Multiparametric evaluation of renal function and morphology after extracorporeal shock wave lithotripsy

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To evaluate the morphological and functional renal changes following extracorporeal shock wave lithotripsy (ESWL), renal sonographic evaluations together with I 131 iodine-orthoiodohippurate renal scans and renal functional laboratory tests were performed in 125 patients who underwent ESWL therapy for renal stones. All of these evaluations were performed before and in the short-long follow-up after ESWL. Alterations in these parameteres were evaluated with Student's t test. Evaluations of our results indicated th,t ESWL therapy results in a transient change in renal function returning to normal range within 3-6 months. On the other hand, sonographic evaluation of the treated and untreated kidneys did not show any significant difference in renal size, particularly in the parenchymal thickness of both kidneys. Number of shock waves seemed effective in the degree of deterioration in renal function. [Turk J Med Res 1994; 12(3): 131-135]

Key Words: Extracorporeal shock wave lithotripsy (ESWL), Kidney, Kidney stone

Extracorporeal shock wave lithotripsy (ESWL) has gained a wordldwide acceptance in the last 10 years and success rates in the management of symptomatic urinary calculi reached as high as 98% (1). Nowadays, as a highly effective treatment modality ESWL became the treatment of choice for most of the urinary calculi and has gained a great approval with its already known minimally invasive nature.

Both the extensive experimental studies and the clinical data have shown some local, regional and systemic effects of ESWL. In addition to transient renal functional alteration, local adverse effects such as perirenal or subcapsular hematomas have commonly been observed. The most important systemic effect well-known is the new onset of hypertension due to the damage and fibrosis of renal parenchyma (2,3,4).

Some animal studies also point out chronic renal changes including diffuse interstitiel fibrosis, loss of nephrons, focal calcification and perinephric scarring **(5).**

Lack of definite standardization of ESWL parameters (SW number, KV value, No. of sessions) may be an important factor in these widely varied effects.

Received: March 4, 1994 **Accepted:** April 26,1994

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We performed a multicentric and multiparametiic prospective study in order to evaluate the adverse effects of shock waves on renal function and morphology together with their correlation with ESWL parameters in the early and late follow-up.

MATERIALS AND METHODS

125 patients with 132 kidney stones in pelvic or caliceal localisation underwent ESWL treatment. All of the patients were selected in a randomised fashion without any selection criteria in terms of sex and age. Male/female ratio was 69/56 (1.2) and age range was from 22 to 54 years. (Mean age 34.3 years). Stone size varied between 14-23 mm. (Mean 19.4 mm). All of the patients were treated with Dornier lithotriptor MPL 9000 under sedative analgesia (Phentanyl 3-7 M9/kg)-

Following the routine laboratory evaluations, serum creatinine, BUN values and creatinine clearence values were recorded. Additionally, excretory urogram, renal sonography (including length, width and parenchymal thickness of the kidneys) and radionuclide renography were performed . Also the diastolic and sistolic blood pressure values were monitored during one year follow-up after ESWL. All of these examinations were performed by the same person in the concerned unit in order to eliminate the risk of errors of different interpretation.

Radionuclide renography was performed to assess renal function and, in particular, to demonstrate svidence for the development of obstructive uropathy. Evaluations were performed by using I- 131 orthoiodo lippurate (I 131 OIH) with Siemens scintiview I Dhogamma IV by using high energy collimator. To ensure adequate hydration each patient was given 400 ml fluid to drink in 30 minutes before evaluation. An average dose of 150 uci I 131 OIH was given intravenously. Following IV injection gamma camera data were recorded of floppy discets for 1280 seconds (21.3 min.) with an interval of 16 seconds regularly.

Table 1. Stone characteristics and ESWL parameters

I.	No. of patients	125
	No. of stones	132
	Stone Size (mm)	14-23(19.4)
	Localization	97 stones in renal pelvis
		35 stones in calices
	Lithotriptor type	Dornier lithotriptor MPL 9000
	No. of SW	900-2500(1645)
	KV value	16-24(19.2)
	No. of sessions	1 sessions in 82 patients
		2 sessions in 43 patients

Computer generated time-activity renogram curves of both kidneys were analysed and peak activity time (t) and half clarence of peak activity time (t/2) were recorded. The results were evaluated as normal t value was between 2-5 min. and t/2 value was under 15 min. (6).

