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Stone Disease

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Article info

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Abstract

Objectives: The purpose of this review is to discuss the major findings presented at the ''New Horizons in Urology'' closed expert meeting, held October 2006 in Marbella, Spain, on improving the management of stone disease (renal and ureteral stones), and to summarise the consequences of these findings on improving current practice in managing stone disease.

Methods: Approximately 135 European urologists attended the meeting. Data and papers discussed in recent congress meetings in 2006 were considered. Experts in the field of stone disease selected and discussed the most relevant new findings. Furthermore, the delegate's opinion on representative clinical case studies was assessed by interactive voting. An expert panel commented on voting results.

Results: At the meeting, it was highlighted that stones that fail to pass spontaneously in a reasonable time can be treated by minimally invasive surgical procedures including extracorporeal shock wave lithotripsy (SWL), ureteroscopy (URS), and percutaneous nephrolithotomy (PNL). The choice of treatment largely depends on the size and location of stones. However, treatment with URS is more frequently used for managing stone disease, and the number of SWL therapies is decreasing. Furthermore, the use of α_1-adrenoceptor antagonists as medical expulsive therapy has been shown to increase the expulsion rate and decrease the time until the stone is passed.

Conclusions: Minimally invasive surgical procedures such as SWL, URS, and PNL have been widely adopted for stone removal, with each approach having its own advantages and disadvantages.

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1. Introduction

Stone disease is more and more common, at least in the Western countries. Over the past 22 yr, there has been a marked increase in the prevalence and incidence of stone disease in Germany [1], with 200,000 stone recurrences per year. Costs for removal of these stones amount to 2500 € per patient [2]. Up to 30% of all urologic patients are stone patients, resulting in a large effect on the health care system [3].

Each type of kidney stone has a different cause. Stones are classified according to their chemical composition. Approximately 80% of all kidney

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stones are calcium oxalate stones, which are the most problematic [4]. The formation of these stones may be caused by genetic factors. However, more important are dietary and lifestyle factors, and the results of acquired metabolic defects leading to crystal formation and growth of a kidney stone. A less common type is the struvite stone, which is caused by infection in the urinary tract. The uric acid stones are another type of stone, whose frequency is decreasing more and more, probably because of dietary effects. Cystine stones are the rarest type of stone, affecting 1–2.5% of patients. When performing flexible ureterorenoscopies or nephroscopies, white plaques or microcalcifications have been described in the renal papillae. These plaques, also called Randall's plaques, were believed to be the nidus upon which calcium oxalate stones arose. Even 80 yr after the first description, how and where these stones develop are still not definitively known. The work by Evan et al [5] has shed new insights. Microscopically, they demonstrated that, in patients with an idiopathic hypercalciuria, the stones are not formed inside the renal tubules but are extratubular, close to the renal papillae. The plaques originate in the basement membranes of the thin loops of Henle. In contrast, patients who have undergone an intestinal bypass operation or who developed severe hyperoxaluria do not produce such plaques, but form intratubular stones in the collecting ducts.

2. Management of patients with stone disease

Management of stone disease largely depends on the size and location of stones. Stones smaller than 5 mm that were more distal and on the right side have a high probability of spontaneous passage. However, spontaneous stone passage may take up to 40 d [6]. During this watchful waiting period, patients can be treated with hydration and with pain medications to control pain. In contrast, stones larger than 5 mm, stones in patients with a higher risk of developing renal insufficiency (eg, patients with a single kidney), or stones that fail to pass through should be treated by some interventional procedures including extracorporeal shock wave lithotripsy (SWL), ureteroscopy (URS), or percutaneous nephrolithotomy (PNL).

2.1. *Medical therapy for removal of ureteral stones*

The past decade has seen a resurgence of interest in conservative treatments. De Sio et al [7] recently demonstrated that addition of the α_1-adrenoceptor (AR) antagonist tamsulosin to standard medical therapy significantly increases the expulsion rate ($p = 0.01$) and decreases the expulsion time ($p = 0.005$), described as the time until the stone is passed. In this study, 96 patients with distal ureteral stones of 10 mm or smaller were randomly divided into two groups and received standard therapy (diclofenac 100 mg/d and aescin 80 mg/d) ($n = 46$) or standard therapy combined with 0.4 mg tamsulosin daily ($n = 50$) for a period of 2 wk. The stone expulsion rate was 90.0% (45 of 50 patients) in the group who received tamsulosin with standard therapy and 58.7% (27 of 46 patients) in the group who received standard therapy as sole therapy with a mean stone expulsion time of 4.4 versus 7.5 d, respectively. The addition of tamsulosin resulted in lower use of analgesics ($p = 0.003$) and fewer hospitalisations for recurrent colic ($p = 0.01$). These positive results support the use of an α_1-AR antagonist in the management of distal ureteral stones.

