Comparison of Treatment Efficacy between Shock Wave Lithotripsy and Ureteroscopic Stone Removal for Lower Ureteral Stones

Eun Suk Kim, Seok Heun Jang, Jeong Hwan Son

From the Department of Urology, Bun-Dang Je Saeng Hospital, Seongnam, Korea

Purpose: We compared the efficacy and patient satisfaction between shock wave lithotripsy (SWL) and ureteroscopic removal of stone (URS) for the treatment of lower ureteral stones.

Materials and Methods: We reviewed 223 patients who were treated for lower ureteral stones from August 2006 to January 2009. SWL and URS were performed in 47 and 176 patients, respectively. After treatment, the patients' subjective inconvenience/pain and their satisfaction with the treatment process were estimated by questionnaire. We analyzed success rates, complication rates, inconvenience/pain scores, and satisfaction scores for each group of patients.

Results: The overall success rates of SWL and URS were 82.9% and 97.7%, respectively (p=0.001). The complication rates of SWL and URS were 8.5% and 10.8%, respectively (p=0.162). The satisfaction scores of SWL and URS were 7.4 and 9.2, respectively (p=0.001). Whereas 87.5% of the URS group preferred the same treatment in case of a recurrence of ureteral stones, only 68% of the SWL group preferred the same treatment in the future (p=0.002).

Conclusions: URS was more successful and satisfactory to the patients with lower ureteral stones. Although both SWL and URS were highly effective for treatment of distal ureteral stones, we believe that URS is the first-line treatment modality for lower ureteral stones. **(Korean J Urol 2009;50: 884-891)**

Key Words: Ureteroscopy, Lithotripsy, Satisfaction

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Correspondence to: Jeong Hwan Son
Department of Urology, Bun-Dang Je Saeng Hospital, 255-2, Seohyeon-dong, Bundang-gu, Seongnam 463-050, Korea
TEL: 031-779-0165
FAX: 031-779-0169
E-mail: sjhwany@dmc.or.kr

INTRODUCTION

Urolithiasis has an incidence of 2% to 3%, and accounts for 30% of urologic inpatients. That is, it is most common in urinary diseases [1]. Shock wave lithotripsy (SWL), introduced by Chaussy et al in 1980, brought forth a great change to the paradigm of urolithic treatment [2,3]. In the early days, it was used to remove renal calculi, but with continuous amelioration, it was recognized as the primary treatment for ureteral stones in 1996 [3]. SWL has the merits of being noninvasive, showing good performance, and being convenient. But at the same time, it is associated with a high rate of retreatment, and the success rate varies according to calculous size and components. Particularly in connection with lower ureteral stones, the success rate becomes lower and patients feel sharper pains [4,5]. On the contrary, ureteroscopic removal of stone (URS) has the merit of having a high rate of success with a low rate of retreatment. However, such results are on the premise of invasive treatment and anesthesia. On that score, it has been disputed which is more suitable as the primary treatment for lower ureteral stones. In some studies, the two were comparatively analyzed, but only a minority of studies have dealt with measurements of patient satisfaction [6].

This study was intended for patients who underwent SWL or URS due to lower ureteral stones. Therapeutic results were comparatively analyzed to determine what was more effective, and a questionnaire survey was conducted of the patients to

investigate their satisfaction.

MATERIALS AND METHODS

This study was intended for patients who were diagnosed with lower ureteral stones in this hospital and who underwent SWL or URS from August 2006 to January 2009. SWL was performed in 47 cases. URS was performed in 176 cases, out of which 78 cases (group A) had selected it for themselves after fully listening to the explanation of the two procedures. The other 98 cases (group B) were hesitant to select URS for themselves but selected the procedure after taking the urologist's recommendation. A lower ureteral stone was defined as a ureteral stone observed below the sacroiliac joint on a plain abdominal radiograph. Stone size was based on the maximum dimension of the ureteral stone as measured by excretory urography or computed tomography.

In the SWL group, an electroconductive lithotriptor (ECL, EDAP-Sonolith Praktis) was used. After a nonsteroidal analgesic (Diclofenac; 1 mg/kg) was intramuscularly injected, radiation was focused with the subjects in a prone position. The power was between 12 and 15 KV, and 2,000 shock waves were applied at intervals of 1.5 seconds.

