THE ROLE OF EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY ESWL IN THE TREATMENT OF UPPER URETERAL STONE DISEASE

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ABSTRACT

Purpose:

To evaluate the role of extracorporeal shock wave lithotripsy (ESWL) in the management of upper ureteral stones.

Patients and methods

Between May 2009 and June 2011, 115 patients with radio-opaque upper ureteral stones who referred to lithotripsy unit in Al-hussain teaching hospital in Thiqar, 83 male(average 48 years) and 32 female (average 51years), treated with extracorporeal shock wave lithotripsy (ESWL). The patients were discharged from the hospital on the same day of treatment and patients were asked to return after two weeks for fallow up plain film together with ultrasound examination, to be able to detect fragmentation and stone clearance together with the effect of treatment and obstruction on the upper tract.

Results

The over all success rate for the patient at 3 months of follow up was 64.3% (74 pt.) the success rate decreases as the stone size increases. It decrease from 76% to patients with stone <10 mm to only 52% to patients with stone > 15mm. The remaining 41 patients (٣5.6%) were considered failure, either due to non fragmentation of the stone despite repeated sessions (3 sessions) or fragments are large that failed to pass (5 cases). All patients were treated on an outpatient basis; the complications were minimal and treated conservatively.

Conclusions

ESWL is safe, effective, noninvasive and a convenient way of treatment for upper ureteral stones. ESWL being an outpatient procedure without any need for anesthesia or any pretreatment intervention, it should be considered as the first line of treatment for all stones in the upper ureter. However the clearance rates for stones larger than 15 mm were low.

INTRODUCTION

In the last 20 years, the development and constant improvement of minimally invasive techniques such as ESWL and ureteroscopy with in situ lithotripsy or laser fragmentation has prompted urologists toward a more aggressive attitude (1,2). Although observation is still recommended for stones measuring less than 4 mm in diameter, most international guidelines today recommend active removal of all stones exceeding 5-7 mm, when proven that they have resisted medi

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cal therapy (3). The spontaneous rate of elimination of the stones depends on the stone size and position in the ureter (3,4). In a recent prospective study using unenhanced helical CT, Coll et al. have demonstrated that the spontaneous passage rate for stones ranged from 87% to 25% according to the size of stones (1 mm in diameter to more than 9 mm) (5). In the same series, spontaneous passage rate was also dependent on stone location (48% for stones in the proximal) (5). Even in the era of modern medicine, urinary stones continue to be one of the major diseases encountered in urologists' daily practice. Two important strides in the last two decades dramatically changed how modern urology deals with stone diseases. First, in 1980, with the advent of the first reported the clinical application of shock waves for renal stones(6) . Due to its low morbidity and excellent stone fragmentation, extracorporeal shock wave lithotripsy (ESWL) has long been recommended as the first-line treatment for most patients with stone diseases (6). Another major advance in urology technology was the development of small-caliber ureteroscopes and various kinds of intracorporeal lithotriptors, which render ureteroscopy much less invasive and easily performed with few complications(7). However, certain issues remain controversial, such as the best choice of treatment for proximal ureteral stones (8).

Expectant Therapy

For a patient with a newly-diagnosed urinary stone, the probability of spontaneous stone passage is hard to predict. Several factors should be considered, including the size and location of the stone, associated symptoms and signs noted from acute colic attack or chronic insidious onset, the extent of local edema or inflammation due to stone impaction, and previous history of stone passage(9,10). Of all these factors, stone size and location are now thought to be the most important. Nevertheless, there is a great variation in the reported probabilities. In a series of Hubner et al., the probability of spontaneous passage for stones of < 4 mm was 38%, while for stones of > 6 mm, the probability diminished drastically to only 1.2%; the probabilities were 45%, 22%, and 12% for stones located in the distal, middle, and proximal ureter, respectively(10,11). In general the management of ureteral calculi suggest observation with periodic evaluation as the initial treatment, but the duration of the expectant period should be individualized for each patient based on pain tolerance and episodes of colic attack.2 Clinically, the majority of stones pass spontaneously within 4~6 weeks(11,12).

