



Efficacy of electromagnetic lithotripter in the treatment of renal and upper ureteral stones

Sadrollah Mehrabi^{1*}, Esmat Rasoli², Hamidreza Ghafarian Shirazi³, Amir Mehrabi²

¹Clinical Research Development Unit, Yasuj University of Medical Sciences, Yasuj, Iran

²Student Research Committee, Yasuj University of Medical Sciences, Yasuj, Iran

³Faculty of Medicine, Yasuj University of Medical Sciences, Yasuj, Iran

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ABSTRACT

Introduction: The innovation of outpatient extracorporeal shock wave lithotripsy (ESWL) has created a revolution in the treatment of urinary tract stones.

Objectives: The aim of this study was to evaluate the success rate of electromagnetic lithotripter, in the treatment of renal and upper ureteral stones.

Patients and Methods: In this study, 84 patients aged over 10 years, with renal and upper ureteral stones less than 20 mm, were considered for ESWL. Patients were randomly assigned into two groups. In all patients, using ultrasound and fluoroscopy, stone was localized and using an electromagnetic machine by standard method, ESWL was performed with electromagnetic waves. ESWL started with 12 kV and was increased to 18 kV, up to a maximum of 3500 shock waves. Two weeks later a kidney, ureter, and bladder (KUB) X-ray and ultrasonography was conducted and the success rate of lithotripsy according to the crushing of stones and decrease in stone size was measured and recorded.

Results: In this study, 61.9% of patients were male. The mean age of patients was 46.62 ± 13.12 years. The mean size of stones in both groups was 13.4 ± 2.5 mm. Around 56.3% of patients had opaque stones and 43.8% had non-opaque stones. A total of 63.5% of patients received up to 3000 shock waves and 37.5% of patients received more than 3000 shock waves. Complete efficacy and clearance of renal and ureteral stones was observed in 54.8% and 59.1% of cases, respectively ($P > 0.05$).

Conclusion: This study showed a similarity in the success and efficacy of electromagnetic lithotripter in the treatment of renal and upper ureteral stones. Additionally, the success rate of opaque and non-opaque stones have no significant differences, while stone size and proportion of shock waves will not increase the efficacy of the electromagnetic lithotripter in crushing the stones.

Implication for health policy/practice/research/medical education:

The innovation of outpatient extracorporeal shock wave lithotripsy (ESWL) has created a revolution in the treatment of urinary tract stones. It has been shown in different studies, that the success rate of extracorporeal lithotripter depends on the location, size and opacity of stones and have been reported to be between 43% to 85%. This study was performed on 84 patients with renal and upper ureteral stones less than 20 mm. We found a similarity in the success rate and efficacy of an electromagnetic lithotripter in the treatment of renal and upper ureteral stones. Additionally, no significant differences regarding opacity, size and location of stones in crushing the stones was seen.

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Introduction

Urinary stone disease is a common disease in all societies and is the third most common urinary tract disease, after urinary tract infections and prostate disease. In

20% of cases if not treated properly, urinary stones will lead to some degree of kidney dysfunction (1,2). The prevalence of urinary tract stones is between 5% to 10% and it is more prevalent in men (2). The recurrence rate is

*Corresponding author: Prof. Sadrollah Mehrabi, Email: sadrollahm@yahoo.com

estimated to be around 50%. In the past decade, there has been an increase in the prevalence of urinary tract stones (3). The innovation of the outpatient extracorporeal shock wave lithotripsy (ESWL) has created a revolution in the treatment of urinary tract stones. At present, this modality is the treatment of choice for renal and ureteral stones less than 20-25 mm. It utilizes high-energy waves that are capable of passing through body tissues to crush stones into smaller pieces (2-4). For clearance of stones, the success rate of ESWL in one study was 95% for stones less than 1cm and 88% in 1-2 cm stones of lower pole (5). The electromagnetic lithotripter is one kind of electro-hydraulic lithotripter that has been marketed in the last decades (6,7). The machine uses an isocentric imaging system that provides precise positioning and flat-out action. In different studies, the success rate of the extracorporeal lithotripter depends on the location, size and opacity of stones, while it has been reported to be between 43 to 85 % (5-10). However, studies on electromagnetic lithotripters are limited and have different results (6-8).

