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ORIGINAL PAPER

Urgent ureteroscopy as first-line treatment for ureteral stones: a meta-analysis of 681 patients

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Abstract There are various recent studies on the use of ureteroscopy and debate on whether this should be the first-line treatment for patients with ureteral stones. The aim of this meta-analysis was to understand the role of this surgical procedure in the emergency setting as first-line treatment and to compare the immediate procedure with a delayed one in terms of stone-free rate and complications. A bibliographic search covering the period from January 1980 to March 2010 was conducted in PubMed, MEDLINE and EMBASE. This analysis is based on the six studies found that fulfilled the predefined inclusion criteria. A total of 681 participants were included. The number of participants in each of the studies considered ranged from 27 to 244 (mean 113). Stone-free rates were 81.9% (72.0–91.8) for the proximal ureter, 87.3% (82.6–92.0) for the mid-ureter, 94.9% (92.1–97.6) for the distal ureter and 89.5% (86.5–92.5) overall according to the logistic regression applied. These values are not statistically significantly different from those reported in the AUA and EAU guidelines. The stone diameter seems to affect the stone-free rate. An increase of the stone diameter of 1 mm beyond 8 mm corresponded to a reduction of stone-free rate of 5% (2.4–8.0) and 8.1% (3.8–12.1) for the distal and proximal ureters, respectively. There is a complete lack of information in international guidelines on the ureteroscopic management of ureteral stones in an emergency setting and the currently available results are dispersed in a few studies in the literature. The rationale for using emergency ureteroscopy is more rapid stone clearance and relief from colic pain. According to our meta-analysis, immediate ureteroscopy for ureteral stone colic seems to be a safe treatment with a high success rate. This evidence will be validated by further randomized studies, with larger series of patients.

Keywords Urgent · Emergency · Ureteroscopy · Ureteral stone · Ureter · Stone · Renal colic · Hydronephrosis

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Introduction

Renal colic accounts for about 1% of all emergency department visits and 1% of hospital admissions. In approximately 95% of the patients, renal colic is caused by stones. This is of great public health importance, given that the lifetime risk of urolithiasis is estimated to be between 5 and 12% in Europe and in the United States, and that about 50% of patients will have a recurrence of renal colic within 5 years of their first episode [1, 2].

The goal of treatment of patients with renal colic is symptomatic relief, in the absence of indications for immediate intervention (such as uncontrolled pain, inadequate renal function, clinical evidence of sepsis or perinephric urine extravasation). In these cases, the placement of a ureteral catheter or a nephrostomy tube is the next step that can provide prompt relief [3]. The management of the stone is usually delayed and includes simple follow-up in patients treated with medical expulsive therapy, extracorporeal shockwave lithotripsy and ureteroscopy.

Recently different works have described the use of ureteroscopy and debated on whether it should be a first-line treatment for patients with ureteral stones [4–10]. The rationale of these studies is related to the improvements in endoscopic instruments and techniques which have made ureteroscopy a safe and highly successful procedure, reducing its complication rates.

The aim of this meta-analysis was to understand the role of this surgical procedure in the emergency setting as first-line treatment and to compare the immediate procedure with the delayed one in terms of stone-free rate and complications.

Materials and methods

The clinical outcomes of interest were stone-free rate and the number and type of complications.

Evidence acquisition

Search strategy

Studies were identified by searching electronic databases and scanning reference lists of articles. A bibliographic search covering the period from January 1980 to March 2010 was conducted in PubMed, MEDLINE and EMBASE. Additional hand searches of the reference lists included studies, reviews, meta-analyses and guidelines on ureteroscopy in an emergency setting (all the surgical procedures were performed within the first 24 h after admission). The following search terms were used in each case: lithiasis, ureter, ureteral lithiasis, ureteroscopy, emergency and urgency. The searches were restricted to publications in English.