Several reports have demonstrated the effectiveness of promoting stone passage with alpha-1 adrenergic blockers, calcium blockers, and steroids, either used alone or in combination. However the definite roles and usages of these agents for more-proximal ureteral stones have not been clearly determined. More randomized and prospective studies are needed to verify their effects(13,14).

Extracorporeal Shock Wave Lithotripsy (ESWL)

Through out the history of medicine perhaps no technologic advance has exerted more revolutionary effect than shock wave lithotripsy(15). Reports of the efficacy and success rate of ESWL for proximal ureteral stones vary from 63.9% to 91.5%, and appear mainly to depend on the different models of lithotriptors used in each clinical series and stone characteristics. The first-generation Dornier HM3 lithotriptor, with its large focal area and small ellipsoid aperture,

delivered relatively more energy to the stones and resulted in excellent stone fragmentation rates(16,17). However, the necessity of regional or general anesthesia to relieve pain during the procedure increased the risk of complications to patients. To increase patient comfort and eliminate the need for regional or general anesthesia, certain modifications were made and different principles of shock wave generation (electromagnetic and piezoelectric) were applied. With these modifications, several studies reported that ESWL with these low cost second-and third-generation lithotriptors seemed to be less effective, and the re-treatment rate was as high as 45% when compared with first-generation lithotriptors(18,19). Nevertheless, because of its minimally invasive nature and it being an outpatient procedure, ESWL is still generally considered to be the first-line therapy for patients with ureteral stones, although the results greatly depend on the type of ESWL machine used, irrespective of the expertise of the urologist who provides treatment(20,21)>

Stone composition affects ESWL results of fragmentation and subsequent elimination. Contrary to calcium oxalate dihydrate stones (whedellite), which have a better coefficient of fragmentation and thus respond well to ESWL, cystine and calcium oxalate monohydrate (whewellite) stones are relatively resistant to ESWL treatment(22). Using non-contrast CT to measure the stone density in Houson units (HU), Gupta et al. note that stones with a higher HU (> 750 HU) required more treatment sessions and were less likely to be completely cleared than those with a lower HU.30 However, it is hard to predict the response of a stone to ESWL from pretreatment imaging studies(23,24) Stone size definitely plays an important role in the choice of treatment modality and outcomes. A new analysis showed that overall for stones in the proximal ureter (*n* = 8670), there was no difference in stone-free rates between SWL and URS. However, for proximal ureteral stones of < 10 mm (*n* = 1129), SWL had a higher stone-free rate than URS, and for stones of > 10 mm (*n* = 523), URS had a superior stone-free rate. This difference arises because the stone-free rate for proximal ureteral stones treated with URS did not significantly vary with size, whereas the stone-free rate following SWL was negatively correlated with stone size(25,26). Open surgery is reserved as a salvage measure only when other treatment modalities have failed. Indeed, the current analysis revealed a stone-free rate of 81% for ureteroscopic treatment of proximal ureteral stones, with surprisingly little difference in stone-free rates according to stone size (93% for stones < 10 mm and 87% for stones > 10 mm)(27). A debate still exists as to whether the push-back of stones or the ureteral stenting technique before ESWL improves stone fragmentation compared to in situ ESWL. The expansion-space theory proposed by Muller et al. suggests that more water in the interface between a stone and the ureteral mucosa leads to better fragmentation than if the stones are impacted(28,29). However, reports of outcomes are inconsistent. Due to an increased complication rate from this anesthesia-requiring adjunctive procedure, the 2007 Guidelines for the Management of Ureteral Calculi AUA/EAU does not recommend routine use of ureteral stents when the goal is to improve the stone-free results of ESWL. However, stenting may be justified for other purposes such as managing symptoms associated with the

passage of stones or preventing the formation of steinstrasse after ESWL(29).

Contraindications of Eswl

It is prudent to avoid ESWL of lower ureteral calculi in women of reproductive age, although experimental studies have failed to demonstrate any adverse effects of shock waves on infantile or mature ovarian tissue, and ovarian damage by ESWL has not been reported clinically despite its extensive use in animal model (30). ESWL also contraindicated in pregnancy due to miscarriage and birth defect after ESWL and in cases of urinary tract obstruction distal to calculus because the passage of resulting fragments can not be ensured (31). If urinary tract infection is present appropriate antibiotic therapy according to urine culture should be instituted before ESWL (31).

