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The Effect of Physical Parameters and ESWL Outcomes: A Prospective Observation Study in Wasit, Iraq

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Abstract

Waste accumulation brought on by disease-induced renal dysfunction necessitates treatments, including stone removal, dialysis, or kidney transplantation. Extracorporeal shock wave lithotripsy (ESWL), a non-invasive procedure that breaks kidney stones into tiny pieces, can remove kidney stones that form in the urinary tract. Depending on a number of variables, the lifetime risk of kidney stones is between 1% and 15%. Calcium makes up about 80% of urinary stones. In this study, 100 patients with renal or ureteric stones measuring 4 to 39 mm underwent ESWL at the Al-Zahraa Teaching Hospital. 64 male and 36 female patients, ages 17 to 80, made up the sample. 65 radiopaque stones were found throughout the laboratory and imaging workup. 60% of the up to 3000 shocks per session were delivered at a frequency of 60 Hz.

Keywords: Kidney, stones, radiopaque stones, ESWL.

1. Introduction

Nephrolithiasis, a state of kidney stones, occur due were mainly caused by drinking impure water containing a lot of sediment, as well as the build-up of too many minerals due dehydration, and stagnation due to local irritation. Other reasons leading to the formation of kidney stones include the long and narrow structure of the male urethra and insufficient fluid intake [1]. Lifetime prevalence rates for this condition range between 1% and 15%. Stone prevalence has increased from 3.8% to 8.8% in the last 30 years based on the data obtained from the National Health and Nutrition Examination Survey. They discovered 10.6% of stones in men and 7.1% of stones in women, hence implying that higher prevalence of kidney stones in men than women [2,3]. The primary chemical composition of kidney stones includes calcium, which accounts stones consist by calcium oxalate (CaOx) are around 60-80%, but with calcium phosphate (Cap) makes up for 10-20%. The other compositions include a mixture of calcium oxalate and struvite (magnesium ammonium phosphate) 10-15%. Uric acid constitutes roughly 5-10% of stones, while cysteine stones account for less than about 1%. Several factors, including the age of the patient and their health complications, the size and composition of the stone, its position, the anatomy of the kidney. Sometimes patient preference, determine the treatment options that may be considered for renal stones [4-6]. Some of these treatment options include oral chemical dissolution, percutaneous nephrolithotripsy, retrograde intrarenal lithotripsy, *Extracorporeal Shock Wave Lithotripsy* (ESWL), and open surgery [6]. ESWL has been employed since 1980 when it was first introduced for the management of renal stones [7].

Extracorporeal Shock Wave Lithotripsy (ESWL) "is a non-surgical, outpatient medical procedure used to break up stones in the kidneys, ureters, and bile or pancreatic ducts". Ultrasound or fluoroscopic X - ray guidance to direct the shock waves on entering the body. The purpose of the procedure is to fragment the stones into pieces which can then be passed spontaneously through the urinary tract. While perirenal hematoma and cardiac dysrhythmias are potential side effects in 0.6% of the patients but this may be happened due another reasons. Where ESWL way is now the most common treatment technique used for kidney stones and the least side effects [8,9].

An imaging modality is required to visualize the stone and monitor its fragmentation process, and fluoroscopy or ultrasonography, or both combined, is typically used for this purpose [10]. One of the major disadvantages of using fluoroscopy imaging includes the cost of maintenance and exposure of the patients and staff to radiation. In addition to avoiding the issue of radiation exposure to both the patient and the staff, ultrasonography is an alternative imaging modality that can be used instead of fluoroscopy when searching for small or radiolucent stones [11].

The conventional stone fragmentation theories are based on the following factors: stress gradient and tensile fracture at the interface between stone and fluid. Acoustic cavitation, squeezing fracture, quasi-static squeezing with a broad focal zone and low pressure to maximize the Hopkins effect. Other factors have direct effect on fragmentation: cavitation, shearing, spalling, dynamic fatigue and dynamic squeezing [12].

2. Materials and Methods

Patients numbering one hundred were chosen from "Al-Zahraa Teaching Hospital" for a prospective observation study after token their oral agreement to use their information for this study. The study based on the following variables: Sex, age, body Mass Index (BMI), urinary tract infection (UTI), diseases of the adrenals, GIT disease, joint disease, renal congenital anomalies, previous treatment through lithotripsy, age of stone, number and size of the stone, duration of the procedure, type of equipment used during the procedure, radiological image of stones, number of shock waves, site of the stone, frequency of the shock waves, and complications of the ESWL

Laboratory investigations, including urinalysis, complete blood count, coagulation study, and renal function test, as well as KUB ultrasonography and radiography for stone visualization, were conducted on all participants. The size and location of the stones were confirmed by a radiology consultant. From Fig. 1, it is evident that the treatment modality applied to all patients was the "UROLITH+ ESWL PIEZOLITH 3000".