Study selection

Studies were excluded if they were case reports, meeting abstracts or conference proceedings. Identified studies were reviewed and selected if they reported the outcome of ureteroscopy performed as first immediate treatment in an emergency setting (within 24 h of admission to the emergency room). Studies were included or excluded with a hierarchical system based first on the title of the report, then on the abstract, and finally on the contents of the full text. A study was accepted for inclusion on the basis of agreement of two investigators (SP and CR); any disagreement on study inclusion was resolved by consulting a third investigator (LC).

Database searches yielded 31 references. Exclusion of irrelevant references left eight references describing studies. We excluded two further references because they were not in English. This analysis is based on the six remaining studies which all fulfilled the predefined inclusion criteria [5–10].

Data extraction and assessment of quality

One author (SP) extracted data from the included studies and entered them into the data extraction form. A second author (CR) checked the extracted data to ensure data quality. Disagreements were resolved by discussion between the two review authors; if no agreement could be reached, it was planned that a third author would decide (LC). The quality of studies was scored using the methods of the US Preventive Services Task Force. The US Preventive Services Task Force classifies a study as "good" if it evaluates relevant available screening tests, uses a credible reference standard, interprets the reference standard independent of the screening test, shows reliability of the test assessed, has few or handles indeterminate results in a reasonable manner and includes a large number of patients (more than 100 broad-spectrum cases); as "fair" if it evaluates relevant available screening tests, uses reasonable although not best standards, interprets the reference standard independent of the screening test, has a moderate sample size (50–100 subjects) and a "medium" spectrum of patients; and as "poor" if it has a fatal flaw such as using an inappropriate reference standard, administering a screening test improperly, biased ascertainment of a reference standard, and has a very small sample size or very narrow, selected spectrum of patients. Three studies included in the meta-analysis were classified as good, two as fair and one as poor.

Statistical analysis

The stone-free rate following emergency use of ureteroscopy was analyzed using logistic regression; the expected stone-free rate is reported as a percentage with 95% confidence limits for the different position of the stone (proximal, mid or distal ureter). Subsequently, the effect of stone size was also investigated by means of logistic regression; when statistically significant, the expected reduction of stone-free rate is reported as percentage point for a given increase of stone diameter of 1 mm. All logistic regression-based approaches were corrected for over-dispersion using deviance or Williams criterion when appropriate [11]. To investigate to what extent the position of the stone could influence the subsequent stone-free rate, a meta-analysis approach was applied; for this analysis a random or fixed effect model was used according to the heterogeneity among studies (a random effect model was used when the I-square was greater than 50%) [12]. Both visual inspection of the funnel plot and Harbord and Egger tests were used to evaluate the effect of small studies and publication bias [13].

All statistical evaluations were performed using SAS version 9.1.3. and by RevMan 5.0. An α level of 0.05 was considered as statistically significant.

Results

Analysis of the database

Table 1 summarizes all the included studies on the use of ureteroscopy as first-line treatment in an emergency setting [5–10]. Overall, there were 681 participants in the six studies considered in this meta-analysis. The number of participants in each study ranged from 27 to 244 (mean 113). All the studies were published after 2000. Two studies were from China, while Jordan, Turkey, Portugal and Italy each provided one study. Enrolment started in 2002 and ended in 2010. The time interval in which patients were recruited in different studies varied between 1 and 7 years.

Table 1 Summary of studies included in the meta-analysis regarding the use of ureteroscopy in an emergency setting as first-line treatment

Authors, year	Nation	Enrolment time	Patients, total
Osorio, 2007 [5]	Portugal	2002–2004	144
Jiang, 2008 [6]	China	2002–2005	27
Yang, 2010 [7]	China	2005–2008	49
Al-Ghazo, 2011 [8]	Jordan	2003–2010	244
Sarica, 2011 [9]	Turkey	2008–2009	76
Guercio, 2011 [10]	Italy	2008–2009	141

The database was divided into the following section:

- general information about the study including the authors, publication year, nationality of the study, interval of time in which the subjects were enrolled, total number of patients, gender and age (range and mean);
- inclusion and exclusion criteria, presence of unilateral or bilateral ureteral lithiasis, stone diameter, stone location (proximal, mid or distal ureter);
- type of surgical procedure, type of stone fragmentation device, antibiotic prophylaxis, anaesthesiological technique and time of surgical procedure;
- number of procedures, successful procedure, post-operative and late stone-free rate, number and type of complications, stone migration rate, use of post-procedural stenting (double and single J stents) and time to removal.