URS was performed after general anesthesia. After a 6 Fr or 8 Fr-rigid ureteroscope was inserted into the ureter, the calculus was removed by the use of a stone basket. The stone, which was too large or was impacted in the ureter, was crushed by the lithoclast. When the ureter seriously swelled, a double-J stent was indwelled. Therapeutic success was limited to cases in which the calculus was not observed in the radiological examination and the patient did not feel symptoms 1 week after treatment. In the case of the SWL group, retreatment was limited to cases in which the calculus, which was at least 5 mm in diameter, was observed on a plain abdominal radiograph and the patient continuously felt pain irrespective of size. When the calculus was not removed although SWL was performed 3 times, URS was recommended to the patient. For the patients who did not want URS, SWL was continued.

The patients' inconvenience/pain and satisfaction were analyzed by a questionnaire survey based on a 10-point visual analogue scale (Appendix). The questionnaire survey was focused on the whole treatment process from diagnosis to the completion of treatment.

In the SWL group, the questionnaire survey was conducted 1 week after the last session after judging complete recovery. In the URS group, it was conducted on the patients who revisited the hospital 1 week after discharge. In the case of the patients who underwent ureteral stent insertion, the stent was removed at the follow-up visit 1 week after discharge. The survey was administered right after stent removal.

The results of the questionnaire survey were analyzed in consideration of intergroup differences and clinical characteristics. Also, the URS group was distinguished into group A and group B. Group A was composed of the patients who selected URS for themselves, and group B was composed of the patients who hesitated to select URS for themselves but selected it after taking the urologist's recommendation. For statistical analysis, the Statistical Package for the Social Sciences (SPSS; SPSS Inc, Chicago, USA) program, Student's t-test, and chi-square test were used, and $p < 0.05$ was considered statistically significant.

RESULTS

1. SWL group

SWL was applied to 47 cases in all. The average age of the patients was 41.5±13.5 years, and the average size of the calculi was 8.9±3.2 mm. The ratio of male to female was 1.8:1 (Table 1). The success rate was 55.3% (26/47) after the first session, and the cumulative success rate was 82.9% (39/47) after the third session. In the calculi that were at most 10 mm in diameter, the cumulative success rate was 89.2% (25/28). In the calculi that were over 10 mm in diameter, it was 73.6% (14/19) (Table 2). The failure rate was 17% (8/47), out of which 1 case (2.1%) was treated with ureterolithotomy. In the other 7 cases (14.8%), URS was applied.

The incidence rate of complications was 8.4% (4/47). Gross

Table 1. Characteristics of the patients

	SWL	URS	p-value
No. of patients	47	176	
≤10 mm	28	148	
>10 mm	19	28	
Sex ratio (male:female)	1.8:1	1.7:1	0.114[a]
Mean age	41.5±13.5	44.5±14.3	0.122[b]
Mean stone size (mm)	8.9±3.2	8.5±3.6	0.083[c]

SWL: shock wave lithotripsy, URS: ureteroscopic removal of stone, [a]: chi-square test, [b,c]: Student's t-test

Table 2. Success rates of SWL and URS for lower ureteral stones

	SWL (%)		URS (%)		
	1st session	3rd session	Total	A	B
Total stone free rate	55.3 (26/47)	82.9[a] (39/47)	97.7[a] (172/176)	97.4[d] (76/78)	97.9[d] (96/98)
≤10 mm	67.8 (19/28)	89.2[b] (25/28)	100[b] (148/148)	100 (66/66)	100 (82/82)
>10 mm	36.8 (7/19)	73.6[c] (14/19)	85.7[c] (24/28)	83.3 (10/12)	87.5 (14/16)
Failure rate		17 (8/47)	2.2 (4/176)	2.5 (2/78)	2.0 (2/98)

SWL: shock wave lithotripsy, URS: ureteroscopic removal of stone, A: group who selected URS for themselves, B: group who hesitated to select for themselves but selected it after taking urologist's recommendations, [a]: $p<0.05$, [b]: $p>0.05$, [c]: $p=0.069$, [d]: $p=0.121$

Table 3. Complications of SWL and URS

	SWL (%)	URS (%)	p-value
Gross hematuria (>24 hours)	2 (4.2)	10 (5.8)	
Flank pain (>24 hours)	2 (4.2)	7 (3.9)	
Urinary tract infection	-	2 (1.1)	
Total	4 (8.4)	19 (10.8)	0.162

SWL: shock wave lithotripsy, URS: ureteroscopic removal of stone

hematuria and flank pain for 24 hours and upward occurred in 2 cases (4.2%) and 2 cases (4.2%), respectively (Table 3).

