

# ORIGINAL ARTICLES

## Endourology and Stone Diseases

### Extracorporeal Shock Wave Lithotripsy and Transureteral Lithotripsy in the Treatment of Impacted Lower Ureteral Calculi

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#### ABSTRACT

**Introduction:** We compared the efficacy of extracorporeal shock wave lithotripsy (SWL) with ureteroscopy followed by transureteral lithotripsy (TUL) for the treatment of impacted distal ureteral calculi.

**Materials and Methods:** A total of 96 patients with solitary impacted distal ureteral calculi were assigned into 2 groups of treatment with SWL (42 patients) and TUL (54 patients) with a 6.9-F semirigid ureteroscope. Characteristics of the patients and the calculi, treatment parameters, clinical outcomes, and patients' satisfaction were assessed for each group as well as efficiency quotient.

**Results:** Demographic characteristics of the patients in the 2 groups were similar as well as the sizes of the calculi. The stone-free rate, 2 months postoperatively, was 71.4% in the patients of the SWL group and 88.9% in those of the TUL group. The efficiency quotient was 56% and 81% for the SWL and TUL groups, respectively ( $P = .004$ ). Retreatment rate was 26.2% (11 patients) and 9.3% (5 patients) for the SWL and TUL groups, respectively ( $P = .027$ ). Thirty patients in the SWL group (71.4%) and 52 in the TUL group (96.3%) were satisfied with their treatment ( $P = .001$ ). There were no major complications in neither of the groups. Minor complications (pain and hematuria) were more common in the TUL group.

**Conclusion:** Based on the results of this study, TUL seems to be more effective than SWL in the treatment of impacted lower ureteral calculi sized smaller than 12 mm, and patients are more satisfied with this treatment method.

**KEY WORDS:** ureteral calculi, ureteroscopy, lithotripsy, shock wave, clinical trials

#### Introduction

Today, selection of the optimal surgical treatment for distal ureteral calculi remains one of the controversial topics in endourology.<sup>(1-3)</sup> Treatment options vary and include expectant

management, placement of ureteral stents, extracorporeal shock wave lithotripsy (SWL), ureteroscopy with basket extraction or intracorporeal lithotripsy, and salvage procedures such as laparoscopic or open ureterolithotomy.<sup>(3)</sup> The likelihood of successful fragmentation of impacted ureteral calculi by SWL is still a matter of debate.<sup>(4-10)</sup> Some investigators have shown that impaction does not affect SWL results and believe that it should be attempted as the first-line treatment.<sup>(5,8)</sup> To our knowledge, there is no report comparing transureteral lithotripsy (TUL)

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and SWL in the treatment of impacted lower ureteral calculi. In this clinical trial, we compared the efficacy and complications of SWL with TUL for the treatment of impacted distal ureteral calculi.

### Materials and Methods

Between September 2002 and March 2004, patients referring to our clinic with a single impacted lower ureteral calculus were evaluated to be enrolled in our study. Intravenous urography (IVU) was performed in all patients and those with a single radio-opaque impacted lower ureteral calculus sized less than 12 mm were selected. Patients with multiple ureteral calculi, solitary kidney, kidney dysfunction, ipsilateral ureteral stricture, plan for ipsilateral or contralateral renal or ureteral surgery, active urinary tract infection, transplanted kidney allograft, and uncorrected coagulopathy were excluded. Impaction was defined as hydroureteronephrosis above the calculus and nonvisualized ureter below it on IVU or no changes in the location of the calculus on serial plain abdominal radiographies (kidney, ureter, and bladder [KUB]) during the past 2 months. Indication for and timing of surgical intervention versus observation was left to the discretion of the treating physician. Patients who met the inclusion criteria and were eligible to undergo both SWL and TUL were enrolled in the study. All patients provided informed consent. They were assigned into either the SWL or the TUL group according to their preferences.