2.2. *Extracorporeal SWL for removal of renal and ureteral stones*

Since the introduction of SWL for the removal of stones, this procedure has been optimised, and new instruments were developed to increase usability by the urologists and to improve tolerability for the patient. This higher treatment comfort includes less pain, no need for general anaesthesia, and treatment on an outpatient basis. One study [8] indicates that the original instrument for SWL, the HM3 lithotripter, yields the best outcome regarding the stone-free rate 1 d after treatment and may still be better than newer instruments such as the LSP and SLX lithotripters. Therefore, they concluded that newer instruments are not always better.

The SWL procedure is the most widely used method for managing renal and ureteral stones. However, treatment success rates depend on stone composition, size, and location, as well as instrument type and shock frequency. It was shown recently that the treatment outcome following SWL could be improved when the patient is additionally treated with α_1-AR antagonists. A double-blind, randomised placebo-controlled study presented at the AUA 2006 meeting provided evidence that supportive treatment of 30 patients with the α_1-AR antagonist tamsulosin (0.4 mg once daily) following SWL for removal of renal and ureteral stones significantly increased the stone clearance ($p < 0.019$) (Fig. 1a) and reduced the analgesic requirement ($p < 0.005$) (Fig. 1b). Treatment continued until stone clearance or for a maximum of 30 d [9]. Moreover, recently published

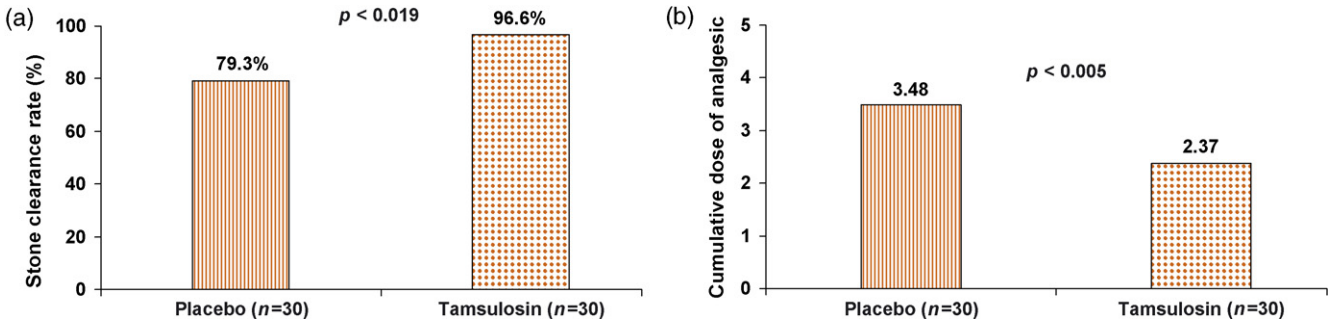

Fig. 1 – The α_1-adrenoceptor (α_1-AR) antagonist tamsulosin following extracorporeal shock wave lithotripsy (SWL) increased renal and ureteral stone clearance (a) and reduced analgesic requirement (b).

clinical data suggest that the stone-free rate is higher if you treat the patient with a lower shock wave frequency (60–90 shocks per minute) than with a higher frequency (120 shocks per minute), particularly for larger stones (>10 mm) [10–12]. In contrast, Krambeck et al [13] reported that SWL for the management of renal and proximal ureteral stones is associated with long-term adverse medical effects such as diabetes mellitus and hypertension at a follow-up of 19 yr. Questionnaires focussing on possible adverse medical effects were sent to 578 patients who underwent SWL performed with an HM3 lithotripter in 1985; 59% of contacted patients completed the survey. The development of hypertension and diabetes was significantly higher ($p = 0.034$ and $p < 0.001$, respectively) for the SWL-treated patients than in the control group or for patients who were treated nonsurgically. However, the study has significant drawbacks, and we have to remember that most patients who form stones are metabolic risk patients, and that hypertension and diabetes could be associated with the occurrence of stones. Meanwhile, a multicentre study has started in Germany to investigate this aspect.