Objectives

This study aimed to evaluate the efficacy of electromagnetic lithotripter in the treatment of renal and upper ureteral stones.

Patients and Methods

Study design

A total of 84 patients older than 10 years were selected for this study by simple sampling method. The patients had renal and upper ureteral stones less than 20 mm and were referred to a urology clinic and were candidates for ESWL (September 2014 to October 2015).

For all the patients, history, complete physical examination and basic serum samples including, PT, PTT, CBC, Na, K, renal function tests (serum BUN and creatinine), urinalysis and urine culture tests were conducted. Patients with severe cardiovascular or pulmonary disease, coagulation disorders, uncontrolled hypertension, pregnant women and those with any contraindications for analgesic and narcotics drugs were excluded. To conduct lithotripsy, all patients had IV line and were maintained in supine position. After adjusting the patient's position and bed, the stone was localized by ultrasonography and fluoroscopy. Using an electromagnetic machine, the standard procedure ESWL was conducted using electromagnetic shock waves. ESWL started with 12 kilovolts (kV) and increased to 18 kV in 10 minutes up to a maximum of 3500 shock waves. Oxygen saturation was controlled by pulse oximetry using a device during operation. After outpatient lithotripsy, the patients were observed for 2 hours. Patients without complications, were discharged with prescription of oral antibiotics and analgesic drugs. Two weeks later, the patients revisited and kidney, ureter, and bladder (KUB) and ultrasonography were done. Thereafter, the success rate of lithotripsy

according to crushing of the stones and decrease in stone size were measured and recorded.

Ethical issues

The research followed the tenets of the Declaration of Helsinki. Informed consent was obtained. The research was approved by the ethical committee of Yasuj University of Medical Sciences (# YUMS.1394.72).

Statistical analysis

All data were collected and analyzed by SPSS 18 software using descriptive (frequency, mean and standard deviation) and analytical (independent sample *t* test and chi-square test) statistics and *P* < 0.05 was considered as the level of significance.

Results

In this study, 61.9% of patients were male and 38.1% were female. The mean age of patients was 46.62 ± 13.12 years. Regarding the location of stones; 47.6% of patients had proximal ureteral stones and 52.4% of patients had kidney stones. The highest rate of stone was found in the renal pelvis whereas the lowest was in the lower calyces. The size of the stones in 23.4% of the patients was between 5 to 10 mm. In 42.2% of patients, it was between 10 and 15 mm and in 34.4% of patients, it was between 15 and 20 mm. However, the overall average size of stones was 13.4 ± 2.5 mm. Regarding, opacity, 56.3% of patients had opaque stone while 43.8% had non-opaque stones. The duration of the procedure in 75% of patients was less than 40 minutes, and in 25% of patients it was more than 40 minutes. Around, 63.5% of the patients received up to 3000 shock waves and 37.5% of the patients received more than 3000 shock waves.

In 57.2% of cases, the efficacy of treatment has been perfect (complete crushing with the residue below 4 mm), was relative (residue below 4 mm) in 29.7% of the cases and was unsuccessful (non-crushing stones) in 13.1%

Table 1. Overall efficacy of electromagnetic lithotripter regarding rate of success

Overall efficacy	No. of patients	Percent
Complete	48	57.2
Relative	25	29.7
Failure	11	13.1
Sum	84	100

Table 2. Comparison of efficacy of electromagnetic lithotripter in renal and ureteral stones

Overall efficacy	Renal	Upper ureter
Complete (%)	64.3	59.1
Relative (%)	21.4	18.2
Failure (%)	14.3	22.7
Sum (%)	100	100

of the cases (Table 1). Complete efficacy and clearance of renal and ureteral stones was observed in 54.8% and 59.1% of cases, respectively ($P > 0.05$) (Table 2). Therefore, the efficacy of treatment in terms of location and size of stones in the kidney and ureter was not significantly different. None of the patients required anesthesia and did not report any complications requiring hospitalization and intervention.

Discussion

Nowadays ESWL is the treatment of choice for most renal and upper ureteral calculi less than 20 mm with success rates of 60%–99% (11,12). The success rate of ESWL depends on several factors such as stone size, location, stone composition, as well as the type of lithotripter (13–17).

