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Shock Wave Lithotripsy for Ureteric Stones: Success Predictors Based onCT-Scan Parameters

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Abstract

Introduction

Shock wave lithotripsy is a safe and effective therapy for nephrolithiasis, with minimal intrusive procedures. A variety of technical factors, as well as the patient's preferences, might have an influence on the procedure's outcome. The goal of this research was to identify the NCCT characteristics that would indicate if shock wave lithotripsy (SWL) is successful in treating ureteral stones.

Methods:

The research comprised 102 patients who got SWL for ureteral stones detected by non-contrasted computed tomography at the Department of Urology, NMCH, Sasaram, Bihar, between September 2019 and November 2022. Remaining stones larger than 4 mm were declared failures. Age, gender, BMI, stone size, location, skin-to-stone distance (SSD), the existence of a Double J stent (JJ stent), and the presence of secondary symptoms (hydronephrosis, renal enlargement, perinephric fat stranding, and tissue rim sign) were all assessed.

Results:

In 102 patients, stone size and density were highly associated with SWL outcomes, with a success rate of 61.8%. Secondary symptoms such as tissue rim sign, perinephric fat stranding, and hydronephrosis, as well as SSD, JJ, and SSD, were mild. According to multivariate analysis, the two independent variables impacting the result of SWL were stone size and density.

Conclusions:

The research found that in people with upper ureteral stones, stone size and density are major and independent predictors of outcome. SSD and impaction markers must still be evaluated, however.

Keywords: Outcome, Shock Wave Lithotripsy, Ureteral Stones.

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Introduction

Beginning with its therapeutic use in the early 1980s [1]. Shock wave lithotripsy (SWL) has become a popular treatment for renal and ureteral calculi due to its dependability, efficiency, and noninvasive nature.

The appropriate course of therapy must be decided by radiographic inspection of the stone. Non-contrast computed tomography (NCCT) is the accepted standard diagnostic imaging modality for urinary stone disease [3]. Several criteria have been used to predict SWL's performance [4]. The stone's size, positioning, density (Hounsfield unit and density), and presence of JJ are all characteristics that may be connected to the patient (skin to stone distance, or SSD) or to the stone. Other signs analyzed on a CT scan include the presence or absence of hydronephrosis, renal enlargement, perinephric fat stranding, and tissue rim sign [5]. By reducing the amount of unnecessary treatment sessions, identifying these traits in a clinical setting would improve effectiveness and reduce costs [5].

Material and Methods

From September 2019 to November 2022, 102 patients had SWL for solitary and radio-opaque ureteric stones ranging in size from 5 mm to 20 mm at the Department of Urology, SCB Medical college and Hospital, Cuttack.

Patients with missing data, missed follow-up, active UTI, bleeding propensity, or increased serum creatinine were excluded from this investigation. Age, gender, weight, height, body mass index (BMI), skin-to-stone distance (SSD), Hounsfield unit (HU), the presence of JJ, and secondary symptoms (hydronephrosis, renal enlargement, perinephric fat stranding, and tissue rim sign) were all assessed. The BMI for each patient was estimated by dividing their weight in kilograms by their height in square meters. The SSD on NCCT was measured using distances of 0°, 45°, and 90°. The SSD is calculated by taking the average of the three. Using a 5-mm collimation width from the pubic symphysis to the top of the kidneys, the HU for each stone was determined. The study focused on three areas of interest. The HU for that stone was a combination of the three areas' HUs. The presence or absence of perinephric fat stranding, tissue rim sign, and hydronephrosis were all considered supplementary indicators. The visual recognition of the dilated renal pelvicalyceal system helped to differentiate hydronephrosis. Perinephric fat stranding is the accumulation of adipose tissue surrounding the kidney. The tissue rim sign was defined as the presence of annular soft tissue caused by an edematous ureteral wall around the stones. SWL sessions were recorded using the Dornier lithotripter SII.

