controversial topics in surgery

The management of ureteric stones

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This topic has been a perennial discussion point amongst urologists; although the latest guidelines have suggested that the stone-free rates for ureteroscopy are higher than with extracorporeal shockwave lithotripsy (ESWL), it is well recognised that the evidence base is weak with many of the studies being retrospective, with precious few randomised clinical trials. This controversy is well argued on both sides by the two sets of authors who are eminent in the field of ureteric stone treatment.

However, for the practicing urologist, the decision-making process is not always so straightforward and the decision to intervene must be based not only on the clinical situation faced by the patient, but also by the level of resource available locally. The EAU Guidelines (2008) suggest that 98% of stones < 5 mm in size will pass spontaneously, whereas in 5–10 mm stones only 53% will pass spontaneously.

The indicators for active intervention include: (i) evidence of persistent obstruction; (ii) failure of stone progression; and (iii) persisting colic. Assuming no complicating factors such as sepsis, for stones in

the proximal ureter, ESWL can be preferred to ureteroscopy, for the reasons stated by Phipps and Tolley; however, the main risk factors for failure of ESWL include: (i) large stones (> 15 mm); (ii) impacted stones; (iii) unfavourable anatomy; and (iv) those in whom two sessions of ESWL have failed to achieve successful fragmentation (T Knoll *et al.* EAU Update Series 3, 2005).

In these scenarios, intervention in the form of ureteroscopy is to be preferred, whilst, in the mid-ureter, the options are equal given the issues in respect of locally available resources and expertise. In the distal ureter, traditionally ureteroscopy is the modality of choice due to the ease of access, high stone-free rates and minimum of complications.

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The case for extracorporeal shockwave lithotripsy

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The earliest observations that acoustic shockwaves could fragment brittle materials were made in the 1950s. The first experience of treating renal calculi in humans using extracorporeal shockwave lithotripsy (SWL) was reported in 1980¹ and by 1983 the first commercially-produced lithotripter was available, the Dornier HM-3. Its use quickly became wide-spread and it revolutionised the management of urinary stone disease from what had previously been entirely surgical to what has become almost exclusively minimally invasive.

Although stone fragmentation rates were impressive, treatment with the HM-3 required general anaesthesia. The development of second-generation lithotriptors allowed local anaesthetic treatment but at the cost of less efficient stone fragmentation. Outcomes of treatment with the most contemporary fourth generation lithotriptors approach those of the HM-3, but as an out-patient procedure with oral or intravenous analgesia.² Today, approximately 80% of all upper tract urinary stone disease is treated with SWL.

Depending on stone size and position, most ureteric stones are managed expectantly, with SWL, or by ureteroscopic extraction (URS). Most ureteric stones of size 5 mm or less will pass, and the relatively uncommon ureteric calculus of 20 mm or greater is best managed by ureteroscopy, percutaneous or laparoscopic means. For those ureteric calculi of dimensions that lie between these extremes, the treatment alternatives are SWL or URS.

The literature addressing management of ureteric stones is composed of a broad range of heterogeneous, randomised and non-randomised, retrospective and prospective trials and case series. However, on consideration of the available data, there emerges a strong argument that SWL should be the first-line treatment for most ureteric calculi.

SWL can be used to treat stones at any position within the ureter. The European Association of Urology (EAU) and American Urological Association (AUA) Nephrolithiasis Guidelines Panel have published guidelines for the management of ureteric calculi.³ This meta-analysis reports that the stone-free rates (SFRs) for SWL to ureteric stones within the upper, middle, and distal ureter were 82%, 73% and 74%, respectively. The corresponding SFRs for treatment with URS were 81%, 86%, and 94%. Nabi *et al.*⁴ also report superior SFRs for URS over SWL in a recent Cochrane review, although there was significant heterogeneity of types of lithotripter and power settings used within trials. Experience within our unit shows that the latest lithotriptors have better outcomes than second- and third-generation machines, and the techniques of SWL are continually developing. For example, a recent meta-analysis shows that improved SFRs are seen with use of a slower treatment shockwave rate,⁵ and there is also evidence of improved stone fragment clearance with the use of medical expulsive therapy following SWL.⁶ The superiority of SFRs from URS within the Nephrolithiasis Guidelines meta-analysis is not unexpected considering the direct visualisation of the stone that URS allows. However, although statistically significant, the superior SFRs may not represent a clinically significant advantage when one considers the advantages that SWL carries with regards to anaesthesia, hospital stay, use of stents and potential complications.

