical repair. Laparoscopic ureteral stones extraction can be performed transperitoneally or retroperitoneally. The transperitoneal approach requires a more extensive dissection since the colon needs to be reflected medially for identification of the proximal ureter. Patients are usually placed in a full flank position and a ureteral stent should be placed before the procedure. Laparoscopic stent placement can be complicated, and significant amount of time can be save by placing the stent cystoscopically before commencing with ure-

teroscopy. Three trocars are usually sufficient for removal of proximal ureteral calculi (one 10 mm at the umbilicus for the laparoscopic lens and two 5 mm at the ipsilateral midclavicular line, 1 subcostal and 1 in the lower quadrant). Ureteral dilatation is usually presents, which facilitates localization of the stone, but fluoroscopic guidance may be occasionally necessary for stone localization. The ureter should be sharply incised longitudinally over the stone and the stone can be removed with graspers through one of the trocars. Simple sutures can be placed laparoscopically to loosely close the defect, although they are not required in all cases. A suction drain is placed.

Retroperitoneal laparoscopy is also performed with the patient in a flank position. Adequate exposure of the retroperitoneal space is obtained with the use of a balloon after blunt entry of the thoracolumbar fascia and finger-dissection of the retroperitoneal space (18). A total of 3 trocars is often sufficient. The primary port (10 mm) should be placed at the tip of the 12th rib, a 5 mm port 2 cm cephalad to the iliac crest, and the second 5 mm port at the tip of the 11th rib. Laparoscopic dissection is less extensive through this approach the colon does not need to be reflected, but sewing of the ureter can be more complicated because of the limited space available in the retroperitoneum.

Excellent results for stone removal and few intra-operative complications have been reported with both techniques (14-17). The main disadvantage of laparoscopic ureteral stone extraction is a longer operative time when compared to open surgery. The main advantages are decreased post-operative pain, shorter hospital stay, and quicker convalescence in comparison to open surgery. Most patients are able to return to normal activity less than 3 weeks after the procedure (17). Laparoscopic ureterolithotomy should be viewed as a preferred alternative to open surgical ureterolithotomy when laparoscopic expertise is available.

SUMMARY

Technological innovations have changed completely the surgical management of ureteral calculi. Twenty years ago, open ureterolithotomy was the standard treatment for upper third ureteral stones, and today it is rarely recommended.

Extracorporeal shock wave lithotripsy is a safe and, when limited to appropriate patients, effective modality. It remains a first line treatment for stones 1 cm or less in diameter in the upper third of the ureter. Stone-free results after one treatment are inferior of those seen after ureteroscopy, but its non-invasiveness is usually more appealing to patients. Ureteroscopic stone extraction is recommended when SWL is not appropriate, such as pregnancy or bleeding diathesis, or when SWL has failed. Treatment of larger upper tract ureteral stones is less predictable. Multiple SWL sessions may be required for a stone-free result, especially for large and/or impacted stones. Retrograde ureteroscopy has emerged as the best treatment for most of these situations. Although most experienced urologists who have them available prefer flexible ureteroscopes, rigid ureteroscopy can be applied effectively to upper third ureteral calculi. Antegrade ureteroscopy should be considered for large (> 2.0 cm) and / or impacted stones in the upper third ureter, or if flexible ureteroscopes are not available and the stone cannot be accessed in a retrograde fashion with the rigid ureteroscope. Open or laparoscopic ureterolithotomy is recommended only when endoscopic procedures are not available or have failed because of the longer hospitalization and duration of convalescence compared to SWL and ureteroscopy. When ureterolithotomy is indicated, a laparoscopic approach is an excellent alternative to the open surgical one, as it reduces somewhat the duration of hospitalization and convalescence (although not as much as SWL and the endoscopic options).

Endourology training should be encouraged in all training programs to allow the more complete dissemination of these techniques. The trend towards less invasive treatment for urinary stones that started 20 years ago will continue. We expect to see more technological innovations that will make minimally invasive treatments for urinary calculi even more safe and reliable, and indications for ureterolithotomy in the future will be even more restricted.

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