On the questionnaire survey, the inconvenience/pain score during the treatment process was 5.5±2.6 points. Scores for satisfaction with the treatment result and the treatment process were 7.4 and 8.7 points, respectively. If stones were to recur, 68% (32/47) of patients wanted to undergo SWL, and 31.4% (15/47) of patients wanted to undergo the other treatment. The primary reason they wanted to undergo the other treatment was the possibility of retreatment (46.7%; 7/15), and the secondary reason was high cost (40%; 6/15) (Table 4).

2. URS group

URS was applied to 176 cases in all. The average age of the patients was 44.5±14.3 years, and the average size of the calculi was 8.5±3.6 mm. The ratio of male to female was 1.7:1 (Table 1). The total success rate was 97.7% (172/176). In the calculi that were at most 10 mm in diameter, the success rate was 100% (148/148). In the calculi that were over 10 mm in diameter, it was 85.7% (24/28). The treatment failed in 4 cases (2.2%) in which the ureteroscope could not be inserted due to serious vesicoureteral junction swelling and lateralization. Afterward, the 4 cases all recovered by retried URS or SWL (Table 2). The incidence rate of complications was 10.8% (19/176). Gross hematuria and flank pain for 24 hours and upward occurred in 10 cases (5.8%) and 7 cases (3.9%), respectively. Urinary tract infection occurred in 2 cases (1.1%). However, serious complications such as ureteral perforation or ureteral stricture did not occur (Table 3).

On the questionnaire survey, the inconvenience/pain score during the treatment process was 5.8±2.9 points. Scores for satisfaction with the treatment result and the treatment process were 9.2 and 9.0 points, respectively. If stones were to recur, 87.5% (154/176) of patients wanted to undergo URS again, whereas 12.5% (22/176) wanted to undergo the other treatment. The main reasons for wanting to undergo the other treatment were the burden of hospitalization (36.4%; 8/22), the burden of anesthesia (22.7%; 5/22), inconvenience/pain score during the treatment process (22.7%; 5/22), the burden of operation (13.6%; 3/22), and high cost (4.5%; 1/22) (Table 4).

3. Comparison between the SWL and URS groups

There were no significant intergroup differences in the average age of the patients, the ratio of male to female patients, or the average size of the stone (Table 1).

The total success rates of the SWL and URS groups were 82.9% and 97.7%, respectively. Resultantly, the success rate of URS was significantly higher than that of SWL (p=0.001). In the cases with calculi that were at most 10 mm in diameter, the cumulative success rate of SWL was 89.2%. But URS showed a success rate of 100%. Thus, it was found that URS was more effective. In the cases with calculi that were over 10 mm in diameter, the cumulative success rates of SWL and URS were 73.6% and 85.7%, respectively. URS showed a higher rate, but there was no significant difference in the statistics (p=0.096 and p=0.069) (Table 2). The incidence rates of complications were 8.4% and 10.8% in the SWL and URS groups, and no significant differences existed (p=0.162) (Table 3).

In relation to the inconvenience/pain score during the treatment process, the scores for the SWL and URS groups were 5.5±2.6 points and 5.8±2.9 points, respectively, and no significant differences existed (p=0.096). For satisfaction with the treatment process, the scores in the SWL and URS groups were 8.7 points and 9.0 points. The URS group got higher points in both, but there were no significant differences statistically (p=0.111).

For satisfaction with the treatment result, the scores of the SWL and URS groups were 7.4 points and 9.2 points. The score of the URS group was significantly higher (p=0.001). In relation to retreatment, the patients who selected SWL and URS accounted for 68% and 87.5% of patients retreated, respectively. Therefore, significantly more patients who selected URS were retreated (p=0.002) (Table 4).

4. Comparison between group A and group B

The URS group was distinguished into group A and group B. The mean sizes of the stones in groups A and B were 8.3±3.7 mm and 8.7±3.6 mm (p=0.092), respectively, and the sex ratio was 1.7:1 equally (p=0.125). The average ages were 46.2±13.9 years and 42.8±14.5 years (p=0.087). There were no significant intergroup differences in the mean size of stones, sex ratio, or the average ages of groups A and B. The success rates in groups A and B were 97.4% and 97.9%, respectively, which were not significantly different (p=0.121) (Table 2).

