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Removal of ureteral stones with extracorporeal shock wave lithotripsy and ureteroscopic procedures. What can we learn from the literature in terms of results and treatment efforts?

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Abstract A literature review was made to obtain information on the treatment efforts required for a successful removal of ureteral stones when extracorporeal shock wave lithotripsy (ESWL) or ureteroscopic stone extraction or disintegration (URS) were used as primary procedures. Data were collected from 59 reports on ESWL and 23 on URS. The study thereby comprised 20,659 patients primarily treated with ESWL and 5,520 treated with URS. A treatment index (TI) was formulated from the total number of patients (N_{TOT}), the number of stone free patients (N_{SF}), the number of patients with retreatment (N_{RE}), auxiliary procedures (N_{AUX}) and general or regional anaesthesia (N_{ANE}). The difference between the TI and the efficiency quotients normally used was the incorporation of the factor N_{ANE} that reflected the need for general or regional anaesthesia. TI had the following form:

$$TI = N_{SF} / (N_{TOT} + N_{RE} + N_{AUX} + N_{ANE})$$

When the groups of treated patients were considered in this way, TI was significantly higher for the patients treated with ESWL than for those treated with URS ($P=0.007$). The median (range) for the groups of ESWL-treated patients was 0.50 (0.25–0.90) and for patients treated with URS 0.42 (0.26–0.94). For the combined groups of patients, the TI-values were 0.54 and 0.40, respectively. Although the average retreatment for URS was only 2.2% compared with 12.1 percent for ESWL, the need for general/regional anaesthesia was 94.3% and 28.3% in the two groups, respectively. The advantage of a lower rate of retreatment in patients primarily referred to URS was thus obviously counterbalanced by the much higher need for anaesthesia. For

ureteral stones treated with ESWL in the author's department using Dornier HM3, MFL 5000, and Modulith SLX lithotripters, stone free rates of 96%, 97% and 95% were associated with TI-values of 0.61, 0.60 and 0.63, respectively. Both ESWL and URS are excellent procedures for the removal of stones from the ureter. In addition to the different degrees of invasiveness, the need for anaesthesia has to be considered in an objective comparison of the two methods.

Keywords ESWL · Meta-analysis · Treatment index · Ureteral stones · Ureteroscopy

Introduction

Technical achievements during the past 20 years have dramatically changed the methods for removal of stones from the kidneys and ureters. The introduction of extracorporeal shock wave lithotripsy (ESWL) and ureteroscopic stone extraction or disintegration (URS) for stones in the ureter, has made open surgery unusual and, in the majority of cases, unnecessary.

There is today a consensus on the superiority of the low-invasive therapeutic approach, but the debate continues on whether ESWL or URS should be the first line treatment for patients with stones located in the ureter.

With modern equipment, it is clear that both procedures can be used to efficiently treat stones at all levels of the ureter. The definite preference for one method over the other must thus to be based on the interpretation of advantages and disadvantages. This matter was clearly discussed in a report of a randomised comparison of ESWL and URS treatments of stones in the distal ureter [1].

The major advantages of ESWL are its non-invasive character and the possibility of completing the treatment with only analgesics and sedation. This means that the procedure can be completed without general or regional anaesthesia. The most important drawback is the need

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for repeated treatment in a substantial fraction of patients. Although URS needs a much lower rate of retreatment, the method in most cases cannot be carried out without regional or general anaesthesia and the procedure requires access to an operating theatre. In addition URS might be associated with a higher risk of complications.

Inasmuch as both ESWL and URS can be referred to as low-invasive procedures, they have become popular in modern urology. There are principally two major directions for selecting the first line treatment for removal of stones in the ureter. Whereas some urologists prefer ESWL others prefer URS.

An appropriate comparison of ESWL and URS is not easy, and attempts have been made to compare the therapeutic efforts and outcome by formulating efficiency quotients [2, 3]. The efficiency quotient in a simple way summarises the fraction of stone free patients in relation to the need for repeated and auxiliary procedures.

None of the reports in the literature has compared the two methods by including a factor representing the need for general or regional anaesthesia.