Shock wave lithotripsy was performed using a Dornier Compact Delta Lithotripter (Dornier MedTech Europe GmbH, Wessling, Germany) and up to a total of 2400 shock waves were administered at a power adjusted between 15 W and 22 W. Transureteral lithotripsy was performed under epidural anesthesia, with a 6.9-F semirigid ureteroscope (Richard Wolf GmbH, Knittlingen, Germany), and all calculi were fragmented using ballistic lithoclast (Swiss LithoClast, EMS, Geneva, Switzerland). Placement of ureteral stent at the end of the procedure was left to the discretion of the treating surgeon.

Physical examination was performed and KUB and ultrasonography were obtained in all patients at 2 weeks and 2 months after the operation. In the presence of hydronephrosis and suspected residual calculi, IVU was also done. Stone-free

rate was defined as the percent with complete clearance or residual calculi sizes less than 2 mm. For a better comparison between the efficiency of both treatments, the efficiency quotient (EQ) was calculated by the formula introduced by Clayman and associates<sup>(11)</sup>:

$[\text{Percent stone free}/(100\% + \text{percent retreatment} + \text{percent auxiliary procedures})] \times 100$

Patients with a failed treatment in each group underwent repeat procedure. Patient's satisfaction was defined as recommendation of the treatment by the patients for their relatives or for themselves in a similar situation and was evaluated at the 2-month follow-up visit.

Statistical analyses were performed with Fisher exact test, chi-square test, Mann-Whitney test, and Student t test where appropriate. Values less than .05 for *P* were considered statistically significant.

### Results

A total of 96 patients were studied, of whom 42 were treated by SWL and 54 underwent TUL. The patients' characteristics are summarized in Table 1. There was no significant difference in patients' age, sex, and calculus size as well as the stone side between the 2 groups. The stone-free rate at 2-month follow-up was 71.4% in the patients of the SWL group and 88.9% in those of the TUL group (Table 2). The EQ was 56% and 81% for the SWL and TUL groups, respectively (*P* = .004). Retreatment rate was 26.2% (11 patients) and 9.3% (5 patients) for the SWL and TUL groups, respectively (*P* = .027), and the number of treatment sessions per patient in the

**TABLE 1.** Characteristics of the patients and calculi in the shock wave lithotripsy (SWL) and transureteral lithotripsy (TUL) groups\*

	SWL	TUL	<i>P</i> value
<b>Number of patients</b>	42 (43.7)	54 (56.3)	
<b>Sex</b>			
Male	28 (66.6)	37 (68.5)	
Female	14 (33.4)	17 (31.5)	.84
<b>Stone side</b>			
Right	17 (40.5)	21 (38.9)	
Left	25 (59.5)	33 (61.1)	.87
<b>Mean stone size (mm)</b>	7.6 ± 1.9	7.5 ± 2.4	.79
<b>Mean patients' age (year)</b>	46.02 ± 13	44.96 ± 12	.69

\*Values in parentheses are percents.

**TABLE 2.** Stone-free rates and complications in the patients of the shock wave lithotripsy (SWL) and transureteral lithotripsy (TUL) groups\*

	SWL	TUL	P value
Stone-free patients			
At 2 weeks	24 (57.1)	37 (68.5)	.28
At 2 months	30 (71.4)	48 (88.9)	.037
Complications			
Pain	14 (33.3)	25 (46.3)	
Pain and hematuria	17 (40.5)	27 (50)	
Total	31 (73.8)	52 (96.3)	.006

\*Values in parentheses are percents.

SWL and TUL groups were 1.26 and 1.09, respectively ( $P = .028$ ). Thirty patients in the SWL group (71.4%) and 52 in the TUL group (96.3%) were satisfied with their treatment ( $P = .001$ ). There were no major complications in neither of the groups; however, minor complications (pain and hematuria) were more common in the TUL group (Table 2).