Although URS has been performed under intravenous sedation,⁷ it is usually carried out under general anaesthesia. A small proportion of these patients may be suitable for management as a day-case, but the majority would require a pre-anaesthetic hospital visit at least. Also, whilst the risks of general anaesthesia are small, they are significant in some patients. In contrast, SWL is routinely performed with oral or intravenous analgesia on an out-patient basis and, therefore, requires a significantly shorter single hospital visit.⁴ As a result, SWL is likely to be a more cost-effective treatment option, as shown by a recent evaluation of the total costs of SWL versus URS for ureteric calculi in a tertiary

referral centre. SWL was more cost-effective for calculi within any position within the ureter, except for very large distal ureteric stones.⁸

The presence of a ureteric stent following URS is associated with significant morbidity in the form of irritative urinary symptoms.⁹ There have been a number of studies suggesting that routine use of a stent following URS may not be necessary.¹⁰ However, many urologists still place a ureteric stent following the URS whereas stenting is rarely, if ever, required following SWL for ureteric stones. SWL to ureteric calculi can be undertaken electively after emergency placement of a ureteric stent but there is evidence that stents may impede the efficacy of SWL in this setting. A recent matched-pair analysis carried out within our department shows that the presence of a ureteric stent is associated with a worse outcome from SWL for ureteric calculi compared with patients without a stent *in situ*.¹¹

Early SWL avoids the need for stent placement. There is also evidence of better outcomes from SWL to ureteric calculi if the treatment is undertaken as an emergency, as shown in recent studies comparing results in patients treated within 24 h versus later,¹² and those presenting with colic versus incidentally detected stones.¹³ This is likely to be as a result of treatment being undertaken before the development of significant ureteric mucosal oedema. We now provide an emergency tertiary referral SWL service within our region for patients presenting to their local hospital with uncomplicated ureteric calculi. Stent placement and general anaesthesia are avoided in these patients, and our audited results suggest success rates in excess of 90%.

A further advantage that SWL carries over URS is a smaller risk of complications. SWL is proven to be a safe treatment. There were early concerns that SWL may be associated with a risk of renal impairment and hypertension due to renal parenchymal injury, but nearly 30 years of SWL experience world-wide has demonstrated that this is not the case. Furthermore, there appears to be a negligible risk of haematoma as a consequence of SWL to ureteric calculi. The greatest risk of complications following URS would appear to be as a result of instrumentation of the urinary tract. The Cochrane review by Nabi *et al.*⁴ showed that the risk of complications from URS was significantly greater than SWL. Most of the complications were minor, but rates of post-procedure urinary tract infection were higher within URS patients. Also, the EAU/AUA ureteric stone guidelines report that the risk of ureteric perforation at URS is 5% and the risk of ureteric stricture in the long term may be up to 2%.

Conclusions

SWL is an effective and safe out-patient treatment for ureteric calculi that is more acceptable to patients than the

more invasive alternative of URS. Whilst the superior SFRs that URS carries over elective SWL is statistically significant, this is at the cost of a procedure requiring general anaesthesia, a hospital stay, and with a greater risk of complications, and may, therefore, not represent a clinical advantage. The latest generation of lithotriptors is more effective and further development of SWL technique continues to improve stone-free rates. We accept that URS must be the management option undertaken for ureteric calculi where SWL is contra-indicated, such as for radiolucent stones, in the morbidly obese, and where anticoagulant therapy cannot safely be interrupted. However, these cases represent the minority of presenting patients. For the majority, the advantages that SWL confers clearly shows that it should be the first-line management option for most ureteric stones.

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The case against extracorporeal shockwave lithotripsy

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Shock wave lithotripsy (SWL) has the obvious appeal to patients of being a truly minimally invasive treatment, and it may also appear to be the easy option for clinicians. Because of the uncertainty of success, all too frequently this leads to repeated, ineffective treatments and delay until the patient is rendered stone- and pain-free. Many stone patients are young and economically active: there is a significant cost to society and the economy to their prolonged morbidity. Most importantly, ureteric stones are associated with the most severe pain known to man (or woman).

The advantages of ureteroscopy

It is fortunate that, for the great majority of patients with ureteric stones of less than 5 mm, spontaneous passage of stone is the expected natural history of acute ureteric colic.^{1,2} In addition, there is some evidence that medical

treatment with alpha blockers or calcium channel blockers may further improve spontaneous expulsion rates, even for stones greater than 4 mm in size.³ For the minority of stones that require intervention, the remaining options comprise SWL or ureteroscopy. The original American Urological Association guidelines from 1997 recommended SWL as first-line treatment for stones of 1 cm or less in the proximal ureter, while similar stones in the distal ureter could be treated with either SWL or ureteroscopy.⁴ The updated AUA/EAU guidelines⁵ from 2007 suggest that stone-free rates are superior with ureteroscopy for all sizes of stone and for all positions in the ureter apart from proximal ureteric stones under 10 mm. The data on which these recommendations relied were generally, however, of poor quality, with many retrospective series included and few randomised clinical trials. They did, however, suggest the ascendancy of ureteroscopy in ureteric stone management.

Furthermore, rapid technological advances in ureteroscopy mean that by the time a systematic review or meta-analysis is published, its results may be effectively out of date.