The aim of this study was to look at the results and therapeutic efforts involved with ESWL and URS presented in the modern literature by comparing the two procedures with an expanded mathematical expression of the treatment outcome related to the various treatment efforts.

Materials and methods

Reports in the literature on the results of ureteral stones treated with ESWL [1, 4–52] and URS [1, 46, 48, 53–71] were reviewed. Only those reports that contained data on the stone-free rate, auxiliary procedures, retreatment and type of anaesthesia were included in the study.

In addition to results from the literature, information was also added from the author's own experience with ureteral stones: ESWL-treated with an unmodified Dornier HM3 lithotripter, a Philips/Dornier MFL 5000 lithotripter and a Storz Modulith SLX lithotripter. Otherwise no attempts were made to stratify the results according to type of lithotripter, ureteroscope or disintegrating device.

For each report the following data were recorded: the total number of patients (N_{TOT}), the patients reported as stone-free (N_{SF}), the number of patients who had been subjected to retreatment with the primary treatment modality (N_{RE}), the number of patients in whom auxiliary procedures had been used (N_{AUX}), and the number of patients treated with general or regional anaesthesia (N_{ANE}). From this information a treatment index (TI) was derived as follows:

$$TI = N_{SF} / (N_{TOT} + N_{RE} + N_{AUX} + N_{ANE})$$

For patients treated with URS, insertion of a stent as well as of a percutaneous nephrostomy catheter was

considered as an auxiliary procedure. Although the stent was generally inserted at the URS procedure, a second session was required to remove it. Patients treated with ESWL and URS who were reported to have residual ureteral fragments of maximally 4 mm were referred to the group of stone-free patients because of the high probability of spontaneous passage of these fragments.

The results were analysed with Statistica (StatSoft, Tulsa, USA) and significant differences analysed with the Mann-Whitney U-test.

Results

The overall stone-free rates, retreatments and auxiliary procedures recorded in 20,659 patients with urethral stones primarily treated with ESWL and 5,520 primarily treated with URS are summarised in Fig. 1. It is obvious that very good results were obtained with both methods, but at the expense of a higher retreatment rate among the patients primarily treated with ESWL.

The distribution of TI-values for the groups of patients treated with ESWL and URS is shown in Fig. 2.

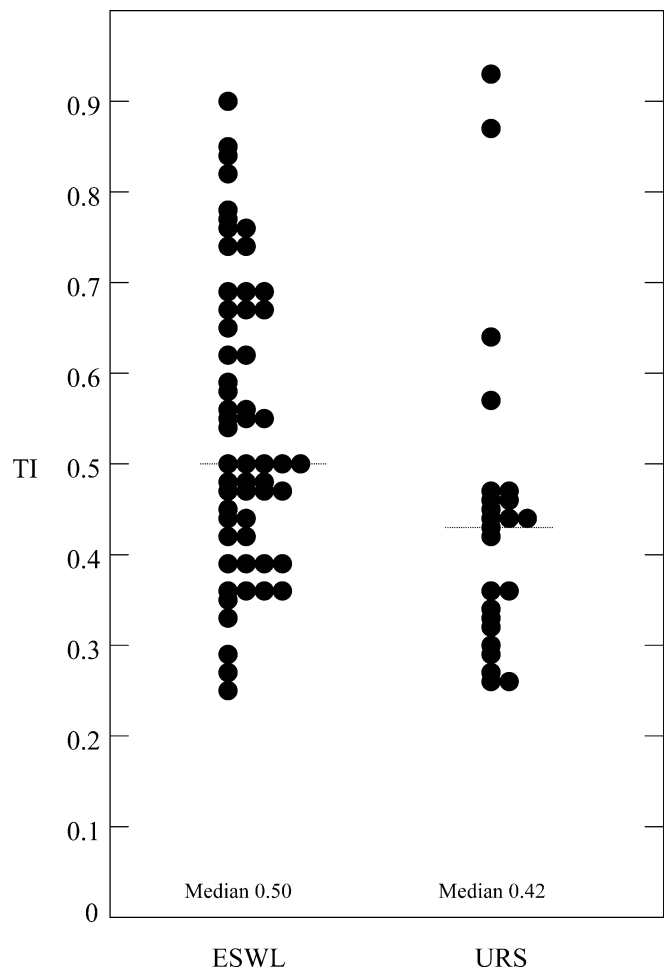


Fig. 1 TI-values in patients treated for ureteral stones with ESWL and URS. The median quotients are indicated in the figure