In this study, 65.6% of patients had renal stones while 34.4% of patients had proximal ureteral stones. Most of the stones were located in the renal pelvis while the lowest rates were in the lower calyx. In both groups, the mean size of stones was 13.4 ± 2.5 mm. Around 56.3% of patients had opaque stone and 43.8% of patients had non-opaque stones. A total of 63.5% of patients received up to 3000 shock and the remaining 37.5% of patients received more than 3000 shock waves. It was found that complete efficacy in renal and upper ureteral stones were 54.8% and 59.1%, respectively. There was no significant difference in success rate regarding location, size and opacity of stones.

To evaluate the efficacy of ESWL in the treatment of urinary stones, 1645 patients were treated with Dornier Compact Delta Electromagnetic Lithotripter in the study conducted by Varshanidze et al. A total of 56.7% of patients were male and 43.3% were female. Of 1719 stones, 84.5% were opaque. They concluded that ESWL is the gold standard treatment of urinary stones less than 20 mm (18). Additionally, in a study by Elkholy et al, 97 patients (54 men, 43 women) with ureteral stones less than 10 mm were treated by ESWL. The patients had a mean age of 42.6 years and the mean shock numbers were 3125 shocks. All patients have some stone passage. They concluded that Dornier Compact 2 Electromagnetic Lithotripter has a high efficacy in the treatment of ureteral stones without any major side effects (19).

Our results are consistent with these studies regarding sex distribution, mean age of patients and mean number of shock waves. Nonopaque stones are more in our study but there was no difference regarding success rate, opacity as well as shock numbers that are inconsistent with other studies. This may be due to technical skills, type of stones and the poor cooperation of patients during the procedure. For comparison of ESWL in the treatment of renal and ureteral stones, 183 patients were evaluated by Neisius et al. Around 46% of stones were in the kidneys and 54% were in the ureter while most of them were located in the renal pelvis (32%). The mean stone size in the kidney and

ureter was respectively 10 and 8 mm. They concluded that stone free rate are higher in standard HM-3 lithotripter. They found ESWL is the first line of treatment in urinary stones less than 10 mm while the rate of retreatment and complication is low (20). Our results are somewhat consistent with this study. However, the mean size of stones was larger in our study and 65.6% of stones were in kidneys. However, the success rate was lower in our study. In another study by White and Klein, 4621 patients with urinary stones were treated with the electromagnetic Delta Lithotripter. The majority of stones were less than 10 mm and 74.4% of stones were in the kidney. The mean shock number was 2037 and the mean operation time was 23/8 minutes. The overall success rate during follow up was 85.1 % (21).

The results of the study by White and Klein are inconsistent with our results while, the success rate in our study was 57.2% complete and 29.7% relative (residual stone more than 4 mm). In addition, the mean time of ESWL was longer in our study. In fact, the lower efficacy and longer time of procedure in our study is somewhat due to larger and hard stones and more shock number and shorter time of follow up.

Likewise, Chung and Turney conducted ESWL in 130 patients with stones varying between 10–20 mm in size. Their overall success rate was 66.4%. Accordingly, the success rate regarding stone location in the upper, lower and middle calyx were 65, 64 and 70%, respectively. They concluded that, the efficacy of ESWL for larger stones (10–20 mm) are similar with smaller stones (22). Our results are similar with this study regarding overall efficacy, success rate and stone location but complete response in our study was lower than the study by Chung and Turney, which may be due to a shorter time of follow-up in our study.

Conclusion

The results showed a similarity in the success rate and efficacy of electromagnetic lithotripter in the treatment of renal and upper ureteral stones. Additionally, no significant difference in the success rate of opaque and non-opaque stones crushing was detected. In addition stone size and number of shock waves do not affect efficacy.

Limitations of the study

Difficulty in localization of non-opaque ureteral stones and interference with bone density.

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Authors' contribution

SM; the concept, design, data analysis, and manuscript preparation and final revision. ER; performing experiments and data collection and writing proposal. HGS; statistical analysis, manuscript editing, and manuscript review. AM, data collection and providing first draft and submission.

Conflicts of interest

None.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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