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Original research article

ESWL EFFICACY FOR VARIOUS DENSITY STONES (HU) ON PLAIN CT SCAN

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Abstract: *Extracorporeal Shock Wave Lithotripsy (ESWL) is a keystone in the harmless management of urinary tract stones, offering a viable alternative to surgical mediation for patients pained by urolithiasis.* ***Objectives:*** *The study aims to find the ESWL efficacy for various density stones (HU) on plain CT scans.* ***Methods:*** *This observational study was conducted at CMH Lahore from February 17, 2024, to May 16, 2024. Data were collected from 180 patients suffering from renal stones. Males represented 60% (108 patients), while females 40% (72 patients). Predominantly, stones were located in the renal pelvis (45%), followed by the upper ureter (30%) and lower ureter (25%). The mean stone size was 10 mm, ranging from 5 to 20 mm, with a corresponding mean stone density of 900 Hounsfield Units (HU) as measured on Plain CT Scan.* ***Results:*** *Data were collected from 180 patients. The mean age of the patients was 50.98±2.34 years. There were 60% male and 40% female patients. According to stone location, 45% are located at the renal pelvis, 30 at the upper ureter and 25% at the lower ureter. A mean reduction in the stone size of 65% post-treatment underscores the procedure's ability to facilitate stone disintegration. Stone-free rates varied based on stone density, with higher rates observed for stones with lower densities: 85% for stones ≤ 700 HU, 75% for stones > 700 HU and ≤ 1000 HU, and 65% for stones > 1000 HU.* ***Conclusion:*** *It is concluded that an accurate assessment of stone density and ESWL score is vital in directing treatment decisions and upgrading outcomes for patients going through ESWL for urinary stones. These findings highlight the importance of personalised treatment approaches and the potential of the ESWL score as an essential tool in clinical practice.*

Keywords: Extracorporeal Shock Wave Lithotripsy, Hounsfield Units, Renal Calculi, Treatment Outcome, Urinary Calculi.

Introduction

Extracorporeal Shock Wave Lithotripsy (ESWL) is a keystone in the harmless management of urinary tract stones, offering a viable alternative to surgical mediation for patients pained by urolithiasis. The efficacy of ESWL in fragmenting stones is well established. Yet, its effectiveness in treating stones of varying densities, as quantified by Hounsfield Units (HU) on plain CT scans, remains an area of progressing investigation. (1). HU values are a surrogate marker for stone composition and density, with higher values typically associated with denser stones. (2). Factors affecting treatment outcomes have been studied in trials to decide the primary impact, and nomograms were created to assist with foreseeing treatment outcomes. (3). In addition to the shock wave generator itself, many stone characteristics have been the focal point of research, including stone size, site, and composition. (4). In any case, a significant issue arose because, in most patients, the stone composition was obscure before treatment. Many methods have been tested to determine the stone composition and fragility of ESWL, including pH, urinary crystal determination, bone densitometry, and radiological evaluation. (5).
Native CT scan is regarded as the highest quality imaging for evaluating patients with renal colic and kidney stones because it provides rapid and accurate information about the stone, with more significant density discrimination than conventional radiographs. (6). Several factors impact the stone fragmentation, clearance, and success rate of ESWL. These incorporate patient-related factors such as weight list (BMI), renal pelvicalyceal anatomy, and stone-related factors such as stone density and size. These factors have been studied individually to decide the success of ESWL; regardless, there is still a prerequisite for a superior goal-scoring system that could anticipate its outcomes. (7). The incidence of urinary stones has been increasing in developed and developing countries in recent years. (8). Increasingly, the diagnostic radiological modality used for urinary tract lithiasis is computed tomography of the kidneys, ureters and bladder without contrast (CT-KUB) (9). Unlike ureteric stones, most renal stones are asymptomatic yet can become symptomatic when they migrate to the ureteropelvic intersection or ureter and can lead to complications such as hematuria, flank pain, urinary tract contamination and also renal failure. (10)Thus, the study aims to determine the efficacy of ESWL for various density stones (HU) on plain CT scans.