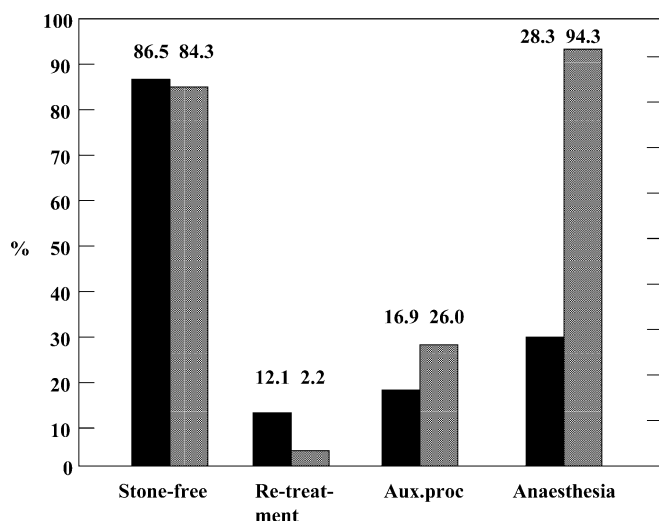


Fig. 2 Average percent of patients treated with ESWL (black columns) and URS (gray columns) who were stone-free, retreated, treated with auxiliary procedures and general/regional anaesthesia

The TI-values calculated for the combined patients in the groups of ESWL and URS-treated patients were 0.54 and 0.40, respectively. The median (range) TI-values were 0.50 (0.25–0.90) for ESWL treatments and 0.42 (0.26–0.94) for URS treatments ($P=0.007$).

When only the randomized studies were compared [1, 40, 41], the TI-values varied between 0.27 and 0.76 in 798 ESWL-treated patients and between 0.33 and 0.59 in 502 URS-treated patients. The TI-values calculated for all patients in these groups were 0.29 and 0.44 following ESWL and URS, respectively. The low TI for the ESWL-treated patients was explained by the common use of anaesthesia in these studies [40, 41]. For the patients reported in [1], the TI-value was 0.76. Non-randomised comparisons of 2,306 patients treated with ESWL and 1,439 patients treated with URS [30, 31, 35, 36, 42, 48] showed TI-values of 0.52 and 0.46, respectively. For 256 children treated with ESWL for ureteral stones [4, 8, 20, 26, 29], the TI-values varied between 0.27–0.90, with a value of 0.47 for the whole group.

The results of ESWL-treated ureteral stones from the author's own experience are shown in Table 1. Similar results were obtained with three lithotripters Dornier HM3 (unmodified version), Dornier/Philips MFL 5000 and Modulith SLX, and the corresponding TI-values were: 0.61, 0.60 and 0.63. The stone-free rates in these groups of patients were 96%, 97% and 95%, respectively.

Table 1 The author's results of ESWL-treated ureteral stones with three lithotripters

Lithotripter	N_{TOT}	N_{SF}	N_{RE}	N_{AUX}	N_{ANE}	TI
Dornier HM3	675	662	223	182	10	0.61
Dornier/Philips MFL 5000	548	532	143	192	2	0.60
Modulith SLX	159	151	46	28	5	0.63

Discussion

About half of all patients who need active stone removal present with stones in the ureter. Whereas concrements that reside in the kidney are very often without symptoms, this is usually not the case for ureteral stones. It is accordingly reasonable to offer these patients a treatment that is both gentle, efficient and easy.