Patients who had required long-term antibiotic therapy due to persistant urinary tract infection or pig tail catheter insertion and ureterorenoscopy for ureteral obstruction following treatment were excluded out of the study.Also those who had previous renal surgery and obstructive stone particles following ESWL were not included into the study group. Post ESWL evaluations in the remaining 20 patients were repeated in the early (0-3 months), intermediate (3-6 months) and late (6-12 months) follow-up period.

In order to evaluate the effect of ESWL parameters (SW number, KV value) on renal functional deterioration, the t and t/2 values were correlated with these parameters.

Follow-up evaluation results were comparatively analysed with preoperative values, and Student's t test was used for statistical analysis.

RESULTS

125 patients with 132 kidney stones were included into the study program. 43 patients received two treatment sessions and total number of sessions was 168. The number of shock waves applied in one session varied form 900 to 2500 with an average value of 1645/session. Electrical discharge during treatment varied between 16-24 KV. (mean 19.2 KV) of these 97 stones 15 were located in renal pelvis and the others were in calices of the affected kidney. Stone characteristics and ESWL parameters are shown in Table 1.

I. Radionuclide renogram studies

Peak activity time and half clarence of this activity time (t and t/2) were assessed from the time activity curves of the normal and stone affected kidneys. Evaluation of these values revealed a statistically significant difference because of the varying degree of obstruction due. to the localisation of the stones in the affected kidneys preoperatively ($p<0.05$).

Evaluation of t ant t/2 values in the first week of follow-up resulted in a marked difference with respect to the both values of normal and treated kidneys ($p<0.001$) indicating a significant decrease-in renal blood flow and obstructive uropathy in the treated kid-

Table 2A.Comparative evaluation of t and t/2 values between treated and untreated kidneys in correlation to follow- up period after ESWL

	Before		1. week		3. month		6. month		1. year	
	t	t/2	t	t/2	t	t/2	t	t/2	tr	t/2
Treated side Min. (+SD)	5.65 ± 2.12	14.73 ± 3.60	6.33 ± 1.94	15.64 ± 3.20	6.03 ± 1.58	15.00 ± 2.77	5.42 ± 1.26	14.37- ± 2.74	5.02 + 1.50	13.74 ± 3.07
Untreated side Min. (+SD)	4.05 + 0.94	11.91 ± 2.19	4.12 ± 0.91	12.03 + 2.18	4.09 ± 0.91	12.23 ± 2.25	4.01 ± 0.95	12.26 ± 2.04	4.04 ± 0.97	12.42 ± 2.01
P	<0.05		<0.001		<0.01		<0.05		>0.05	

Table 2B.Evaluation of t and t2 values of treated and untreated kidney before and in the folow-up period after ESWL

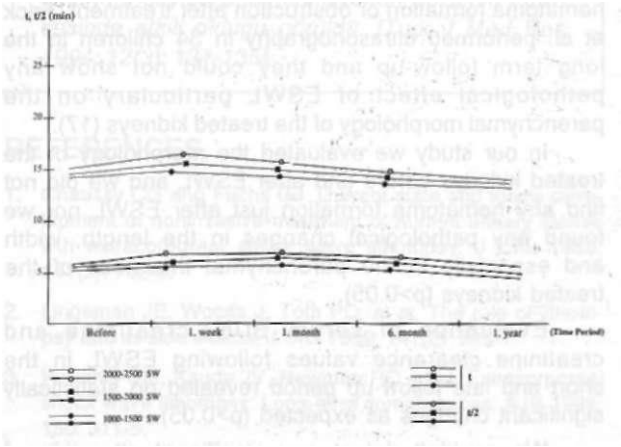
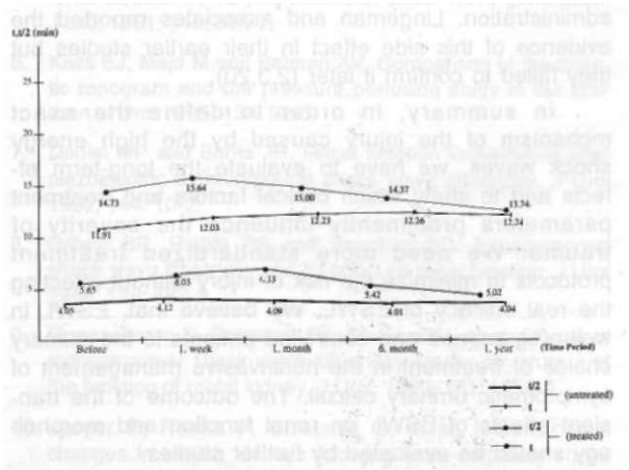


Table 3. Evaluation of t and t2 values in correlation with the number of shock waves.



ney. As none of the patients ^had a stone particle on the treated side, this functional deterioration was attributed to the adverse effect of ESWL.