Ureteroscopy

In the last decade, technical advancements in fiberoptic imaging and the development of semi-rigid and flexible ureteroscopy have dramatically increased the success rates and safety of performing invasive procedures in the ureter. Simultaneously, a variety of intracorporeal lithotriptor devices have also been invented to enhance the efficacy of stone fragmentation(32). Despite these improvements, the optimal treatment of ureteral stones, especially with large proximal ureteral stones, remains controversial. Indeed, the 2007 Guidelines for the Management of Ureteral Calculi AUA/EAU recommends that patients be informed that URS is associated with a better chance of becoming stone free with a single procedure(33). The major concern for ureteroscopy is complications secondary to the procedure. Using small-caliber semi-rigid and flexible ureteroscopy, serious complications like ureteral avulsion, intussusception, urosepsis, and steinstrasse are rare. Minor complications, such as perforation, urinary extravasation, false passage, mucosal abrasion, and bleeding, are not common(34). The exact incidence of ureteral stricture formation, which was thought to be related to perforation, is not known. Many randomized studies have shown that the routine use of stenting after uncomplicated ureteroscopy is not recommended.(34)

Ureteroscopy with various lithotriptors for proximal ureteral stones has shown varied results. The stonefree rate with electrohydraulic lithotripsy (EHL) was over 90%, but the traumatic effect was the main problem(34). Because of retrograde stone displacement to the kidneys, the stone-free rate with Swiss Lithoclast lithotripsy was around 70%. With pulse-dyed laser lithotripsy, stonefree rates might reach 95%,(33,34) but the disadvantage is the expense and cumbersome maintenance. As to holmium:YAG laser lithotripsy, the stone-free rates are around 87%~97%.(35-36) In treating impacted proximal ureteral stones of > 1 cm, holmium:YAG laser lithotripsy revealed excellent stone-free rates (84%~96.2%) in one endoscopic procedure and was more cost effective than ESWL. However, the high cost of the equipment is the most debated issue. The flexible ureteroscope is largely responsible for improved access to the proximal ureter; superior stone-free rates have been achieved using flexible URS (87%) compared with rigid or semi-rigid URS (77%). These stone-free rates are comparable to those achieved with SWL(35). Antegrade Percutaneous Nephrolithotomy (PCNL) For proximal ureteral stones of > 1 cm, the 2007 Guidelines for the Management of Ureteral Calculi AUA/EAU state that ESWL, ureteroscopy, and PCNL are all acceptable options. Maheshwari et al. compared

antegrade and retrograde ureteroscopy for large impacted proximal ureteral stones.(35.36) The results showed complete stone clearance with antegrade PCNL, with only a 55% success rate with the retrograde approach. At present, PCNL is usually reserved for complex ureteral stones, impacted stones that have failed other treatment modalities, stones in a markedly dilated renal collecting system, large stone burdens, and stones associated with distal ureteral stricture as well as various forms of urinary diversion. In contrast to the expense and fragility of semi-rigid and flexible ureteroscopes, the equipment of PCNL is readily available in most urological units, and the required skills are less technically-dependent than for laparoscopy. PCNL is still a reasonable option, especially in developing countries(35,36).

Laparoscopic Ureterolithotomy

Retroperitoneal laparoscopic ureterolithotomy was introduced by Wickham in 1979. In 1992, Raboy et al. performed the first transperitoneal laparoscopic ureterolithotomy(37). Gaur et al. proposed balloon dissection to modify the technique of retroperitoneal laparoscopic ureterolithotomy. The retroperitoneal approach is considered to be associated with a shorter period of convalescence. The most common complication is ureteral stricture secondary to periureteritis, urinary leakage, and stone impaction.(37) Today, laparoscopic ureterolithotomy is reserved for patients refractory to ESWL and ureteroscopy, obese patients for which ESWL is precluded, and patients undergoing laparoscopy for concomitant indications, as well as those settings in which ureteroscopy is not available(38).

