

## ORIGINAL ARTICLES

# The effect of shockwave lithotripsy on blood pressure, patients' tolerance to pain and perirenal hematoma in renal stone patients

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## ABSTRACT

**Purpose:** To assess the effect of extracorporeal shockwave lithotripsy (SWL) on blood pressure, patients' tolerance to pain and perirenal hematoma in patients with renal stones.

**Patients and methods:** One hundred eighty nine patients between 2007-2009 underwent SWL procedures at 4.5 and 5.5 KV with shockwaves of up to 4,000 and 5,000 shockwaves, they were followed up for post procedure pain, hypertension and perirenal hematoma. For statistical analysis, chi square test was used.

**Results:** One hundred fifty three (81%) patients developed post procedure pain. The degree of pain was of mild that relieved by analgesia to severe that required hospitalization, increasing energy level did not increase the chance of post SWL pain while the larger stones caused more post SWL pain ( $p = .003$ ). Fifteen patients (7.9%) developed post SWL hypertension, female patients and age more than 50 years found to increase the risk of post SWL hypertension. Post SWL hypertension is not affected by increasing energy level and number of shockwaves. Only one patient (0.52%) developed post SWL perirenal hematoma.

**Conclusion:** SWL has a high incidence of post SWL pain. Females and age above 50 years are more prone to develop post SWL hypertension. However the number of shockwaves and energy level did not increase the risk of developing post SWL hypertension. Perirenal hematoma is a rare complication of SWL.

**Key Words:** Renal stone, Shockwave lithotripsy, Pain, Hypertension, Perirenal hematoma

## 1. INTRODUCTION

Urinary stones have afflicted humankind since the earliest records of civilization.<sup>[1]</sup> The lifetime prevalence of urinary tract stone disease is about 10%, with the rate being higher in developed countries and less in developing countries.<sup>[1,2]</sup> Men are affected more than females with the rate being about

2:1.

Treatment of renal stone disease ranges from conservative to surgical intervention.<sup>[2,4,5]</sup> The surgical modalities include: extracorporeal shockwave lithotripsy (SWL), percutaneous nephrolithotomy (PNL), ureterorenoscopy (URS) and open surgery.<sup>[6]</sup>

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Renal stones can be fragmented using shockwaves that are generated by specific generators and the shockwaves are focused on the stone causing its fragmentation directly by mechanical stress or indirectly by the collapse of cavitation bubbles.<sup>[3,7]</sup>

Pain is the most common complication after SWL. The mechanism of pain is due to either the passage of the stone fragments, or due to the injury sustained by the skeletal muscles.<sup>[7,8]</sup> The pain is of varying degrees (mild, moderate and severe).<sup>[9,10]</sup> Post SWL pain ranges from 22.5% to 74%.<sup>[11,12]</sup> It can be assessed according to the visual analog scale (VAS) which is a patient self-report on a scale of 0-10.<sup>[13]</sup> It is usually treated on outpatient basis by the administration of analgesics in the form of NSAID or narcotics, and only few patients require hospitalization.<sup>[9,14,15]</sup>

Hypertension is another complication of SWL.<sup>[9]</sup> According to the WHO, hypertension is defined as having systolic blood pressure (BP) above 140 mmHg or diastolic BP above 90 mmHg.<sup>[16]</sup> A study showed that 45% of patients above 50 years will develop hypertension after SWL.<sup>[9,17]</sup>

The mechanisms of post SWL hypertension include: renal damage induced by any energy level of shockwaves, tubular atrophy, glomerular destruction, capsular thickening, perivascular fibrosis and mild arteriolar wall thickening. Hypertension in few cases is caused by the compressive effect of a perirenal hematoma.<sup>[18]</sup> Increased number of shockwaves has been attributed to cause permanent hypertension.

Perirenal hematoma occurs due to the effect of the shockwave which damages the renal parenchyma.<sup>[12,16,21]</sup> The patient presents with severe flank pain, tachycardia, local tenderness and sometimes shock. Diagnosis is by renal ultrasonography during the first 24 hour after SWL. Its incidence is about 0.28% to 0.9%.<sup>[12,16]</sup>

Although addressed in some studies, the effects of SWL on blood pressure, patients' tolerance to pain and perirenal hematoma are still controversial issues.<sup>[18,19]</sup> We try to show our experience in these subjects in a single center during April, 2007 to April, 2009.