Figure 1: ESWL Machine model "UROLITH+ ESWL PIEZOLITH 3000" The image has been taken by the authors.

All patients received intravenous administration of antibiotics and injection of diclofenac 30 minutes before the procedure in case there were signs and symptoms of UTIs. Five days following sessions, patients were given antibiotics and pain killers. Patients stayed for one hour in the urology ward in order to monitor possible complications. Clearance of the stone and its pieces was done via KUB after seven days. Monitoring of the patient continued for four weeks, which is when patients either had clearance of the stone or failure to clear it. In the event that patients could not clear their stone via ultrasound treatment, another session was given two weeks after. Failure to show any fragments in four sessions meant that they should seek surgery and be dropped from the study- no patient there.

Furthermore, patients who failed to repeat the ESWL procedures after their disintegration failures were not included in the research.

To quantify this, information regarding the size and position of the stones was collected and correlated with the number of ESWL processes required for disintegration of the stones. "Statistical Package for Social Sciences 11.5 (SPSS 11.5)" was employed in analysing the data. Tables 1-6 present the findings per variable.

3. Results and Discussion

3.1 Gender disparity

The study revealed that the frequency of stones is greater in males compared to females; the former being 64 (64%) and the latter 36 (36%).

It is clear from Table 1 that there exists a statistically significant relationship between gender and stone frequency (P value= 0.005). There is enough data available to suggest that there exists a correlation between gender and stone frequency.

Another frequent finding within the current literature was that there was a predominance of males [4, 13].

Such gender disparities were noted among this study's subjects as well, as there was a predominance of males (64% versus 36%) in urinary stones. Such differences are brought about by such factors as hormones, dietary intake, and even the physiological differences. The statistical significance of the relationship confirms the necessity to take gender into consideration as one of the possible risk factors in stone formation. Similar conclusions can be drawn from another Iraqi study [14]. Males had stones more than females as shown in Fig. 2.

Table 1: The analysis of parameters

Gender	Value
male	**64 (64%)**
Female	**36 (36%)**
Chi-square test	**X2=7.840**
P value	**0.0051**

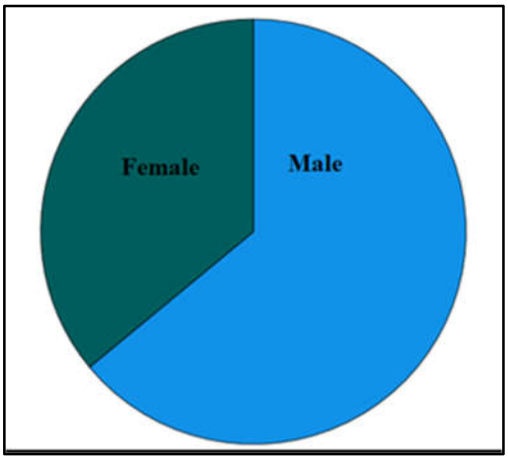

Figure 2: Gender difference**.**

3.2Site distribution of stones

In 32 cases, the left kidney was the most affected area, while the right kidney was the most affected area in 26 cases, according to an analysis done in Table 2, The result that stone formation was highest in the left kidney; Furthermore, the stones' formation is higher in the kidneys than in the ureters.

Table 2: Site distribution of stones

Site	Value
Rt kidney	26 (26%)
Lt kidney	32 (32%)
Rt upper ureter	20 (20%)
Lt upper ureter	17 (17%)
Rt lower ureter	2 (2%)
Lt lower Ureter	3 (3%)
Chi-square test	X2 = 44.120
P value	< 0.001

Right upper ureters were followed in 20 patients, while left upper ureters were followed in 17 patients, while the least followed stones were the left and right lower ureters in three and two patients, respectively. The P value obtained from this finding is 0.001, thus creating a statistically significant association.

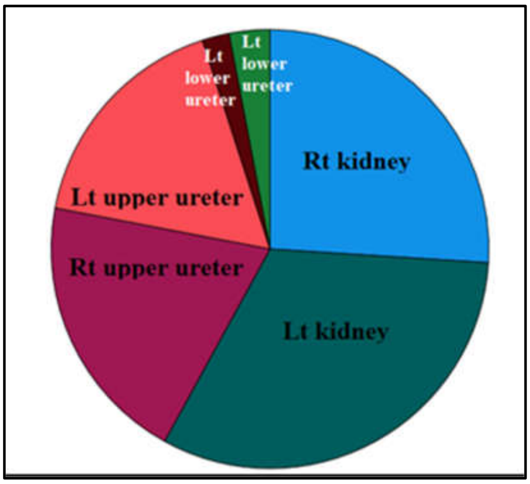

Figure 3: Site of stones

Stone prevalence at each site in the urinary tract is a key determinant in terms of treatment options. Stones that formed in both the left and right kidneys, as well as the upper ureters, were found to be much more prevalent than stones formed in the lower ureters. It is easier to pass smaller stones from the upper tract.