Patients' characteristics

Four studies reported the patients' gender: in these four studies there were 302 males and 189 females with a male to female ratio of 3 to 2. All studies reported the participants' age: the mean age was 46.9 years and the range was between 17 and 92 years. Sixty-one patients presented with bilateral stones and 620 with unilateral lithiasis. The total number of stones treated was 742.

Indications and inclusion criteria for the surgical procedure

Patient underwent an emergency procedure if they had:

- pain resistant to medical therapy with no infection, no acute renal failure, first time at emergency department and ureteral calculus of up to 20 mm [5];
- postrenal acute renal failure [6, 7];
- pain resistant to medical therapy with no infection, no acute renal failure, first time at emergency department and stone size above 7 mm [8];
- ureteral stones bigger than 5 mm in which shockwave lithotripsy was not successful and/or available and obstructing ureteral stones with solitary functioning kidneys [9];
- acute flank pain caused by a ureteral stone (at least 5 mm) with hydronephrosis [10].

Surgical procedure

All the procedures were carried out under spinal or general anaesthesia. In three studies stone lithotripsy was performed with an Ho:YAG laser, in two with a pneumatic

device (lithoclast) and in one study with both methods. No patients were inoperable. No endoscopic procedure was converted into an open one. Three studies reported the mean procedure time which was 36.4 min (range 13–80 min). A double J ureteral stent was inserted in 316 patients, while in 134 patients a single J stent was inserted and removed 24 h after the surgical procedure.

Assessment of small studies and publication bias

Visual inspection of funnel plots and Harbord and Egger tests agreed in showing a strong small study and publication bias for comparisons of stones in the distal and mid-ureter versus those in the proximal ureter, but not for comparison of stones in the distal versus mid-ureter (Fig. 1).

Stone-free rates

According to the logistic regression applied, stone-free rates were 81.9% (72.0–91.8) for the proximal ureter, 87.3% (82.6–92.0) for the mid-ureter, 94.9% (92.1–97.6) for the distal ureter and 89.5% (86.5–92.5) overall. These values are not statistically significantly different from those described for this type of procedure in the AUA and EAU guidelines [14]. In particular the p value was not statistically significant when compared to the overall rate and for lithiasis in the proximal, mid and distal ureters. Figure 2 shows the variability of the stone-free rate in the different studies with respect to the value generally reported in the international literature.

The stone diameter seems to affect the stone-free rate in patients treated with urgent uteroscopy as first-line therapy. An increase of the stone diameter of 1 mm beyond 8 mm corresponded to a reduction of stone-free rate of 5% (2.4–8.0) and 8.1% (3.8–12.1) for stones located in the distal and proximal ureters, respectively. The same effect was not confirmed for stones located in the mid-ureter.

The meta-analysis showed that the position did not influence stone-free rates.

Complications

Complications were divided into fever, sepsis, perforation, avulsion, fracture, haematuria, perinephric haematoma, and ureteral stenosis, for which repeats have been reported in 8, 2, 17, 1, 0, 6, 1, 2 patients. A total of 52 complication occurred in 681 patients, this means a ratio of 7.6%.