2.3. *URS for removal of ureteral stones*

In addition to SWL, other interventional procedures such as URS have been developed and improved for removal of ureteral stones. The new generation of ureteroscopes are flexible, smaller in diameter, stiffer, and more durable, and have an improved tip deflection. Of the many laser systems that have been used for stone fragmentation, the holmium-yttrium-aluminum-garnet laser is today the gold standard for intracorporeal lithotripsy. Furthermore, there are new tools for stone extraction such as the Nitinol baskets [14–18]. These improvements resulted in a change in the management of ureteral stones. An important trend in stone therapy is the increasing use of URS, whereas the use of SWL is decreasing. Besides the availability, the major advantages of SWL in the treatment of distal ureteral stones are its noninvasive nature and the possibility to complete the treatment without the need for regional or general anaesthesia. An important drawback, however, is that this method results in a higher retreatment rate in a substantial proportion of patients [19]. In comparison with SWL, the URS procedure is more cost-effective, and results in a higher and faster stone-free rate. In addition, sometimes it is easier with URS to locate a stone [14,20,21]. Recently, Honeck et al [21] performed a prospective, nonrandomised study to determine the appropriate first-line treatment modality for distal ureteral stones. A total of 124 patients with distal ureteral stones were enrolled into the study; 62 patients were treated with SWL and 62 patients with URS. The average stone size was 6.9 mm for SWL and 7.2 mm for URS. The authors demonstrated that both procedures could induce a high stone-free rate 7 d after treatment. However, patients treated with SWL reached an 84% stone-free rate, whereas patients treated with URS reached almost a 100% stone-free rate within 7 d. These results show a significant treatment success ($p = 0.005$) in favour of URS.

Several data indicate that URS as well as SWL can be used for the treatment of ureteral stones, depending on the size and location of the stones. For larger distal ureteral stones, URS should be recommended, but for smaller stones it seems that both procedures have a comparable efficacy [19]. In contrast, for proximal ureteral stones, URS might be superior to SWL, but for smaller stones SWL would be preferable because of the lower degree of invasiveness. Last but not least, Lingeman [22] cited that ''if one had to choose an indispensable tool for urolithiasis management, the ureteroscope and a holmium laser might be a better choice than an SWL.'' However, URS remains more invasive than

SWL. Therefore, the final decision on the appropriate treatment should be based on individual experience, available equipment, and patient's preference.

2.4. PNL for removal of renal stones

This approach was established as a minimally invasive treatment modality for removal of larger kidney stones. Improvements in instruments and lithotripsy technology including ultrasound have expanded the capability of percutaneous stone disintegration. Recently, Oman et al [23] conducted a study including 315 patients with renal and/or impacted proximal ureteric stones, which were treated with combined ultrasound/fluoroscopy-guided PNL. The mean stone size was 27 mm. Four weeks after treatment, the total stone-free rate was 96.5%, with 45.7% of all patients being primarily stone-free immediately after one PNL, and 21.3% having clinically insignificant residual stones that passed spontaneously. In summary, 67% of the patients were sufficiently treated by one procedure, but 33% of the patients needed secondary measures after one PNL. There were complications in only 50.8% of the present procedures. Most complications were clinically insignificant and could be managed conservatively. These data suggest that PNL is a highly efficient procedure that provides fast and safe stone removal.

The most difficult location of stones is in the lower pole of the kidney. The management of these lower pole stones is controversial. Two prospective, randomised studies about the efficacy of stone removal for the treatment of lower pole stones have been published. The first study treated 122 patients with lower pole stones of approximately 14 mm either by SWL ($n = 64$) or PNL ($n = 58$). They clearly showed that PNL is superior ($p < 0.001$) to the SWL procedure regarding the stone-free rate at 3 mo after treatment (Fig. 2) [24]. As expected, SWL had a lower risk of complications than PNL (11% vs. 22%); however, this difference was not statistically significant. In the second study, 67 patients with lower pole stones less than 10 mm were treated either by SWL ($n = 32$) or flexible URS ($n = 35$) [25]. They did not describe a significant difference ($p = 0.92$) between both procedures regarding the stone-free rate (35% vs. 50%, respectively). This finding can be explained by the fact that the patients are treated in 19 institutions with different physicians and equipment.