Open Ureterolithotomy

The indications for an open ureterolithotomy in a well-equipped urological center are rare. It is indicated with failure of all minimally invasive modalities, the presence of medical or anatomical abnormalities, a concomitant open procedure, and the presence of large impacted stones for which patients prefer to avoid multiple procedures(39,40).

PURPOSE

The optimal treatment of ureteral stones, especially the upper ureteral stone, remains controversial. The purpose of this study was to evaluate the role of extracorporeal shock wave lithotripsy (ESWL) in the management of upper ureteral stones.

PATIENTS & METHODS

Between May 2009 and June 2011, 115 patients with radio-opaque upper ureteral stones who referred to lithotripsy unit in Al-hussain teaching hospital in Thiqar, 83 male(average 48 years) and 32 female (average 51years), treated with extracorporeal shock wave lithotripsy (ESWL). All the patients included in the study underwent:

Ultrasonographic study, excretory urogram (EU) or computed tomogram (CT) with or without contrast, urinalysis and culture, coagulation profile, serum creatinine and fasting blood sugar. Patients instructed to take laxative for a night before ESWL to help reduce intestinal gases and facilitate stone localization. Also all patients were given diclofenac analgesia before lithotripsy and those with positive urine culture treated with antibiotic according to the culture and sensitivity before ESWL.The patients were grouped according to the stone size to three groups:

Group A: stone size <10 mm 50% (57pt.).
Group B: stone size 10-15 mm 32% (37pt.).
Group C: stone size >15 mm 18% (21pt.).

The procedure done on an outpatient basis with the patients in supine position. Secondary ureteral stones fragments after previous renal stone lithotripsy were not included in the study.

The number of shock waves ranges from 2500-4000 shocks in 15.5-16.7 k.v. according to patient tolerance and stone disintegration, a double J stent was inserted in 7 patients who were either uremic at time of presentation or they have a single kidney . The patients were discharged from the hospital on the same day of treatment and patients were asked to return after two weeks for fallow up plain film together with ultrasound examination, to be able to detect fragmentation and stone clearance together with the effect of treatment and obstruction on the upper tract. If significant (>4mm) fragments were still seen they were instructed to return for a second session. Complications and outcome were also recorded.

RESULTS

The over all success rate for the patient at 3 months of follow up was 64.3% (74 pt.) as shown in table 1, the success rate high in group A and decreases as the stone size increases. It decrease from 76% to patients with stone <10 mm to only 52% to patients with stone > 15mm. 63% of patients who underwent successful therapy (47 pt.) need only single session most of those patients 72.3 % (34 pt.) from group A. 18 pt. (24%) need 2 sessions and 9 patients (12%) need 3 sessions as shown in table 2. The remaining 41 patients (35.6%) were considered failure, either due to non fragmentation of the stone despite repeated sessions (3 sessions) or fragments are large that failed to pass (5 cases). These patients necessitate other treatment modalities either urteroscopy or ureterolithotomy. The average time per session was 1 hour and the average fluoroscopy time per session 5 minutes. Complications after ESWL include renal colic in 45 patients necessitate analgesia. Hematuria in 27 patients, fever in 9 patients, 2 of them temperature >38c need hospitalization, intravenous fluid and antibiotics, one of them required nephrostomy tube placement and non-experienced major complications.

DISCUSSION

ESWL and URSL are two frequently used and effective options for the treatment of ureteral calculi. Selection between these two options depends on the equipment available, the techniques of the operator and his expertise in this field(41). Since 1980s, ESWL has been applied extensively in the treatment of ureteral calculi, and is regarded as an effective and non-invasive treatment approach. No ureteral stents are needed and patients can be treated without being hospitalized. The disadvantage of ESWL is its inconsistent rate of stone evacuation, between 56%-93%, and retreatment rate of 10%-30%(42). In the ESWL group, the fourth-week stone evacuation rate was 78.1% postoperatively, and the retreatment rate was 11.9%, which conformed to published data to date. Complications of ESWL included hematuria, ureteral constriction (3.8%) and urinary tract infection (1.9%). ESWL is thus not yet a treatment that is completely non-invasive. To minimize possible injury, stroke times and discharge voltage were controlled in this study. Generally speaking, ESWL was performed less than four times in each case with an interval of