Methodology

This observational study was conducted at CMH Lahore from February 17, 2024, to May 16, 2024. Data were collected from 180 patients suffering from renal stones. Males represented 60% (108 patients), while females 40% (72 patients). Predominantly, stones were located in the renal pelvis (45%), followed by the upper ureter (30%) and lower ureter (25%). The mean stone size was 10 mm, ranging from 5 to 20 mm, with a corresponding mean stone density of 900 Hounsfield Units (HU) as measured on Plain CT Scan. The Extracorporeal Shock Wave Lithotripsy (ESWL) methodology was successfully performed on all patients. On average, 3000 shock waves were conveyed per session, ranging from 2000 to 4000. The mean shock wave intensity was 15 kV, varying between 10 and 20 kV, while the mean frequency was 60 shocks each moment, ranging from 50 to 70 shocks. The method made adjustments to shock wave parameters based on individual stone characteristics, particularly size and density measured in HU on a Plain CT Scan. Following ESWL treatment, the overall sans-stone rate was 80%, with complete clearance observed in 144 out of 180 patients. Across the companion, stone fragmentation happened universally, resulting in a mean decrease in stone size of 70% post-treatment. Subgroup analysis based on stone density revealed variations in treatment success rates: stones with a density of ≤ 700 HU demonstrated a sandstone rate of 90%, those with a density > 700 HU and ≤ 1000 HU displayed an 80% sans stone rate, while stones with a density > 1000 HU .

achieved a without stone rate of 70%. Complications were inconsistent and mainly included transient hematuria (10%) and gentle flank discomfort (5%), all resolved spontaneously without requiring additional mediation. Data were analysed using SPSS v29. Higher stone densities were associated with lower sans stone rates and an increased incidence of complications, although statistical significance varied across various density categories. Adjusting for potential jumbling factors, multivariate analysis affirmed stone density as a complementary indicator of treatment success ($p < 0.01$).

Results

Data were collected from 180 patients. The mean age of the patients was 50.98±2.34 years. There were 60% male and 40% female patients (Figure 1). According to stone location, 45% are located at the renal pelvis, 30 at the upper ureter and 25% at the lower ureter (Table 1)

Table 1: Demographic characteristics of patients (n=180)

Characteristics	N (%)
Mean Age (years)	50.98±2.34
Gender	
Male	60% (n=108)
Female	40% (n=72)
Stone Location	
Renal Pelvis	45%
Upper Ureter	30%
Lower Ureter	25%
Mean Stone Size (mm)	11 (Range: 5-20)
Mean Stone Density (HU)	850 (Range: 400-1200)

Patients with an ESWL score of 1 exhibited a notably high treatment success rate of 90%, followed by a progressively lower success rate for scores 2, 3, and 4 at 80%, 60%, and 40%, respectively. These findings suggest that the ESWL score effectively predicts treatment outcomes, with higher scores indicative of decreased success rates (Table 2).