These results indicate that PNL as well as SWL could be used for removal of renal stones. The choice of treatment depends on the size of the stones. For large renal stones of more than 2 cm, PNL might be superior to SWL, but for small stones SWL might be the method of choice [19]. Intermediate stones of 1 to 2 cm should be treated with SWL and prior placement of a double-J catheter. The second choice might be an excellently performed PNL. However, further developments in the field of flexible URS could provide evidence that this procedure would be better for management of smaller stones than the SWL procedure because of treatment time, cost, and outcome.

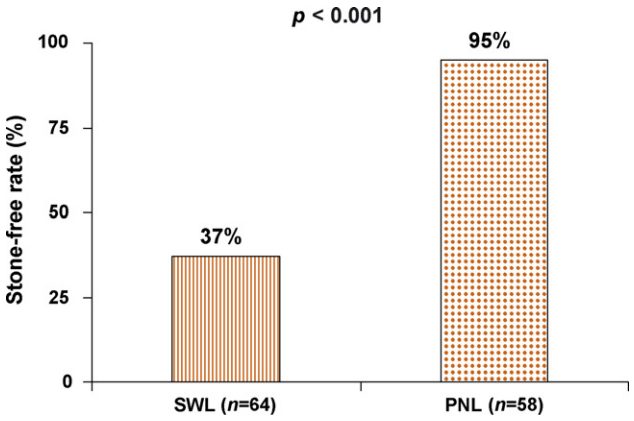

Fig. 2 – Comparison of stone-free rate for lower pole stones treated either by shock wave lithotripsy (SWL) or percutaneous nephrolithotomy (PNL).

3. Clinical case studies related to stone disease

3.1. Case 1

The first study consisted of a 48-year-old man with acute renal colic. Ultrasound revealed that he had hydronephrosis on the left kidney. There was no history of urinary tract infection and he had no fever. Radiologic imaging showed a 5 mm distal ureter stone. About 33% of the audience voted to treat the patient with an α_1-AR antagonist such as tamsulosin or with a nonsteroidal anti-inflammatory drug such as diclofenac, whereas 30% voted to perform an URS, 21% to perform a SWL, and another 14% to use a double-J catheter only (Fig. 3). The ''subject expert'' treated the patient with tamsulosin and diclofenac according to the treatment plan selected by the audience. Nevertheless, after 2 d the patient was taken back to the emergency room with persistent pain symptoms. Following the medical treatment, the expert performed two SWL procedures. The SWL procedure was performed for 5 d to get rid of the stone.

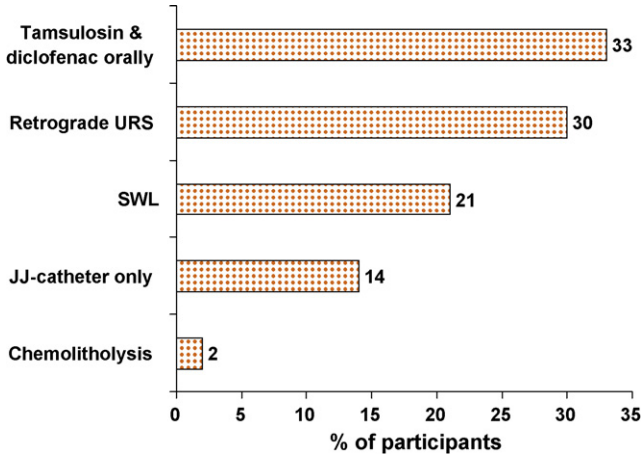

Fig. 3 – Results from interactive voting on a representative case indicate that an α_1-adrenoceptor antagonist such as tamsulosin or a nonsteroidal anti-inflammatory drug such as diclofenac and a ureteroscopy (URS) are the preferred treatment options.