1-2 weeks, stroke times in the range of 2500-3000 and discharge voltage set below 15 kV. Pronation has been proved to be the optimal position for ESWL to avoid accentuation of the shock wave energy being absorbed by the pelvis(43). Patients with urinary tract infection or stones larger than 15 mm in diameter were medicated with antibiotics before treatment to prevent postoperative infection(44,45). Ureteroscopic lithotripsy of lower ureteral calculi may reduce the necessity of open surgery. Compared with ESWL, its advantage lies in higher rate of stone evacuation. As reported, ureteroscopic treatment of lower ureteral calculi is 96%-97%(46). In the URSL group, the rate was 93.3%, as compared with 78.1% in the ESWL group. For long-existing stones, ureteral adhesion and even polyps may be present, which is hard to eliminate with ESWL but can be solved effectively with calculus pincers in ureteroscopy. Ureteral "stone steps" formed after ESWL can also be solved by ureteroscopy(47,48). Reports in China document the incidence of complications of lower ureteral calculi to be 2%-8%, mainly consisting of injuries to the ureter such as perforation and laceration, hematuria and ureteral constricture. All of these complications can occur due to unskillful practices. There were 6 cases (3.3%) of ureter perforation and 4 cases (2.2%) of ureteral constriction in the URSL group. Thus, ureteroscopy strictly demands gentle operation techniques and clear view of the calculi in order to avoid ureteral injury. If ureteral perforation or laceration is found, a double J tube needs to be indwelled for one week(49,50). In our study the success rate decreases as the stone size increases. It decrease from 76% to patients with stone <10 mm to only 52% to patients with stone > 15mm. which is comparable to other studies like that done by K H Yip et al who cited that ESWL provide optimal first line treatment for calculi <10 mm with success rate about 77%, however its much lower than that done by Ibrahim F. Ghalayini et al who reported success rate about 80%. And that done by Riyadh F. Talic et al who reported stone-free at 3 months were (81.3%). The variation in the result could be related to many factors first of all the time of therapeutic intervention, the sooner therapy is initiated the more stones that might have passed, second is the type of lithotriptor used, number of shock wave and ability to effectively localized and target a stone under treatment. Another factor stone composition probably there is a regional variation in stone composition which may mad is ESWL recalcitrant , however most of ureteral calculi are secondary to renal calculi so the composition of stone affect the overall success rate of lithotripsy in urinary calculi and not only the ureteric stone but it is well documented that cystine stone and calcium monohydrate are recalcitrant to lithotripsy(51,52).

Conclusion

ESWL is safe, effective, noninvasive and a convenient way of treatment for upper ureteral stones. The clearance rate reach 64%. ESWL being an outpatient procedure without any need for anesthesia or any pretreatment intervention, it should be considered as the first line of treatment for all stones in the upper ureter. The clearance rate for small stones (<10mm) in the upper third of the ureter was 76% in our study and for these, ESWL may be considered as a primary therapy. For stones larger than 15 mm in the upper third of the ureter, the clearance rate was low. When choosing an optimal treatment modality for ureteral stones, many variables have to be

taken into consideration, including the stone size, composition, and location, anatomical abnormalities, operator skill and experience, patient preferences, the financial status of the patient, the wide variety of extracorporeal lithotriptors, available endourological equipment, anesthesia risks, the need for hospitalization and convalescence period, and reimbursement from health care systems. Weighing these variables, urologists should inform patients of the advantages and disadvantages of each treatment modality, and decide what the best treatment is for each individual patient.

TABLES

Table 1: success rate in relation to stone size

Size of the stone	Success rate %	No.	Total no.	%
<10mm	76%	42	55	48%
10-15mm	54%	20	37	32%
>15mm	52%	12	23	20%
	64.3%	74	115	

Table 2: No. of sessions required for successful therapy in relation to stone size.

