



EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY; WHICH PARAMETER DETERMINES THE OUTCOME: CALCULUS RADIODENSITY OR CALCULUS SIZE

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Article received on:
25/06/2014
Accepted for publication:
22/11/2014
Received after proof reading:
17/01/2015

ABSTRACT... Objective: To evaluate the effect of urinary calculi attenuation values from non enhanced computed tomography (stone radiodensity) and stone size in determining the outcome of treatment by ESWL. **Study design:** Descriptive case series study. **Setting:** Department of Diagnostic Radiology, Lahore General Hospital Lahore, in collaboration with the Department of Urology, Lahore General Hospital Lahore. **Duration of study with dates:** Study was carried out over a period of six months from January 2012 to July 2012. **Subjects and Methods:** Seventy patients with solitary renal calculus of 05 mm – 20 mm size were evaluated for calculus attenuation values in Hounsfield Units on non enhanced computed tomography. Patients were being grouped according to calculus attenuation values as: 1) less than 500 HU (soft) 2) 500-1000 HU (medium) 3) more than 1000 HU (Hard). Patients were also distributed in three groups according to stone size as: 1) 5-10 mm 2) 11-15 mm 3) 16-20 mm. Patients were being subsequently treated with ESWL. During each ESWL session 3000 shockwaves were given. Stone clearance was documented by USG within three month after start of treatment. **Results:** Out of 70 patients stones were cleared in 84.3% (n=59) patients. According to the stone density, the rate of stone clearance was 100% (n=19) in group 1, 88.9% (n=27) in group 2 and 66.7% (n=24) in group 3. Regarding the stone size, stones were cleared in 88.9% (n=9) in group 1, 77.4% (n=31) and 90% (n=30) in group 3. The best outcome was in patients with stone diameter of 16-20 mm and a density of < 500 HU. The worst outcome was in patients with stone diameter of 11-15 mm and a density of >1000 HU. **Conclusions:** The attenuation value of stone has a greater impact on ESWL outcome than the stone size. Further these attenuation values of urinary tract stones before ESWL helps in determining the treatment outcome and in planning alternative treatment in patients with likelihood of poor outcome from ESWL.

Key words: Non enhanced computed tomography (nect), extracorporeal shock wave lithotripsy (eswl), attenuation value of urinary calculi, Hounsfield units (hu), stone density.

Article Citation: Akbar AA, Mahmood S, Majid A. Extracorporeal shockwave lithotripsy; which parameter determines the outcome: calculus radiodensity or calculus size. Professional Med J 2015;22(1):031-035.

INTRODUCTION

Urolithiasis is prevalent worldwide and it is considered third commonest urological problem¹. Prevalence of urolithiasis in Western countries is around 3%². Pakistan is included in the so-called “stone belt” constitute by areas with high incidence of urolithiasis. Advent of ESWL as noninvasive technique revolutionized therapy for renal tract stones. It is regarded effective and safe in 98% patients³.

Different factors have influence on the success rate of extracorporeal shockwave lithotripsy (ESWL) for kidney calculi: calculus type, calculus size, calculus location within the renal system and

the ESWL machine used⁴.

Computed tomography without contrast has become the investigation of choice in the assessment of acute flank pain⁵. CT has emerged as the radiological investigation of choice in diagnosing and treating patients of urinary tract stones, with up to 95% sensitivity, 98% specificity and 97% accuracy for detecting urinary tract stones⁶⁻¹¹. Use of non-enhanced computed tomography (NECT) for detecting attenuation values of urinary tract stones prior to extra-corporeal shock wave lithotripsy can help to propose treatment options and to plan alternative management in patients with

likelihood of poor outcome from ESWL. Gupta et al⁵ found best outcome in patients with stones having mean densities of ≤ 750 HU; Eighty three percent needed 3 or less ESWL sessions and clearance rate was ninety percent. They found worst outcome in patients with stone densities of > 750 HU; seventy seven percent needed 3 or >3 ESWL sessions and clearance rate was sixty percent only. The stone density was seen to be stronger indicator of outcome than stone size only.

CT attenuation values of renal stones can differentiate calculi that will fragment easily with ESWL from those stones that can require larger number of shock waves or will fail to fragment. A study by Joseph et al. demonstrated that rate of stone clearance was 100% for stones having attenuation value of less than 500 HU, 85.7% for 500-1000 HU stones and 54.5% for >1000 HU stones. The success rate of calculi with attenuation value of less than 1000 HU was found to be significantly better than calculi of more than 1000 HU¹².

In this study we analysed the impact of stone radiodensity as determined by the NECT and stone size on treatment outcome from ESWL for renal calculi.