These findings are consistent with another study conducted in Iraq that discovered a propensity to include the left kidney. According to this study, the left kidney was the first anatomical location in 30% of cases, and 26% of cases had a right kidney stone. Urinary stones were more common in the other sites in a urinary system, with a tendency for numerous stones [14].

3.3 Difference in frequency of shocks

The majority of patients experience shock at a frequency of 60 Hz in 60%. While 27% of the time, 90 Hz. But the lowest cases get 120 Hz in 13% of the time. Table 3 and Fig. 4 below show that there was a statistically significant link between them (p value = 0.001).

Table 3: Frequency of shocks

Frequency / Hz	Value
60	60 (60%)
90	27 (27%)
120	13 (13%)
Chi-square test	X2 = 34.94
P value	< 0.001

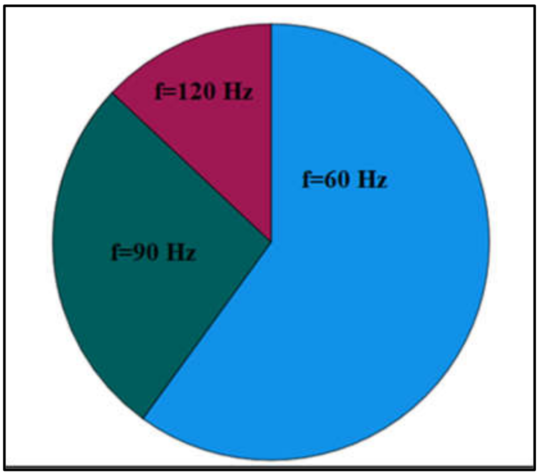

Figure 4: Frequency of shocks.

The frequency of the shockwave is another important factor in ESWL. The majority of patients in this study experienced shocks at a frequency of 60 Hz. The connection between the number of shocks and the results of treatment shows how important it is to pay close attention to shockwave parameters that are aimed at breaking up stones with the least amount of risk.

Many studies investigated the same kinds of shock waves in terms of frequency (60, 90, and 120 Hz), just like this one. They demonstrate that decreasing the firing frequency of the lithotripter to 60 Hz or lower diminishes the size of kidney lesions at frequencies of 90 and 120 Hz, resulting in a lower cure rate [15,16].

3.4 Total Shock number distribution

During the treatment period, the majority of shocks were 3000 (68%), followed by 2000 (11%), 4000 (8%), 1000 (7%), and 2500 (6%). There was a statistically significant association (P value = 0.001) when using chi-square, as shown in Table 4.

Table 4: Total Shock number distribution

Shock number	Value
1000	**7 (7%)**
2000	**11 (11%)**
2500	**6 (6%)**
3000	**68 (68%)**
4000	**8 (8%)**
Chi-square test	**X2 = 44.120**
P value	**< 0.001**

The number of shockwaves delivered during ESWL can affect the treatment outcome, which is an important variable parameter that affects how well the therapy works. Around 3000 shocks make up most of them. Fig. 5 clearly shows that there is a strong link between the number of shocks and the results of treatment. This shows that both patient factors and stone characteristics need to be taken into account such as stone' size and the percentage of their mineral, which will lead to more personalized treatment plans.

Most ESWL devices recommend no more than 3000 shocks per treatment for each kidney, but this can change depending on the equipment and whether the kidney is in the right place.

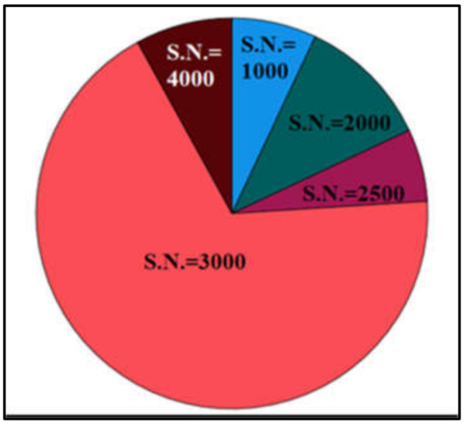

Figure 5: Total shock number distribution

If the kidney is not treated, it is safer to give more shocks because there is less chance of bruising, bleeding, contusions, hematuria, and kidney damage [17].