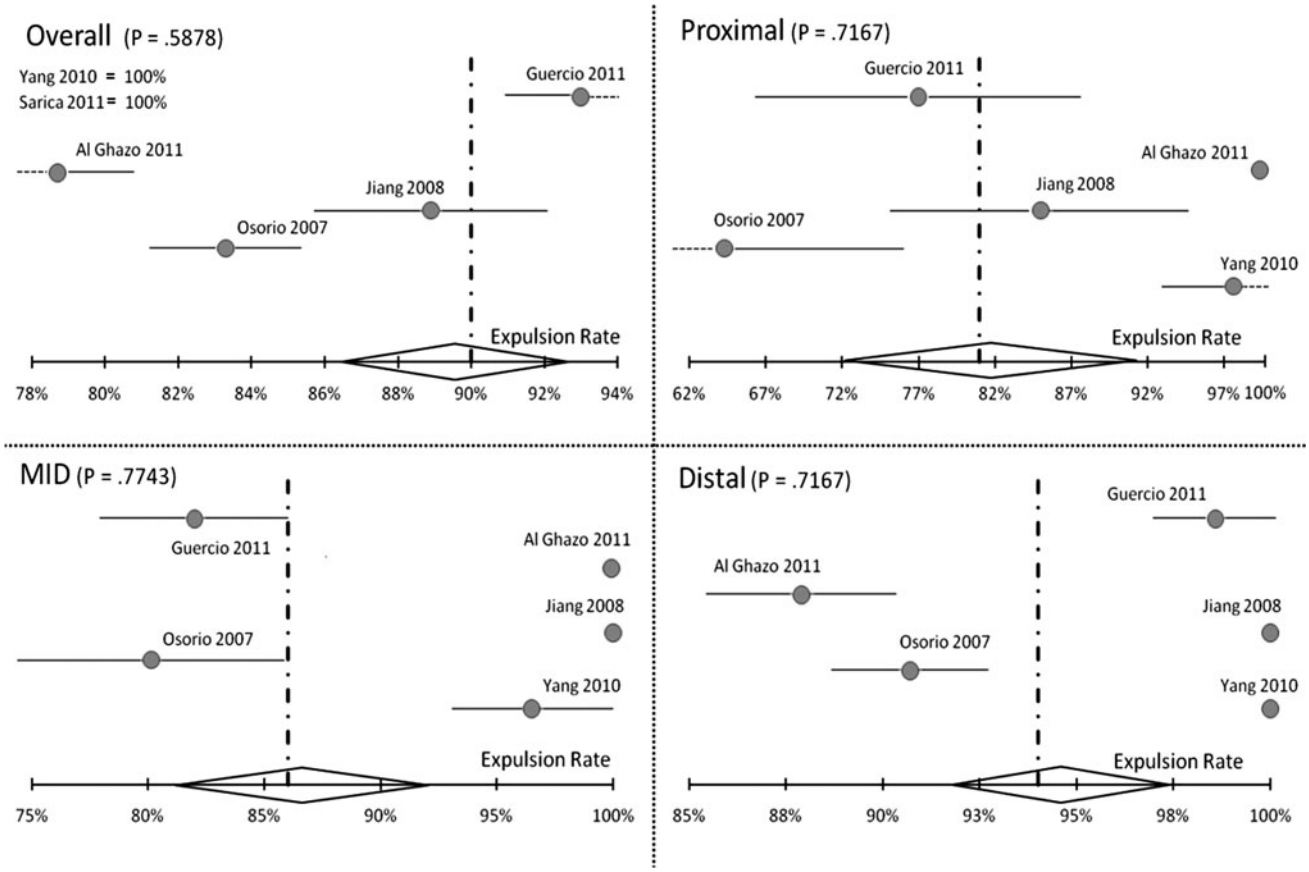

Fig. 1 Meta-analysis of differences in stone position rates. Funnel plots, Harbord and Egger tests are reported on the left side of the panel