MATERIALS AND METHODS

This study was done in the Department of Diagnostic Radiology, Lahore General Hospital Lahore, in collaboration with the Department of Urology, Lahore General Hospital Lahore. Duration of study was six months starting from January 2012 to July 2012.

Sample size was calculated as 70 cases with 12% margin of error, 95% confidence level and taking least expected percentage of usefulness of NECT for renal calculi before ESWL.

Seventy patients of both genders from 15 to 70 years of age included in this study with solitary renal calculus measuring 5 – 20 mm. Patients with pregnancy, congenital renal anomalies, renal failure and bleeding disorders were excluded from

the study. Technique used was non-probability, Purposive sampling.

All patients collected from Urology Outdoor, Lahore General Hospital, Lahore meeting the inclusion criteria were taken. Informed consent for NECT and ESWL taken. Age, gender and address of all patients were recorded.

Before ESWL all patients under went NECT with thin slices at the level of renal stone, using soft tissue window settings. Size and the mean density of the calculus recorded by drawing a region of interest (ROI) over the stone. Attenuation value of calculus measured in Hounsfield Units (HU) and patients grouped according to the attenuation values of calculus as: 1- Soft (< 500 HU). 2- Medium (500-1000 HU). 3- Hard (more than 1000 HU). The maximum diameter of stone was measured in millimetres (mm) and patients were grouped as: 1) 5 to 10 mm 2) 11 to 15 mm 3) 16 to 20 mm.

All patients underwent ESWL (Storz Medical Modulith SLX-F2). The process of stone fragmentation during therapy was observed by fluoroscopy or ultrasonography. Each patient was started with 0.5 KV and increased gradually after every 20 shock waves to a maximum of 6.0 KV. During each session of ESWL up to 3000 shock waves were given. Ultrasound for kidneys, ureter and bladder done after every session of ESWL to monitor fragmentation. Ultrasound was also done before the next session of ESWL to see location and clearance of fragments. Stone Clearance was determined by ultrasound within 3 months and was defined as: 1- Complete clearance of renal stone. 2- Fragment less than 5 mm (considered clinically not significant).

ESWL was considered unsuccessful after 3 months of start of treatment if there was: 1- Incomplete fragmentation of renal calculus (fragment size equal or more than 5 mm). 2- Failure of fragmentation on ultrasonography.

All the information was collected through a specially designed proforma. Data was analyzed for description using SPSS version 16. Quantitative

variables of interest (age, size of stone, stone density and total number of ESWL sessions of shockwaves) were presented as mean \pm SD and for qualitative variables (gender, category of stone and stone clearance) frequencies and percentages were calculated. Data was stratified with reference to calculus attenuation values, size of the calculus and age of the patient to explain effect modifiers.

Chi-square test was used for the statistical significance of stone-free rates. A p-value of 0.05 or less taken as significant.

RESULTS

The study was conducted on 70 patients for a period of six months in the Department of Diagnostic Radiology, Lahore General Hospital Lahore with collaboration of Urology Department, Lahore General Hospital Lahore.

The calculus size ranged from 7 mm to 20 mm with mean size 14.6 ± 3.8 mm. The highest number of patients had stone sizes between 11-15 mm i.e. 31 (44.3%). 9 (12.9%) patients had stone sizes between the size group 5-10 mm and 30 (42.9%) patients were in the size group 16-20 mm.

Ranges of stone density were between 355 HU to 1635 HU. Result showed that out of 70 patients 19 (27.1%) had stone density less than 500 Hounsfield Units on non-enhanced computed

tomography, 27 (38.6%) had between 500-1000 Hounsfield Units and 24 (34.3%) had stone density more than 1000 Hounsfield Units. Stones were cleared in 59 (84.3%) patients while not cleared in 11 (15.7%) patients.

Mean number of sessions in soft stone category was 1.3 ± 0.5 . In medium category it was 4.2 ± 1.1 and 5.4 ± 0.7 in hard stone category.

In soft stone category all 19 (100%) patients were cleared of stones. In medium category 24 (88.9%) patients had stone clearance while not cleared in 3 (11.1%) patients. Regarding hard stone category 16 (66.7%) patients had complete stone clearance and 8 (33.3%) patients were not cleared of stones.

Mean number of sessions in 5–10 mm size category was 3.2 ± 1.9 . In 11–15 mm category it was 3.7 ± 1.8 and 4.0 ± 1.9 in 16–20 mm size category.