3.5 Number of sessions

Most of the patients had one session of 46%, 2 sessions of 37% whereas 16% had three sessions and 1% had four sessions. Statistically there is a significant association between them (P value less than 0.001).

Table 5: Number of sessions

Number of sessions	value
1	46 (46%)
2	37 (37%)
3	16 (16%)
4	1 (1%)
Chi-square test	$X^2 = 49.68$
P value	< 0.001

The number of sessions that are required for ESWL for the stone fragments are an important factor that plays a critical role in the management of patients. It is seen that a considerable number of patients required only one session of ESWL whereas others needed sessions ranging from 2 to 4 depended on stone size, location, and composition. These numbers are depicted below in Fig. 6.

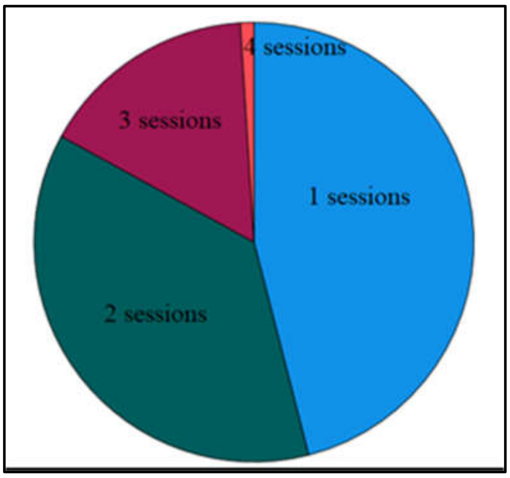

Figure 6: Number of sessions

The results obtained from the study conducted by Jasmin Alić et al. are quite close to our study, with about 59.1% of the patients being stone-free after a single treatment session. On the other hand, 17.4% needed two sessions while 6.1% needed three sessions. Another session was administered to those who performed poorly in their previous attempts [18].

3.6 Stone density

Table 6 shows the results of a statistical analysis that found out that 65% of the stones were radiopaque while 35% were radiolucent, and there is a statistically significant correlation between them (P value = 0.003, <0.05).

Table 6: Stone density.

Density	Value
Radiolucent	**35 (35%)**
Radiopaque	**65 (65%)**
Chi-square test	$X^2 = 9.00$
P value	**0.003**

Stone density is one of the crucial aspects which play a vital role in determining the outcome of the procedure. Radiopaque stones were common (65%) whereas radiolucent stones were rare (35%), which has been shown in Fig. 7. The above finding is in line with the concept that radiopaque stones are relatively easier to treat by means of shock waves since they absorb shock waves easily.

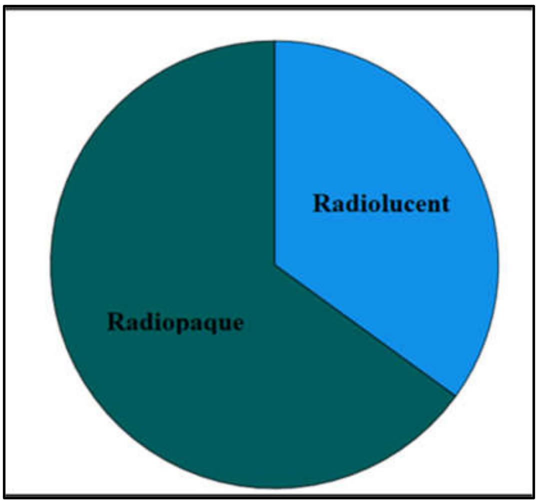

Figure 7: Stone density

Upon comparing our findings with those from studies [19,20], it becomes evident that our results complement theirs perfectly well. Radiopaque is the most common type of renal calculi and represents 70%-75% of all urinary stones. They are often combined with calcium phosphate so as to make them radiolucent. There is also a small quantity of cysteine and uric acid stones present. A second category of radiopaque stones is triamterene and magnesium trisilicate. As for the second most common type of bladder stones, there is radiolucent uric acid stones. They account for roughly 8%-10% of all urinary stones, ciprofloxacin, indinavir, sulphonamides and guaifenesin/ephedrine.

4 Conclusion

The recent prospective observational study on 100 patients with urinary stones was designed to emphasize the benefits associated with ESWL. Analysis of data acquired from the study identified some elements influencing the success or failure of the use of Extracorporeal Shockwave Lithotripsy (ESWL). According to the analysis after interrupting the results of parameters among themselves, were found that 46% of patients achieved a successful result in one treatment session using 3000 shocks at 60 Hz without any complications or failure in the procedure. This implies that such a discovery emphasizes the need for a proper consideration of different elements in relation to gender, stone location, parameters of shockwaves and stone density when planning an ESWL procedure. The current study contributes immensely to literature and there is a need for further research in this area of study.

5 References

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