The two treatment options that we have to consider today are ESWL and URS. Each one of these methods has its own advantages and disadvantages, and several factors influence the choice of treatment. Those urologists who favour ESWL base their decision on the fact that in most patients this is a non-invasive procedure that can be carried out without general or regional anaesthesia and usually without any specific preparations. Urologists in favour of URS claim that, although this is an invasive procedure, it has, in contrast to ESWL, a higher success rate at the first treatment session. The lack of access to a nearby lithotripter and the personal preference for an endourological procedure also play an important role. By an individual selection of pros and cons, different urologists can thus come to the opposite conclusion on how an individual patient is best treated, and there is no consensus on how ureteral stones should be removed. With the modern equipment for ESWL and URS, both techniques are acceptable low-invasive alternatives.

A fair comparison of the two procedures, however, cannot be made unless all factors of importance are considered. In this report an index (TI) was calculated in a way similar to the efficiency quotients previously published [2, 3]. The calculation was based on the numbers of patients that were stone free, retreated, treated with auxiliary or adjuvant procedures as well as with general or regional anaesthesia. Other factors such as, for instance, the average stone burden and the frequency of complications would also have been of great interest to incorporate in such an index, but this information has not been consistently reported in the literature. Such factors, therefore, need to be analysed in prospective studies.

From the data shown above, it is evident that the highest TI-values were recorded for patients treated with ESWL. This was also the result when only distal ureteral stones were considered.

When ESWL, including the auxiliary and adjuvant procedures, is carried out without general or regional anaesthesia, there is no need for an anaesthesiologist or an operating theatre. Anaesthesia in association with

ESWL was recorded in 28.3% of cases. This figure also includes ESWL-treated children. When this group was excluded, the fraction of patients treated with anaesthesia was 27.9%. In contrast 94.3% of patients treated with URS required anaesthesia.

The general conclusions from this review of data in the literature do not provide evidence for an unequivocal superiority of URS. With a lower grade of invasiveness and the possibility of completing the treatment with only analgesics and sedation, ESWL still appears to be an excellent alternative for removal of stones in the ureter.

The real cost for ESWL and URS varies considerably from one centre to another, and so do the principles of reimbursement from the health care system. There is today a disseminated trend to apply more invasive procedures for the removal of ureteral stones. The major argument for this strategy is the assumption that a single session removal of a stone in a greater number of patients is more cost effective than ESWL. In a cost analysis that was carried out for the International Urolithiasis Symposium in South Africa in 2000, the average cost for an ESWL procedure was estimated to be 1,200 euros compared with 2,100 euros for a URS procedure [72]. With this treatment cost, it is evident that even at a retreatment rate of 60–70%, ESWL remains the economically most favourable method. The principles of reimbursement in some regions obviously favour URS over ESWL, and accordingly several urologists today use URS mostly for economic reasons. This means that patients will be treated invasively more frequently than non-invasively, a development that in the author's opinion is a step backwards from the very useful and versatile procedure for removal of ureteral stones that the ESWL technology provides. It is important that the selection of method for stone removal be made without hindrance from economic regulations, particularly in case the latter are less well supported by an appropriate analysis of the real cost. Most certainly the cost varies from one centre to another as a result of variations in internal organisation, but in such cases it appears more reasonable to change the organisation than the method.

With a consistent use of ESWL as the primary procedure for removal of ureteral stones without regional or general anaesthesia, TI-values of 0.60–0.63 were recorded with stone-free rates of 95–97%. The advantages of a procedure carried out with only analgesics and sedation are obvious. There is, in the vast majority of cases, no need for the patient to make any particular preparations before the treatment and no need for an anaesthesiologist or an operating theatre during the treatment. This means that the procedure can be carried out straight away when there is an indication for active stone removal. It is the author's opinion that this versatility far outweighs the drawback of the need for repeated sessions of ESWL in a fraction of the patients. This conclusion is in agreement with the view of Olsburg and Ramsay [73].

The purpose of this review of data from the literature on modern removal of ureteral stones is to emphasize the influence of relevant variables and to combine them in one mathematical expression to enable a reasonable comparison between the two prevailing methods. It is the author's hope that future studies will include more informative data of this kind as well as on the average stone burden and complications in treated patients. Such reports will provide additional data for an even better comparison between different methods for stone removal.

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