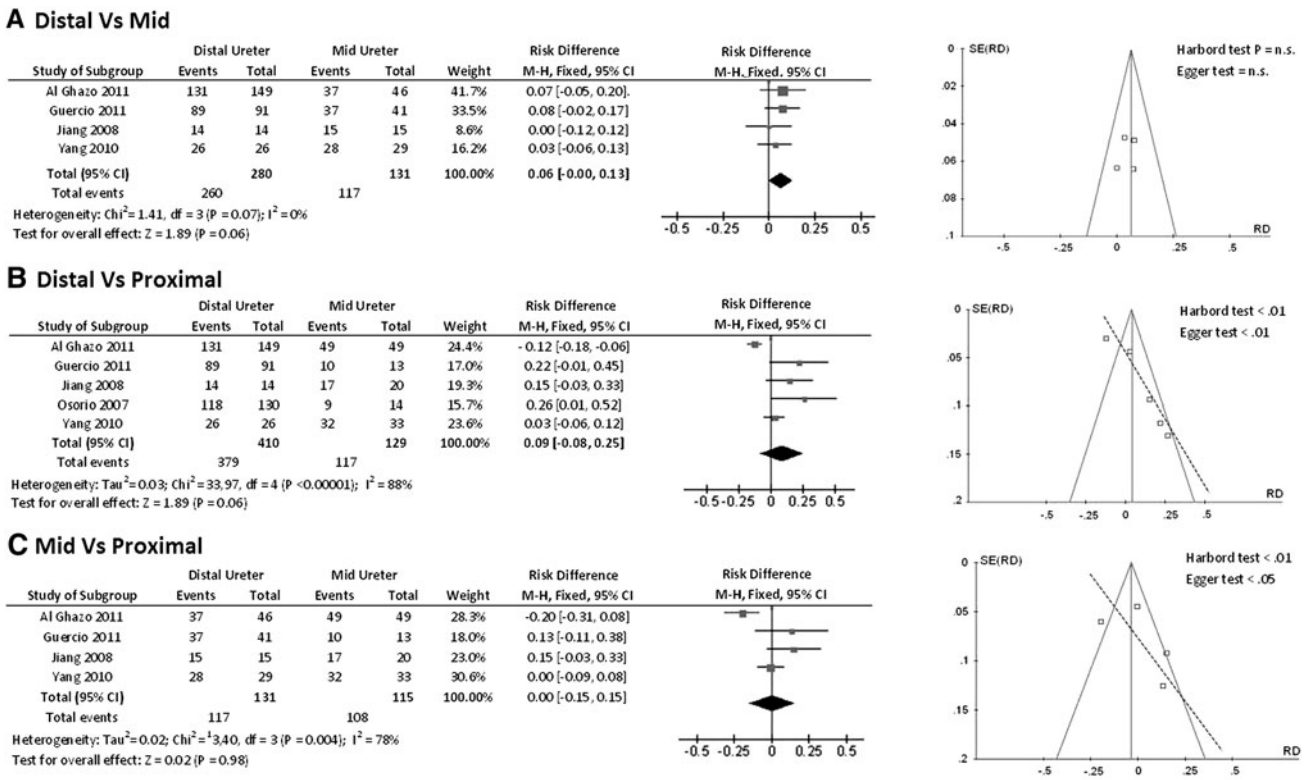

Fig. 2 Comparison between expulsion rates in emergency and AUA-EUA guidelines

Discussion

There are no conclusions on the ureteroscopic management of ureteral stones in an emergency setting in the international guidelines and the results available on this strategy are dispersed in the literature. Improvements in ureteroscope design, probes, and stone extraction devices have clearly played an important role in the advancement of upper urinary tract endoscopic surgery. Likewise, the introduction of holmium:yttrium–aluminum garnet (Ho:YAG) laser lithotripsy has increased stone-free rates while decreasing the risk of complications significantly.

Compared with medical expulsive therapy and extracorporeal shockwave lithotripsy, the rationale of emergency ureteroscopy is more rapid stone clearance and relief from colic pain. Although ureteroscopy is a more invasive treatment option than medical expulsive therapy and shockwave lithotripsy, the success rate of the latter is probably lower, especially for mid and distal ureteral stones.