Table 4. Comparison of inconvenience/pain and satisfaction between SWL and URS

		SWL	URS	p-value
Inconvenience/pain during treatment process		5.5	5.8	0.096[a]
Satisfaction with treatment result		7.4	9.2	0.001[a]
Satisfaction with treatment process		8.7	9.0	0.111[a]
Rate of future preference-same treatment (%)		68 (32/47)	87.5 (154/176)	0.002[b]
Rate of future preference-different treatment (%)		31.4 (15/47)	12.5 (22/176)	
Cause (%)	Retreatment possibility	46.7 (7/15)	-	
	Cost	40.0 (6/15)	4.5 (1/22)	
	Inconvenience/pain during treatment process	13.3 (2/15)	22.7 (5/22)	
	Hospitalization	-	36.4 (8/22)	
	Burden of anesthesia	-	22.7 (5/22)	
	Burden of operation	-	13.6 (3/22)	

SWL: shock wave lithotripsy, URS: ureteroscopic removal of stone, [a]: Student's t-test, [b]: chi-square test

Table 5. Comparison of inconvenience/pain and satisfaction between groups A and B of the URS group

		A	B	p-value
Inconvenience/pain during treatment process		5.7	6.0	0.071[a]
Satisfaction with treatment result		9.1	9.3	0.093[a]
Satisfaction with treatment process		9.0	9.0	0.062[a]
Rate of future preference-same treatment (%)		87.1 (68/78)	87.7 (86/98)	0.112[b]
Rate of future preference-different treatment (%)		12.8 (10/78)	12.2 (12/98)	
Cause (%)	Retreatment possibility	-	-	
	Cost	10.0 (1/10)	8.3 (1/12)	
	Inconvenience/pain during treatment process	40 (4/10)	33.3 (4/12)	
	Hospitalization	30 (3/10)	16.6 (2/12)	
	Burden of anesthesia	10 (1/10)	33.3 (4/12)	
	Burden of operation	10 (1/10)	8.3 (1/12)	

A: group who selected URS for themselves, B: group who hesitated to select for themselves but selected it after taking urologist's recommendations, [a]: Student's t-test, [b]: chi-square test

Inconvenience/pain scores during the treatment process were 5.7 points and 6.0 points, respectively (p=0.071). The scores for satisfaction with the treatment result were 9.1 points and 9.3 points, respectively (p=0.093). The score for satisfaction with the treatment process was 9.0 points in both groups (p=0.062). Overall, there were no significant intergroup differences (Table 5).

DISCUSSION

Instead of laparotomy, which has traditionally been applied, minimally invasive treatments such as SWL and URS have been applied to urolithiasis that needs active treatment. The applicability of SWL has been widened so that it is now applicable for not only upper ureteral stones but lower ureteral stones as well. There have been reports that SWL is not much different from URS in therapeutic effects [7-9], but the problems of a high retreatment rate and high expense are seldom considered. URS has been widely applied since the report by Pérez-Castro and Martinez-Pineiro in 1980 [10], owing largely to its ability for near complete treatment of urolithiasis with only one treatment session, along with the development of small- caliber and flexible ureteroscopes and the safety of anesthesia. Many patients have undergone the treatment despite the burdens of hospitalization and anesthesia. In this context, the two treatment methods have been in rivalry [11-13].

Since its high efficacy and safety were reported in 1982, SWL has been applied to all types of urolithiasis, with the exception of lower urinary obstruction and hemorrhagic disease, which are difficult to treat. The success rate of SWL varies according to models, and it ranges from 67.3% to 98.3%. Its therapeutic effect is affected by the position, size, shape, and component of the calculus; the severity of urinary tract infection; and impacted depth. Segura et al reported that SWL was more efficacious against lower ureteral stones than renal ones [14]. They argued that shock waves can be effectively transmitted to lower ureteral stones, because they are more likely to be stationary because respiration does not affect their position much. In addition, the crushed calculus can rapidly reach the urinary bladder by the peristaltic movement of the ureter. However, there are also reports of difficulty in achieving high success rates with lower ureteral stones compared with upper ones, and that patients would suffer sharper pains [4,5]. In the present study, in which an electrohydraulic pressure-type lithotriptor was used, a nonsteroidal analgesic (Diclofenac; 1 mg/kg) was preventively injected into the muscle to alleviate sharp pain in the patients before the lithotripsy was performed. Also, the intensity of the shock waves was controlled according to the patients' pain level. Additional lithotripsies were performed at intervals of 1 or 2 weeks, and the interval was controlled according to the patients' conditions. Patients who undergo SWL ordinarily suffer from complications such as gross hematuria, perirenal hematoma, perirenal edema, steinstrasse, and fever [15]. In this study, mild gross hematuria was observed in 40 cases (85%) but only 2 cases showed gross hematuria for 24 hours and upward. Afterwards, the 2 cases were completely recovered with conservative treatment.