This functional deterioration gradually improved in the intermediate period of follow-up ($p<0.05$) and finally our long-termed evaluations revealed no statistically significant difference between the functional parameters of both kidneys ($p>0.05$).

All of these values are shown in Table 2 a-b. On the other hand evaluation of the possible correlation between the shock wave parameters and the degree of functional deterioration revealed a statistically significant correlation between the number of shock waves applied and the t and t/2 values ($p<0.05$). KV value seemed not effective in this aspect, Table 3.

Ⅱ. Sonographic evaluation of the kidneys

Length and width of treated and normal kidneys together with their parenchymal thickness were as-

Tabled Alteration of kidney parameters (length, Width and parenchymal thickness) in correlation to the follow-up period after ESWL treatment.

		Before treatment	After 1 year	p
Treated side (cm,±SD)	L	12.14±0.55	12.05±0.49	<0.001
	W	5.02+0.32	4.92±0.33	<0.001
	P	1.28±0.93	1.24+0.74	<0.05
Untreated side (cm, ±SD)	L	12.20+0.47	12.18+0.46	>0.05
	W	5.06±0.228	5.05±0.27	>0.05
	P	1.28±0.93	1.26+0.31	>0.05

Table 5. Evaluation of blood pressure before and after ESWL therapy

	Blood pressure (mm Hg)	
	Systolic	Diastolic
Before treatment	126.75±12.06	80.00+7.94
After 1 year follow-up	128.75+10.86	81.55+7.85
P	>0.05	

sessed by sonographical evaluation before and after ESWL therapy.

Pretreatment evaluation of these values showed no statistically significant difference between the stone affected and normal kidneys ($p>0.05$). Following ESWL therapy, we repeated these evaluations at the end of 1 year follow-up and there was no significant difference, related to the parenchymal thickness and other values of both kidneys ($p>0.05$), Table 4.

Ⅲ. Excretory urogram findings

Evaluation of intravenous urogram of 20 patients before and after ESWL therapy showed no meaningful difference. related to the function and the morphology of the treated kidneys.

Ⅳ. Serum BUN, **Creatinine and Creatinine clarence values**

As it was expected, no difference between the pre -and post treatment values was observed. All of these values remained in the normal range following shock wave administration.

V. Evaluation of blood pressure before and after treatment

Monitoring of diastolic and sistolic blood pressure values before and after ESWL treatment revealed no statistically significant difference either in short-termed or long termed follow-up. (Sistolic blood pressure values were recorded as 126.75±12.006 and 128.75±10.86 mmHg before and 1 year after ESWL respectively. The results were 80.00±7.94 and 81.55±7.85 mmHg for diastolic blood pressure measurements.) ($p<0.05$), Table 5.

DISCUSSION

Treatment of urinary calculi has changed dramatically in the last ten years and ESWL became the preferred treatment modality with its highly effective results and significantly less morbidity rates. However, despite its proved safety and efficacy, recently it has been reported in a number of studies that shock waves would cause some adverse effects on the function and morphology of parenchymateous organs (7-10). Although the main target of high energy shock waves is the stone located in the kidney, the surrounding renal tissue or the other organs are also subjected to trauma and morphological, functional changes in the stone affected kidney may be presented in any time following ESWL (11-14).

Up to now, radionuclide renography has been widely used to assess the functional status of the kidney treated with ESWL quantitatively (3,15,16) and ultrasound is also a commonly used method in assessing the morphological changes in the treated kidney (17).