The most recent Cochrane review⁶ included more recent and higher quality prospective multicentre studies. It concluded that stone-free rates were lower in patients treated with SWL than those treated with ureteroscopy. Furthermore, these rates were usually measured at a generous interval of up to 3 months. Thus, those patients treated unsuccessfully with SWL may have a long time to wait before receiving definitive treatment or passing stone fragments. Re-treatment rates were also lower in the ureteroscopy group. The rate of complications and length of hospital stay was, however, higher in the ureteroscopy group. The great majority of complications were minor, such as haematuria. The specific and major complications of ureteroscopy essentially revolve around significant ureteric trauma, either manifesting as peri-operative ureteric avulsion, perforation or late stricture formation. It must be realised, however, that studies included in this analysis included techniques and equipment that would now be considered obsolete: ureteroscopes up to 11.5-F diameter and stone fragmentation with electrohydraulic, pneumatic and ultrasound probes were described. Furthermore, during surgery in these studies, stone fragments were extracted with a variety of baskets and forceps. The reduced diameter of modern semi-rigid ureteroscopes significantly reduces peri-operative ureteric trauma, leading to extremely low complication rates.⁷

For work in the upper ureter, these historical series commonly included only rigid ureteroscopy; by contrast, current standard practice is to use a smaller diameter flexible ureteroscope. The now wide-spread use of the Holmium/YAG laser enables extremely safe fragmentation of stones into minute particles, thus frequently obviating the need for basket extraction. This further reduces the risk of operative damage to the ureter from a basket becoming trapped. The Holmium/YAG laser's inherent properties, with penetration of only around 0.5 mm if misfired into the ureteric wall, further reduces the risk of ureteric perforation. Furthermore, there is no stone that will not fragment with laser lithotripsy, unlike shock wave lithotripsy which is likely to have minimal effects on harder stones such as cystine or calcium oxalate monohydrate.

Advances in ureteroscopic techniques continue, with the recent introduction of improved optical performance from ureteroscopes with in-built digital cameras at their distal end, the so-called 'chip at the tip', and improved extraction baskets. Thus, ureteroscopy is likely to continue to improve in both ease and safety in the future.

The human factor is also not to be underestimated in improvements in ureteroscopy; subspecialisation of urologists in the UK and other countries into 'stone specialists' is likely to reduce complication rates and improve outcomes.⁸

Critics of ureteroscopy might emphasise the need for post-operative stenting, which many centres still practice as standard. The presence of a ureteric stent is clearly associated with a decreased quality of life, and lower urinary tract symptoms.⁹ There is increasing evidence of the lack of necessity for stenting, however,¹⁰ which is likely to have a beneficial effect on patients' recovery in future clinical practice.

The disadvantages of SWL

In contrast, technological advances in SWL have centred on making the technique suitable for out-patient treatment without the need for anaesthesia, rather than increased efficacy in stone clearance. Thus, the original Dornier HM-3 required general anaesthesia, as opposed to simple analgesia given to patients before treatment on modern machines. The HM-3, however, is generally agreed to be more effective in stone fragmentation and clearance than more modern machines.¹¹ Indeed, the only trial included in the recent Cochrane review that included the HM-3 found no difference in stone clearance rates compared with ureteroscopy, while every other randomised controlled trial reported significantly better stone-free rates with ureteroscopy.^{6,12} The HM-3, however, is no longer used in the UK. The large capital cost of a machine means that, for the majority of NHS patients, SWL is provided by a mobile service operated by private contractors. This usually visits only on a fortnightly or monthly basis, causing access to be delayed and intervals between treatments to be long. Medical staff presence at SWL sessions is also highly variable, which can lead to poor quality control and inappropriate repeat treatments. Further delays before out-patient review of failed SWL patients place the patient at unnecessary risk of complications from their stone as well as prolonged morbidity.

There are numerous technical difficulties around the practice of SWL. Since ureteric stones are poorly seen on ultrasound, SWL typically utilises fluoroscopy to localise stones and target shock waves. Ureteric stones may be radiolucent or overlie bony areas such as the sacrum. Overlying bowel gas can also obscure a stone. This compares unfavourably with the direct visualisation and aiming of the laser fibre that ureteroscopy allows. Other difficulties include stones simply being too hard to fragment with lithotripsy, attenuation of shock wave power in obese patients or poor patient tolerance leading to reduced power or time of treatment. SWL remains contra-indicated in significant numbers of patients, most notably in pregnancy and anticoagulated patients. In contrast, ureteroscopy may be performed safely in such patients. Furthermore, even if SWL does fragment a stone, the fragments may not clear due to oedema or impaction. Passage of the fragments may involve repeated episodes of renal colic and clinical uncertainty, which may impair their return to normal activities.

Conclusions

Extracorporeal shockwave lithotripsy (SWL) has too frequently become the 'no-brainer' option for treatment of ureteric stones. Ureteroscopy enables an extremely high rate of immediate stone-free status. In even the most basic NHS urology hospital unit there is rapid access to the necessary equipment, without the need to wait for the next visit of the mobile lithotripter. The introduction of modern equipment means that actual complication rates for ureteroscopy are now lower than previously quoted. Most patients are young and healthy and the risks of general anaesthesia are extremely low. Therefore, we argue that, for the minority of ureteric stones that do not spontaneously pass, the first choice for most patients should be ureteroscopy, enabling a rapid return to a healthy and pain free status.

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