## Discussion

The choice of TUL or SWL for the treatment of lower ureteral calculi is still open to debate. The indications for ureteroscopic lithotripsy for the stones of all parts of the ureter have been expanded with the advent of smaller semirigid ureteroscopes, laser technology, and more robust flexible instruments.<sup>(12)</sup> It is stated that SWL, even in its new generation formats, takes a back seat to more invasive endoscopic therapy.<sup>(13)</sup> Previous SWL failure, large calculi, hard calculi, and obstruction or impaction are clinical parameters that affect the outcomes of TUL and even more the SWL.<sup>(4)</sup>

In this randomized clinical trial, we compared the efficacy of SWL and TUL for the treatment of impacted distal ureteral calculi. There are different definitions of impacted ureteral calculus in the literature. Sinha and colleagues used a definition similar to one in our study except for they considered that the ureter below the stone should not be visualized in any IVU radiography up to 3 hours after the injection of the contrast.<sup>(5)</sup> Roberts and coworkers defined impaction as ureteral calculi remaining unchanged in their location for at least 2 months,<sup>(14)</sup> while Mugiya and colleagues defined it as calculi causing ureteral obstruction and not moving in response to manipulations such as ureteral catheteri-

zation.<sup>(15)</sup> Regarding these different definitions of stone impaction in the literature, there are contradictory opinions that impacted stones may affect the treatment outcome. Based on a critical analysis of the literature, Segura determined previous SWL failure, large or hard calculi, obstruction or impaction, and certainty of results as the clinical parameters that are associated with a higher likelihood of SWL failure.<sup>(4)</sup> Sinha and colleagues investigated the effect of the failure to visualize the ureter distal to an impacted calculus on the successful lithotripsy. They concluded that complete clearance rates in the impacted as well as the nonimpacted calculi were both 76.7% and impaction seen on the IVU does not affect the results of SWL.<sup>(5)</sup>

In the report of endoscopic management of impacted ureteral stones using a small-caliber ureteroscope and a laser lithotripter, Mugiya and coworkers showed that the stone-free rate with a single session of ureteroscopy was 96%.<sup>(15)</sup> This is comparable with the stone-free rates of 97% to 100% for the ureteral calculi generally reported in the literature for the treatment of lower ureteral calculi using a single procedure and laser lithotripsy without ureteral orifice dilatation.<sup>(16)</sup> Generally, stone-free rates for SWL and TUL of the distal ureteral calculi are 50% to 99% and 86.4% to 100% in the literature, respectively; whereas, retreatment rates (in patients with treatment failure) are 7.1% to 50% and 0.8% to 19.8%, respectively.<sup>(1,17-21)</sup> The stone-free rate from a single procedure with ballistic lithotripsy is 74% to 100%.<sup>(22-28)</sup> In our study, the stone-free rate was 71.4% with SWL and 88.9% with TUL using ballistic lithotripsy, and retreatment rate was 26.2% and 9.3%, respectively ( $P = .027$ ).

In 1990, Clayman and colleagues developed the EQ to help compare the results of the different SWL technologies that also takes into account the need for retreatment and auxiliary procedures. According to this formula, an ideal SWL machine would have an EQ of 100%, ie, all calculi are fragmented and passed without any retreatment or auxiliary procedure. In contrast, lithotripters with an EQ of 50% or less would be largely inefficient since each patient would require a retreatment or auxiliary procedure to achieve a 100% stone-free rate.<sup>(11)</sup> In our study, the EQ for TUL and SWL were 81% and 56.1%, respectively ( $P = .004$ ), demonstrating the advantage of the former. There were no major complications in neither group and only minor

temporary complications were noted which were more frequent in the patients treated with TUL. However, the satisfaction rate, albeit assessed subjectively, was higher among the patients in the TUL group.

### Conclusion

Based on the results of this study, it seems that for the impacted calculi less than 12 mm in the distal ureter, ureteroscopy with intracorporeal lithotripsy is the preferred treatment method and patients are more satisfied with this option.

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