The therapeutic effect of URS is affected by the position and size of the calculus and the operator's experience. However, its success rate can be nearly 100% for lower ureteral stones and it has the merit of a very low retreatment rate. It has been reported that the success rate of URS for lower ureteral stones reaches 90% to 98.2%. In this study, it reached 97.7%. Also, it is known that the incidence of complications ranges from 4.5% to 27%, and hemorrhage, flank pain, ureteral perforation, ureteral stricture, and vesicoureteral reflux account for most complications. In addition, dysuria, suprapubic discomfort, urinary frequency, urinary urgency, movement of the ureteral stent, hematuria, and ureterocele may occur in the patients who undergo ureteral stent insertion. In this study, hematuria and flank pain, which lasted 24 hours and upward, accounted for 5.8% (10/176) and 3.9% (7/176), and urinary tract infection accounted for 1.1% (2/176). However, serious complications such as ureteral perforation and ureteral stricture were not observed.

In relation to complications, there was no significant intergroup difference. The total success rate of SWL was 82.9%, but that of URS was 97.7%. Therefore, the total success rate was significantly higher in URS (p=0.001).

From the patient's standpoint, to compare SWL and URS, which are both accepted as an efficacious treatment for lower ureteral stones, we conducted a questionnaire survey about satisfaction with the treatment, inconvenience and pain during the treatment process, and preference for retreatment.

The scores for inconvenience/pain as assessed by the questionnaire survey were 5.5 points and 5.8 points for the SWL and URS groups, respectively. There was no significant

difference between the groups, contrary to the expectation that SWL would result in less inconvenience and pain to the patients during the treatment process. The URS group was not significantly different from the SWL group, although URS requires general anesthesia. Likewise, there were no significant intergroup differences in satisfaction with the treatment process.

In relation to satisfaction with the treatment result, the scores for the SWL and URS groups were 7.4 points and 9.2 points (p=0.001). The score of the URS group was significantly higher for the question of whether to undergo the same treatment in the future. The proportions of patients who would select the same treatment in the case of recurrence were 68% and 87.5%, respectively. Therefore, the URS patients, who selected the same treatment, were more significantly satisfied. In a study released by Choi et al, the level of satisfaction with URS was higher than that with SWL [16]. The results of our study were similar. In the case of the patients who did not want to undergo SWL again, the primary reason for refusal was the possibility of retreatment (46.7%; 7/15), and the secondary reason was high cost (40%; 6/15). A study by Pearle et al also showed that those surveyed felt much more satisfied with URS because it was more inexpensive [17].

The URS group was distinguished into groups A and B. Group A was composed of the patients who selected URS for themselves, and group B was composed of the patients who hesitated to select URS for themselves but selected it after taking the urologist's recommendation. In the comparison of inconvenience/pain and satisfaction, there were no significant intergroup differences (Table 5). This shows that the patients were satisfied with URS as the primary treatment whether they selected it for themselves or not.

It is known that the larger the size of a stone, the lower the success rate and the higher the complication rate. To classify whether the stones were large or not, 10 mm was used as a cutoff in this study. A total of 40.2% of the patients in the SWL group and 15.9% in the URS group had lower ureteral stones that were more than 10 mm in diameter. The diameter of the stones that were over 10 mm in the SWL group ranged from 10 to 13 mm (95%, 18/19). Moreover, the average size of the stones in the SWL group was 8.9 mm and that of stones in the URS group was 8.5 mm (p=0.083). Therefore, it was difficult to make clear the difference between URS and SWL in terms of the size of the stones. On this account, it was considered that the comparison between the URS group and the SWL group was meaningful.

In the results of this study, the success rate of URS was significantly higher than that of SWL. Also, in the measurement of satisfaction, URS received higher scores. URS has the annoyance of hospitalization, general anesthesia, and ureteral stent removal; on the other hand, SWL involves a higher retreatment rate, long-term follow-up, and frequent visits. Moreover, patients may visit the emergency room to control intolerable pain in the course of the treatment. In this study, such problems worked against SWL. The merit of being free from urolithiasis in a short time period might be why patients preferred URS. Altogether, it may be desirable to adopt URS as the primary treatment. Before the choice of treatment in the case of lower ureteral stones is made, a full explanation needs to be given to patients and their family so that they can select a treatment for themselves.