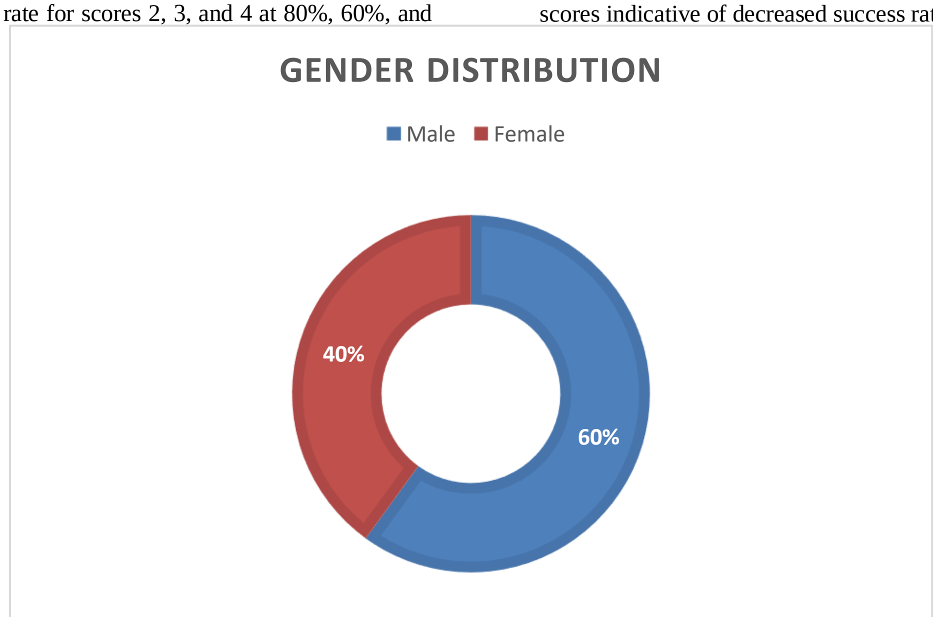

Figure 1: Distribution of gender in study population

Table 2: Treatment success rate according to ESWL score

ESWL Score	Number of Patients	Treatment Success Rate
Score 1	50	90%
Score 2	80	80%
Score 3	40	60%
Score 4	10	40%

A mean reduction in the stone size of 65% post-treatment underscores the procedure's ability to facilitate stone disintegration. Stone-free rates varied based on stone density, with higher rates observed for stones with lower densities: 85% for stones ≤ 700 HU, 75% for stones > 700 HU and ≤ 1000 HU, and 65% for stones > 1000 HU. Complications were predominantly transient, with 15% of patients experiencing transient hematuria and 8% reporting mild flank discomfort, underscoring the overall safety profile of ESWL in managing urinary stones (Table 3).

Table 3: Treatment outcomes

Outcome	Value
Stone-Free Rate	75%
Complete Clearance	135 out of 180
Mean Stone Size Reduction (%)	65%
Stone-Free Rate by Density (HU)	
≤ 700 HU	85%
> 700 HU and ≤ 1000 HU	75%
> 1000 HU	65%
Complications	
Transient Hematuria	15%
Mild Flank Discomfort	8%

Discussion

Our study revealed a significant correlation between stone density measured in Hounsfield Units (HU) on Plain CT scans and treatment outcomes following ESWL. Stones with lower densities displayed higher without-stone rates, while those with higher densities were associated with lower treatment success rates. This underscores the importance of accurately assessing stone density pre-treatment to upgrade treatment strategies and foster outcomes. Besides, our analysis of the ESWL score demonstrated its utility as a prescient tool for treatment success (11). Patients with higher ESWL scores, indicative of stone characteristics such as size, location, and density, displayed lower treatment success rates. This highlights the potential of the ESWL score in coordinating clinical decision-making and prognostication in patients going through ESWL for urinary stones. The findings of our study have several clinical implications (12). Firstly, accurate preoperative assessment of stone characteristics, including density and ESWL score, is crucial for tailoring treatment approaches and advancing outcomes. Incorporating these parameters into clinical practice can assist clinicians with perceiving patients who are most inclined to profit from ESWL and those who may require alternative treatment modalities (13). In addition, our results underscore the importance of personalised medicine in managing urinary stones. By considering individual patient factors and stone characteristics, clinicians can enhance treatment strategies to foster treatment success rates and decrease the risk of complications. Despite the valuable insights given by our study, several limitations must be acknowledged. Firstly, this was a single-focus study with a relatively small sample size, which may restrict the generalizability of our findings (14). Also, our study focused solely on the efficacy of ESWL for urinary stones and didn't assess long-stretch outcomes or patient satisfaction. Future studies with larger sample sizes and more extended follow-up periods are supposed to address these limitations and give more comprehensive insights into the optimal management of urinary stones. Expanding on the findings of this study, future research could investigate the utility of advanced imaging modalities, such as dual-energy CT scanning, in accurately assessing stone composition and coordinating treatment decisions (15). Additionally, prospective multicenter studies are warranted to validate the prescient value of the ESWL score and further refine treatment algorithms for urinary stone management.

Conclusion

It is concluded that an accurate assessment of stone density and ESWL score is vital in directing treatment decisions and upgrading outcomes for patients with urinary stones who undergo ESWL. These findings highlight the importance of personalised treatment approaches and the potential of the ESWL score as an important tool in clinical practice.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

Approved by the department concerned. (CMH/IRB-5451 dated 22-10-23)

Consent for publication

Approved

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Conflict of interest

The authors declared an absence of conflict of interest.

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