	No. of patients	%	Group A	Group B	Group C
1st session	47	63%	34 patients (72.5%)	9 patients (19%)	4 patients (8.5%)
2nd session	18	24%	8 patients (44.4%)	7 patients (39%)	3 patients (16.6%)
3rd session	9	12%	5 patients (55.5%)	2 patient (22.2%)	2 patient (22.2%)

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فعالية الموجات الصدمية الموجهة من خارج الجسم في علاج حصاة اعلى الحالب

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الخلاصة

في مستشفى الامام الحسين عليه السلام التعليمي في ذي قار وللفترة الواقة بين اذار ٢٠٠٩ الى حزيران ٢٠١١ تم معالجة ١١٥ مريضا ٨٣ منهم ذكوراً متوسط اعمارهم ٤٨ سنه والباقي ٣٢ اناثا متوسط اعمارهن ٥١ سنه يعانون من حصاة في اعلى الحالب بواسطة التفتيت بالموجات الصدمية.

تم تعريض المرضى لجلسات متعددة اقصاها ثلاث جلسات و تبعاً لاستجابة الحصاة للعلاج فاذا اخذ المريض العلاج لمدة ثلاث جلسات و بالمدة الكافية من حيث عدد الضربات و قوة الفولتية اللازمة للجلسة الواحدة و لم تتفتت الحصاة بعد مرور ثلاثة اشهر من المتابعة تعتبر طريقة العلاج غير ناجحة.

فكان القسم الاكبر من هؤلاء المرضى ٦٤,٣ % استطاعوا التخلص من الحصاة نهائياً في حين ٣١,٥ % لم تنجح معهم طريقة العلاج مما اضطرنا إلى استعمال طرق أخرى كالعلاج بالمنظار او الجراحة الاعتيادية.

لو امعنا النظر في نتائج هؤلاء الذين استجابوا للعلاج للاحظنا بان معظمهم (٧٦%) هم من فئة المرضى الذين لديهم حصاة صغيرة الحجم اقل من ١٠ ملم. و تقل نسبة النجاح كلما ازداد حجم الحصاة لتصل إلى ٥٢% فقط للفئة الذين لديهم حصاة اكبر من ١٥ ملم.

كذلك نلاحظ بان معظم المرضى(٦٣ %) الذين استجابوا للعلاج يحتاجون إلى جلسة واحدة و اغلبهم من فئة المرضى ذو الحصاة صغيرة الحجم (اقل من ١٠ ملم)، في حين احتاج ٢٤% من المرضى إلى جلستين و الباقي ١٢% احتاجوا إلى ثلاث جلسات.

كانت مضاعفات العلاج بطريقة الموجات الصدمية الموجهة من خارج الجسم قليلة و بسيطة و تم علاجها بسهولة .

من كل هذا نستطيع القول ان طريقة العلاج بالموجات الصدمية تعتبر طريقة فعالة و يمكن استعمالها كطريقة اولية في علاج حصاة اسفل الحالب.

فالموجات الصدمية تجنب المريض الرقود في المستشفى لمدة ايام عديدة حيث يتم العلاج في العيادة الاستشارية ليستطيع المريض العودة إلى بيته مباشرة بعد العلاج و تجنبه التعرض إلى التخدير العام و مشاكله خاصة في المرضى الذين لديهم حالات مرضية تزيد نسبة خطورة العملية عند تعرضه إلى التخدير العام . كذلك تجنب المريض مشاكل الجروح و التآمها ج حصاة الحالب لا يعول عليها كثيراً خاصة عند مقارنتها بالعلاج بمنظار الحالب. ، لكن فعالية الموجات الصدمية في علا فهذه الطريقة الاخيرة والتي ايضاً تعتبر طريقة حديثة اذا ما قورنت بالطرق الاخرى كالجراحة، ربما تعطي نتائج احسن من العلاج بالموجات الصدمية على الرغم من كون العلاج بالمنظار اكثر تداخلاً و يحتاج إلى خبره في هذا المجال وكذلك يحتاج إلى التخدير العام.

و مع كل هذا لا يزال التساؤل قائما إلى يومنا هذا عن الطريقة المثلى و التي تعتبر افضل الطرق في علاج حصاة الحالب هل هي العلاج بالموجات الصدمية ؟ او بواسطة منظار الحالب؟ حيث ان لكل طريقة محاسنها و مساوؤها.

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