In 5–10 mm size category, stones were cleared in 8 (88.9%) patients and not cleared in 01 (11.1%) patients. In 11–15 mm category 24 (77.4%) patients had stone clearance while not cleared in 7 (22.6%) patients. Regarding 16–20 mm size category 27 (90%) patients had complete stone clearance and 3 (10%) patients were not cleared of stones.

Category	Number	Cleared		Not cleared	
		No.	%age	No.	%age
Soft	19	19	100	0	0
Medium	27	24	88.9	3	11.1
Hard	24	16	66.7	8	33.3
Total	70	59	84.3	11	15.7

Table-I. Distribution of cases by stone clearance in different stone density categories (n = 70)

Category	Number	Cleared		Not cleared	
		No.	%age	No.	%age
5 – 10 mm	9	8	88.9	1	11.1
11 – 15 mm	31	24	77.4	7	22.6
16 – 20 mm	30	27	90	3	10
Total	70	59	84.3	11	15.7

Table-II. Distribution of cases by stone clearance in different stone size categories (n = 70)

DISCUSSION

CT without contrast has become mode of choice in the diagnosis of acute flank pain¹³⁻¹⁵. Main benefits of non-contrast CT scan are high sensitivity and specificity in the diagnosis of renal tract calculi, high speed, diagnosis of other pathologies and cost. Routine radiographs can not detect those stones reliably which are composed of cystine and uric acid. These stones can be detected easily with CT scan¹⁶.

Once urinary tract calculi are diagnosed, CT is also helpful in the necessary management by detecting calculus size, its location and composition by measuring its density. It is considerable and helpful to check the calculus composition before management. It will help the urologist in grouping patients according to stone density and treating accordingly. Thus patients having high density calculi can be treated endoscopically instead of ESWL. ESWL can not typically fragment those stones which are composed of calcium oxalate monohydrate and cystine¹⁷⁻²⁰.

In this study regarding soft stone category of < 500 HU all 19 (100%) patients were cleared of stones and required 1.3 ± 0.5 sessions. In medium category of 500-1000 HU 24 (88.9%) patients had stone clearance while not cleared in 3 (11.1%) patients, requiring mean of 4.2 ± 1.1 sessions. Regarding hard stone category 16 (66.7%) patients had complete stone clearance and 8 (33.3%) patients were not cleared of stones and required mean of 5.4 ± 0.7 sessions. These results are in accordance with literature findings of Joseph et al¹², who found in a study of 30 patients that patients with stones of less than 500 Hounsfield units had complete clearance and these patients required 2500 shock waves (medium), while patients with stones of 500 to 1000 Hounsfield units had 86% clearance rate and required a medium of 3390 shock waves. Patients having stones of ≥ 1000 HU had 55% clearance rate requiring a medium of 7300 shock waves. Another study of 112 patients by Gupta et al⁵ showed that patients with stones of ≤ 750 HU, 80% (41) needed 3 or <3 ESWL sessions and 88% (45) got complete clearance. Patients having

stones of ≥ 750 HU, 72% (41) required 3 or >3 sessions and 65% (37) had complete clearance.

This study also showed that in 5–10 mm size category stones were cleared in 8 (88.9%) patients and not cleared in 01 (11.1%) patients and required 3.2 ± 1.9 sessions. In 11–15 mm category 24 (77.4%) patients had stone clearance while not cleared in 7 (22.6%) patients, requiring mean of 3.7 ± 1.8 sessions. Regarding 16–20 mm category 27 (90%) patients had complete stone clearance and 3 (10%) patients were not cleared of stones and required mean of 4.0 ± 1.9 sessions.

Best outcome seen in patients with stone diameter of 16-20 mm & a density of < 500 Hounsfield units. Worst outcome seen in patients with stone diameter of 11-15 mm & a density of >1000 HU. It was analysed that attenuation value of stone has greater effect on outcome than the stone size. Gupta et al⁵ demonstrated best outcome in patients with stones diameter of < 11 mm and mean densities of ≤ 750 HU; 83% (34) required 3 or <3 sessions and clearance rate was ninety percent. Worst outcome seen in patients with stones densities of > 750 HU and diameters of > 11 mm; 77% (23) required 3 or >3 sessions and clearance rate was sixty percent only.

Use of non contrast CT prior to ESWL helps in detecting the stone density, which can predict its fragility and hence treatment outcome. This can help in the choice of other treatment options like percutaneous nephrolithotomy in patients with suspected poor outcome.

CONCLUSIONS

This study concluded that the attenuation value of stone has greater effect on ESWL outcome than the stone size. Further these attenuation values of urinary tract stones prior to ESWL help in determining treatment outcome and in planning alternative management options in patients with suspected poor outcome from ESWL.

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