## 2. PATIENTS AND METHOD

This is a prospective uncontrolled clinical study that was conducted from April, 2007 to April, 2009.

During 2 years 189 patients were enrolled. Ages ranged from 18-69 years. They had renal stones with size ranging from 6 mm to 27 mm (mean  $12.1 \pm 3.9$  mm). They were evaluated by history, physical examination and investigations which included: urinalysis and urine culture, blood biochemistry, imaging of the urinary tract which included kidneys, ureters

and bladder (KUB), ultrasound scan, Intravenous urography (IVU) and/or computed tomography (CT) scan.

Exclusion criteria included congenital urinary tract abnormalities, multiple renal stones, previous hypertension, bleeding tendency, and history of heart disease, duodenal ulcer and those patients with other risk factors of hypertension, *i.e.*, positive family history of hypertension, smokers and those with body mass index above 24. None of them had JJ stent and no emergency SWL were included. All patients had a single SWL session.

Patients were fast for 6 hours before SWL and they were given laxatives in the form of Bisacodyl tablet 5 mg orally a day before the procedure. A new pre-SWL KUB film and ultrasound were done for all patients on the evening before the procedure. The BP were recorded before the procedure. All were given analgesia just before starting the procedure in the form of Diclofinac Sodium 75 mg ampoule.

The SWL machine used was the "Siemens Lithostar Multiline". The energy source of this machine is an electromagnetic. The energy level of 4.5 KV and 5.5 KV with shockwaves numbers of up to 4,000 and 5,000 shockwaves.

All patients were checked after SWL by BP measurement. It was measured after 5 minutes of rest. The baseline BP of the patient was designated as an average of two measurements taken 5 minutes apart. These have been followed up for 3 years.

Post SWL ultrasound was performed during the first 24 hours after SWL, then after 3 days for perirenal hematoma and after 2 weeks. While a KUB film was arranged 2 weeks after the procedure to assess the effect of SWL on the stone.

Pain was assessed according to the VAS which was translated to patient's language and well explained. It was classified into no pain (VAS = 0), mild (VAS = 1-4), moderate (VAS = 5-7) and severe (VAS = 8-10).

For statistical analysis, chi square test was used. *P* values lower than .05 was considered statistically significant.

## 3. RESULTS

During this study, 189 patients received SWL for renal stone, 121 (64%) of them were males and 68 (36%) females, male to female ratio is 2:1.

Ninety six patients (51%) had left sided renal stone and 93 (49%) had right sided renal stone. Post SWL pain found in 153 patients (81%); 30 of them had mild pain, 65 had moderate pain relieved by Diclofinac sodium or Tamadol hydrochloride ampoules and 58 patients had severe pain requiring admission.

Table 1 shows statistically insignificant relation between the development of post SWL pain and the energy level used.

**Table 1.** Relation of pain to the energy level

Energy level KV	No pain VAS = 0	Mild pain VAS 1-4	Moderate pain VAS 5-7	Severe pain VAS 8-10	Total
4.5	29	27	52	39	147
5.5	7	3	13	19	42
Total	36	30	65	58	189

Table 2 shows the relation between post SWL pain and the size of renal stone. This relation is statistically highly significant ( $P = .003$ ). This indicates that the more stone size the more possibility of post SWL pain.

**Table 2.** Relation of pain to size of renal stone

Level of pain	6-10 mm	10-15 mm	15-20 mm	More than 20	Total
No pain	14(38.9%)	19(52.8%)	3(8.3%)	0(0%)	36(100%)
Mild	16(53.3%)	13(43.3%)	0(0%)	1(3.3%)	30(100%)
Moderate	23(35.4%)	25(38.5%)	16(24.6%)	1(1.5%)	65(100%)
Severe	19(32.8%)	34(58.6%)	2(3.4%)	3(5.2%)	58(100%)
Total	72	91	21	5	189

Post SWL hypertension found in 15 patients (7.9%), 9 of them (60%) were female, 6 patients (40%) were male.