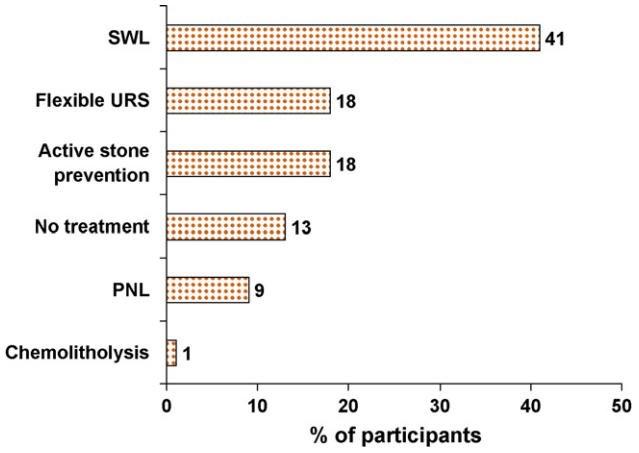

Fig. 4 – Results from interactive voting indicate that about half of the participants chose shock wave lithotripsy (SWL) as the treatment option for a patient with recurrent calcium oxalate stone formation, whereas a percutaneous nephrolithotomy (PNL) was a less favoured option.

However, about half the audience suggested a URS, 29% suggested insertion of a double-J catheter, and 22% suggested a SWL. The expert commented that, in most cases, a URS is not an emergency procedure and the patient refused a URS or a double-J catheter. During a panel discussion, most of the delegates agreed with the expert and would have performed the same SWL procedure, because a lot of patients, specifically males, prefer to avoid any endoscopic procedures. However, the choice of treatment could also depend on the accessibility of the procedure and the speed with which the patient has to be free of any stone and to return to work. All together, the patient's input and expectations as well as the availability of the procedure are very important aspects.

3.2. *Case 2*

The second study consisted of a 35-year-old woman with recurrent calcium oxalate stone formation and with a history of multiple previous stone removal treatments including SWL, URS, and PNL. She was not treated for prevention of stone recurrence, and she had mild flank pain. The ''subject expert'' stated that the most important therapy for stone prevention besides dietary modifications is the administration of citrates. He commented that it is important that patients have a normal calcium intake and that they do not reduce or avoid calcium because of evidence that reducing the calcium intake will lead to a higher rate of stone formation. Furthermore, to identify that this patient is a high-risk patient who needs regular 24-h urine examinations, the physicians should investigate whether any metabolic risk factors for stone formation exist, which is probably true for this patient. The expert performed an ultrasound to investigate the presence and position of stones. After performing a plane abdominal X-ray, it was possible to identify calcification under the costal margin. In addition, an intravenous urography was performed, which revealed that the stone was located in the middle calyx, as expected from the ultrasound. Nevertheless, during a panel discussion, the delegates suggested a computed tomography scan to locate the stone. In fact, this is a difficult case. The expert suggested treating the patient with URS or SWL. However, the problem with SWL is that it is difficult to identify the stone when an X-ray is used. As a consequence, when performing SWL, one has to locate the stone by ultrasound. Otherwise, it would be better to perform URS, because this middle calyx will be easy to enter. About 41% of the delegates voted to perform a SWL to treat this patient (Fig. 4). About 18% suggested a URS, whereas another 18% suggested treating the patient by active stone prevention. The expert further commented that he would never perform a PNL, because the stone is far too small and an ultrasound could be performed to determine whether the stone is in a posterior or an anterior calyx.

4. Conclusions

From the data presented at the New Horizons in Urology 2006 closed expert meeting, we can conclude that active stone treatment is minimally

invasive. Minimally invasive surgical procedures such as SWL, URS, and PNL have been widely adopted for removal of stones from the kidney, especially in conditions in which stones fail to pass spontaneously, with stones larger than 5 mm, or with high-risk patients. Each approach has its own advantages and disadvantages. However, URS is more frequently used than SWL; use of the latter procedure is decreasing almost everywhere. The urologists advice that both SWL and URS are excellent procedures for removal of ureteral stones, depending on the preference of the patient as well as on the size and location of the stones, equipment available, expertise of the physician, and cost of the procedure. Although SWL is not as effective for treatment as URS, SWL may prevent the need for more invasive treatment. Nevertheless, it should be considered only as initial treatment in patients with smaller proximal ureteral stones. For larger proximal and distal ureteral stones, URS results in higher stone-free rates and is more cost-effective than the SWL procedure. In contrast, PNL should be regarded as first-line treatment for removal of lower pole stones. Finally, using tamsulosin as medical expulsive treatment in the management of distal ureteral stones has been shown to be very promising, but further clinical research in this field is warranted.

Conflicts of interest

The author has nothing to disclose.

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