CONCLUSIONS

SWL and URS are known for their efficacy in treating lower ureteral stones. In this study, we compared the two procedures and concluded that URS was superior in success rate and patient satisfaction. Before treatment, the well-defined characteristics of the two procedures are needed to be fully explained to the patients. When considering the treatment efficancy and patient satisfaction, it may be advisable to adopt URS as the primary treatment modality for lower ureteral stones.

REFERENCES

1. Lee F, Patel HR, Emberton M. The 'top 10' urological procedures: a study of hospital episodes statistics 1998-99. BJU Int 2002;90:1-6.
2. Chaussy C, Brendel W, Schmiedt E. Extracorporeally induced destruction of kidney stones by shock waves. Lancet 1980;2: 1265-8.
3. Chaussy C, Schmiedt E. Shock wave treatment for stones in the upper urinary tract. Urol Clin North Am 1983;10:743-50.
4. Kim HH, Noh JH. Comparison of cost and clinical outcome for ureteral stones larger than 1cm; extracorporeal shock wave lithotripsy versus ureteroscopic lithotripsy. Korean J Urol 2005;46:1141-6.
5. Byeon SS, Jeon SS, Lee HW, Park EC, Lee JH, Kwak C, et al. Ureteroscopic manipulation for ureteral calculi: comparison with ESWL. Korean J Urol 1996;37:1124-31.

6. Lotan Y, Gettman MT, Roehrborn CG, Cadeddu JA, Pearle MS. Management of ureteral calculi: a cost comparison and decision making analysis. J Urol 2002;167:1621-9.
7. Kapoor DA, Leech JE, Yap WT, Rose JF, Kabler R, Mowad JJ. Cost and efficacy of extracorporeal shock wave lithotripsy versus ureteroscopy in the treatment of lower ureteral calculi. J Urol 1992;148:1095-6.
8. Candace FG, Amy EK, Matthew TG. Long-term follow-up of pediatric shock wave lithotripsy. J Urol 2008;179(4 Suppl): 383.
9. Pearle MS, Lingeman JE, Leveillee R, Kuo R, Preminger GM, Nadler RB, et al. Prospective randomized trial comparing shock wave lithotripsy and ureteroscopy for lower pole caliceal calculi 1 cm or less. J Urol 2008;179(5 Suppl):S69-73.
10. Pérez-Castro Ellendt E, Martinez-Pineiro JA. Transurethral ureteroscopy. A current urological procedure. Arch Esp Urol 1980;33:445-60.
11. Turk RM, Jenkins AD. A comparison of ureteroscopy to in situ extracorporeal shock wave lithotripsy for the treatment of distal ureteral calculi. J Urol 1999;161:45-6.
12. Dretler SP. Management of the lower ureteral stone. AUA Update Series 1995;14:62-7.
13. Kim KH, Shim BS. The comparison of efficacy of ureteroscopic removal and shockwave lithotripsy in lower ureteral stones. Korean J Urol 2001;42:905-9.
14. Segura JW, Preminger GM, Assimos DG, Dretler SP, Kahn RI, Lingeman JE, et al. Ureteral stones Clinical Guidelines Panel summary report on the management of ureteral calculi. The American Urological Association. J Urol 1997;158:1915-21.
15. Chaussy CG, Fuchs GJ. Current state and future developments of noninvasive treatment of human urinary stones with extracorporeal shock wave lithotripsy. J Urol 1989;141:782-9.
16. Choi HW, Kim SD, Kim DB, Sohn DW, Kim SW, Cho YH. Effectiveness of emergency ureteroscopic lithotripsy for distal ureter stones. Korean J Urol 2008;49:257-61.
17. Pearle MS, Nadler R, Bercowsky E, Chen C, Dunn A, Figenshau RS, et al. Prospective randonmized trial comparing shock wave lithotripsy and ureteroscopy for management of distal ureteral calculi. J Urol 2001;166:1255-60.

Appendix

Questionnaire for patients' inconvenience/pain and satisfaction measurement

1. Mark the number corresponding to the inconvenience/pain you felt during the treatment process (SWL or URS).

(0: none 5 10: worst possible)

2. Mark the number corresponding to the treatment result.

(0: none 5 10: best satisfaction)

3. Mark the number corresponding to the treatment process.

(0: none 5 10: best satisfaction)

4. In case of a recurrent urolithiasis, would you want to undergo the same treatment again?

5. If you decide to undergo the other treatment, what is your reason?