The choice of therapeutic approach depends on the diameter and location of the stone, the onset of symptoms, presence and degree of obstruction, the patient's wishes, the urologist's preference, lithotriptor availability, the patient's status, comorbidities, use of anti-aggregant and anticoagulant medications, and the presence of complications such as uncontrolled pain, inadequate renal function, clinical evidence of sepsis or perinephric urine extravasation.

Most ureteral stones can be observed with a reasonable expectation of uneventful stone passage, and this strategy is generally less costly and less invasive than any other option, if successful [15]. We recently reported the results of a meta-analysis showing that the use of medical expulsive therapy, with analgesics, antispasmodic agents (tamsulosine and nifedipine), anti-inflammatory drugs, adequate hydration, and antibiotics, gives the patient the chance of a spontaneous passage of the stone [15]. We demonstrated that medical expulsive therapy could be proposed as a treatment for patients with ureteral calculi who are amenable to a waiting management. Benefits associated with medical expulsive therapy are a shorter time to spontaneous stone expulsion and less need for analgesic drugs and hospitalisation for treatment. In four of the studies in which this meta-analysis is based, the use of medical expulsive therapy as first-line treatment was an exclusion criterion [5–8]. In fact these four articles reported a clinical situation to be managed with immediate surgical treatment. In these cases the standard first-line approach in the management of symptomatic ureteral stones is relief of obstruction by the insertion of a nephrostomy tube or double J stent [3].

Regarding the success rates for ureteroscopy, the American/European Urological Association ureteral stones guidelines panel summary report described an overall stone-free rate of 90% for ureteral stones [14]. In the current meta-analysis, independent of many factors, the overall stone-free rate was 89.5%, implying a high rate of successful stone removal with a reasonably low complication rate of 7.6%. It can, therefore, be concluded that urgent removal of ureteral stones by ureteroscopy can constitute an effective therapy when used in selected cases.

The possible reasons leading urologists to use this surgical approach were to save patients from prolonged anti-inflammatory and analgesic medication against possible additional colic attacks and the relatively longer hospitalization period (including visits to the emergency department), which implies less loss in working days and social activities for the patients. Another advantage is the limited need for auxiliary procedures because of the short period the stone remains in the ureter and the consequent lower incidence of stone-induced alterations in the ureteral wall (e.g. oedema formation, bleeding). However, the disadvantage of this strategy is the decreased chance of conservative management with spontaneous passage of the stone, thereby exposing patients to potential surgical and anaesthesiological risks associated with overtreatment. Furthermore, the routine placement of a ureteral stent after ureteroscopy, which is widely recommended in order to reduce postoperative pain, prevents ureteral obstruction at the stone impaction site and facilitates the passage of the remaining small fragments of stone, it could increase the post-operative morbidity of such active treatment by causing symptoms of irritation and episodes of haematuria and colicky pain.

According to international guidelines, the initial management for patients who have a newly diagnosed ureteral stone of lesser than 10 mm in diameter may be observed with strict clinical and radiological surveillance [3]. As we previously reported for medical expulsive therapy, also for first-line therapy with urgent ureteroscopy we noted that the stone diameter seems to affect stone-free rates. An increase of the stone diameter of 1 mm beyond 8 mm corresponded to reductions of stone-free rate of 5% (2.4–8.0) and 8.1% (3.8–12.1) for the distal and proximal ureter, respectively.

Conclusions

Besides the influence of stone position and size, the efficiency of ureteroscopy depends on the experience and skill of the operating urologist and better outcomes are obtained by surgeons with more experience. According to our meta-analysis, immediate ureteroscopy for ureteral stones seems to be a safe treatment with high success rate. This evidence needs to be validated by further randomized studies on larger series of patients. Such studies would be able to determine the economic benefits of emergency ureteroscopy in terms of decreased drug administration, less need for clinical surveillance, and earlier return to work and daily activities.

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