Table 3 shows the relation between development of post SWL hypertension and energy level. This relation was statistically insignificant ( $P = .66$ ) in which energy level not related post SWL hypertension according to this results.

**Table 3.** Relation of energy level to changes in blood pressure

Energy level (KV)	Post SWL blood pressure		Total
	Normotensive	Hypertensive	
4.5	136	11	147
5.5	38	4	42
Total	174	15	189

Table 4 shows the relation post SWL hypertension and the numbers of shockwaves. This relation was statistically insignificant ( $P = .85418$ ).

**Table 4.** Relation of number of shockwaves to changes in blood pressure

BP after SWL	Number of shockwaves		Total
	4,000	5,000	
Normotensive	161	13	174
Hypertensive	15	0	15
Total	176	13	189

Table 5 shows the relation of age to the development of post SWL hypertension. This relation was statistically highly significant ( $P \leq .001$ ).

**Table 5.** Relation between age and BP after SWL

Post SWL blood pressure	< 50 years	> 50 years	Total
Hypertensive	7	8	15
Normotensive	148	26	174
Total	155	34	189

Only one patient (0.52%) developed perirenal hematoma.

#### 4. DISCUSSION

SWL is currently accepted as the treatment of choice for the majority of patients with renal stones. It is minimally invasive with low morbidity and complications. In this study 64% of the patients were male and 36% were females, giving a ratio of about 2:1 which is consistent with the results obtained by others.<sup>[1,4]</sup>

One of the drawbacks of SWL is pain. Eighty one percent of patients experienced post SWL pain. This is consistent with what is reported in literatures.<sup>[11,22]</sup>

In this study there was a significant relation between the size of stone and the development of pain after SWL ( $P = .003$ ), with larger stones causing more degree of pain after SWL. This finding is supported by Sun *et al.*, and Tiselius *et al.*<sup>[10,19]</sup> Increasing the energy level did not cause increased risk of developing post SWL pain ( $P = .65$ ).

Another complication of SWL is hypertension. In this study 7.9% of patients developed hypertension. This value is lower than that obtained by Yokoyama *et al.*, who recorded an incidence of 25%.<sup>[19]</sup> They attributed the development of hypertension after SWL to the number of shockwaves given, but this relation proved to be insignificant in this study ( $P = .85418$ ). Elves *et al.* recorded an incidence of 11%, (they used the Siemens Lithostar Multiline machine) and showed that there is no relation between the number of shockwaves and development of hypertension after SWL which is consistent with this study.<sup>[9]</sup> The energy level used showed no relation to the development of hypertension after SWL ( $P = .66$ ). This is consistent with the results obtained by Lingeman *et al.*<sup>[20]</sup>

Gender proved to have a significant effect on blood pressure in this study, with females having higher risk for development of post SWL hypertension as compared to males ( $P = .043$ ). This was also supported by the work of Claro *et al.*, this may be due to the higher age-related rise in blood pressure in women than in men.<sup>[23,24]</sup>

In this study age proved to have a significant effect on the development of post SWL hypertension, with patients above 50 years having greater risk of developing post SWL hypertension ( $P \leq .001$ ). This is consistent with international standard.<sup>[17]</sup>

A relative severe complication for the patient and confusing for the treating physician is perirenal hematoma which is due to direct injury to the renal parenchyma.<sup>[21]</sup> It is usually mild and self-limiting, but may be severe to cause shock that necessitates hospitalization and blood transfusion.<sup>[16]</sup> With regards to this study, the incidence of perirenal hematoma was 0.52%. This is consistent with the results obtained by others.<sup>[11, 12, 16]</sup>

## 5. CONCLUSION

SWL has a high incidence of post SWL flank pain despite receiving pre-SWL analgesia. The severity of pain being directly related to the size of stone treated. A small percentage of patients can develop post SWL hypertension, the mechanism of which is not well elucidated and it needs more prolonged period of follow up and more study (including color Doppler ultrasonography of the renal vessels for resistive index), and the patients should be treated accordingly. Females are more prone to develop this complication as those above 50 years of age. However the number of shockwaves and energy level do not increase the risk of developing post SWL hypertension. Occasionally the patient might develop perirenal hematoma.

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