No definite standardized mechanism has yet been established in explaining the adverse effects of shock waves on renal function and morphology. Although it is currently well recognised that acute morphological changes such as perirenal or subcapsular hematomas may occur and resolve in a short period of time in most cases, there is also evidence to suggest that these adverse effects due to ESWL are not limited only by acute effects but also may involve chronic parenchymateous changes resulting in new onset of hypertension, decrease in renal function and increased rate of stone recurrence (3,18).

Radionuclide renographic studies have mostly shown a transient short-termed renal functional deterioration following ESWL. On the other hand, in a number of studies the functional changes have been found to be presented for a long period of time at least 3 months or more. In their original study, Thomas and associates have found a significant decrease in renal function in 74 patients after 1-7 days following ESWL (19). In another study Williams et al. have reported a marked difference in effective renal plasma flow rate (ERPF) in the treated kidneys as long as 2 years following ESWL therapy (3).

We performed radionuclide renography and ultrasound evaluation of treated kidneys to assess the functional and morphological status of the kidneys in short, intermediate and late follow-up after ESWL. Our renograpphic evaluations revealed a transient decrease In renal function in the shock wave subjected kidneys that has lasted 3 months following ESWL This functional deterioration returned to normal range after one year. Thus ESWL seemed producing a transient failure of function of the treated kidneys but long termed evaluations revealed no significant functional pathology ($p<0.05$). On the other hand, comparative evaluation of the correlation between the shock wave parameters (SW number, KV value) revealed a significant correlation between the number of shock waves applied and the degree of deterioration ($p>0.05$). Electrical discharge value did not seem effective in this aspect.

Sonographic evaluation is an important way of assessing the pathological effects of shock waves such as hematoma formation or obstruction after treatment. Frick et al. performed ultrasonography in 34 children in the long term follow-up and they could not show any pathological effect- of ESWL particulary on the parenchymal morphology of the treated kidneys (17).

In our study we evaluated the morphology of the treated kidneys before and after ESWL and we did not find any hematoma formation just after ESWL nor we found any pathological changes in the length, width and especially in the parenchymal thickness of the treated kidneys ($p>0.05$).

Evaluation of serum BUN, creatinine and creatinine clearance values following ESWL in the short and late follow-up period revealed no statistically significant changes as expected ($p>0.05$).

We couldn't detect any significant alteration of diastolic and sistolic blood pressure values in 20 patients following one year ESWL treatment ($p>0.05$). In the literature there are contradictory reports about the new onset of hypertension following shock wave administration. Lingeman and associates reported the evidence of this side effect in their earlier studies but they failed to confirm it later (2,3,20).

In summary, in order to define the exact mchanism of the injury caused by the high energy shock waves, we have to evaluate the long-term effects and to study which clinical factors and treatment parameters prominently influence the severity of trauma. We need more standardized treatment protocols to minimize the risk of injury without affecting the real efficacy of ESWL. We believe that, ESWL in well-programmed and controlled patients is the primary choice of treatment in the noninvasive management of symptomatic urrinary calculi. The outcome of the transient effects of ESWL on renal function and morphology should be evaluated by further studies.

Ekstrakorporeal şok dalga lithotripsy sonrası böbrek fonksiyonunun ve morfolojisinin multiparametrik değerlendirilmesi

Ekstrakorporeal şok dalga lithotripsy'i ESWL takiben oluşan morfolojik ve fonksiyonel renal değişikleri değerlendirmek için, böbrek taşları için ESWL tedavisi gören 125 hastada 1131 iodin-orthoiodohippurate ile birlikte sonografik böbrek değerlendirmeleri ve renal fonksiyon laboratuvar testleri yapıldı. Bu değerlendirmelerin tamamı ESWL-'den önce ve sonraki kısa veya uzun takip döneminde yapıldı. Bu parametrelerdeki değişiklikler Student's t testi ile deçprendirildi. Sonuçlarımızın değerlendirilmesi ESWL tedavisinin renal fonksiyonda 3-6 ay içerisinde normal sınırlara gelen geçici bir değişikliğe yol açtığını gösterdi.

Diğer yandan, tedavi edilen ve edilmeyen böbreklerin sonografik değerlendirilmesi, böbrek çapında özellikle de her iki böbreğin parankima! kalınlığında herhangi bir anlamlı değişiklik göstermedi. Şok dalgalarının sayısı renal fonksiyonun bozulma derecesinde etkili olduğu görüldü. [Türk J Med Res 1994; 12(3): 131-135]

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