Under fluoroscopy, fragmentation occurred. During each session, adults got 3000 shocks and children received 1200 shocks at a rate of 80 per minute. Localization occurred every 500 shocks. Two weeks after the first session, plain KUB examined all patients to assess if the stones had broken down and whether more treatments were required. A second SWL session was considered for pieces measuring 4mm or greater. Three months after the last consultation, simple KUB examined all patients to ensure they were remaining stone-free. Clearance, defined as the complete removal of ureteral calculus, was recorded on a plain film two weeks after the last SWL session. Clinically insignificant residue.

Fragments (CIRF) are defined as pieces less than 4 mm, and patients with CIRF need conservative treatment.

The data were analyzed to identify clinical and radiologic parameters that are associated with treatment results. To assess the link between the different factors and outcomes, univariate analysis

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was used. The substantially linked variables were then tested for independent predictors of treatment outcome using multivariate logistic regression analysis. Statistics were considered significant with p-values ≤0.05.

Results

The research included 102 individuals with ureteric stones. The failure rate was 38.2%, while the success rate was 61.8%. A univariate analysis revealed no statistically significant differences in age (table 1) or sex (table 2). The success and failure groups had mean stone sizes of 9.3±2.2 mm and 11.2±2.2 mm, respectively (p <0.001) (table 1). Table 2 shows that the successful group had a mean density of 855±219, whereas the failed group had a mean density of 1039±267. The secondary symptoms (hydronephrosis, perinephric fat stranding, and tissue rim sign), the SSD (table 1), the JJ stent (table 2), and the SSD were all not statistically significant. Multivariate analysis revealed that stone size and density were both independent predictors of SWL success (statistically significant p values for size and density were 0.002 and 0.003, respectively) (table 3).

B=Regression coefficients, SE=Standard error of the coefficient, OR=Odds Ratio, 95% CI for OR = 95% confidence interval for the = Odds Ratio. P- value≤0.05 is considered significant

Table 1: Univariate analysis of the factors in success and failure groups

	Failed		Success		
	Mean	**SD**	**Mean**	**SD**	**P value**
Age	41	14	37	12	0.105
BMI	27.4	5.8	27.9	6	0.691
Size(mm)	11.2	2.2	9.3	2.2	<0.001
Mean SSD	10.1	0.9	10.1	0.8	0.830
Density	1039	267	855	219	<0.001

SSD= skin to stone distance, SD= standard deviation

Table 2: Univariate analysis of the factors in success and failure groups

		Failed		Success		
		Count	**%**	**Count**	**%**	**P value**
Sex	Female	9	39.1	14	60.9	0.920
	Male	30	38.0	49	62.0	
JJ stent	Yes	9	23.07	14	22.22	0.920
HN	Yes	30	67.9	47	74.6	0.791
Tissue rim sign	Yes	9	23.07	20	31.7	0.346
Perinephric stranding	Yes	4	10.2	3	4.7	0.423

HN= hydronephrosis

Table 3: Multivariate analysis

					95% CI for OR	
	B	**S.E.**	**p value**	**OR**	**Lower**	**Upper**
Size(mm)	0.366	0.116	0.002	1.4	1.1	1.8
Density	0.003	0.001	0.003	1.0	1.0	1.0

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Discussion

Upper ureteric stone removal with shock wave lithotripsy has been shown to be easy, safe, non-invasive, and effective. NCCT has recently been shown to predict the results of SWL therapy, which are measured using a range of metrics such as stone size, skin to stone distance, and stone density. The capacity to predict stone fragility has been examined using a range of radiological methods and variables [6]. Our research included 102 patients who underwent SWL. 39 patients (38.2%) failed, while 63 (61.8%) were successful. Goel et al. studied 110 people and divided them into two groups depending on the size of the stones: group (A) included 84 patients (76%), and group (B) had 26 patients (24%). In groups a (success) and B (failure), the average stone size was 8.1 mm and 11.3 mm, respectively. He found that the size of the stone significantly predicted SWL performance ($p<0.001$). Both univariate and multivariate analysis found that larger stone size was an independent predictor of SWL failure [5]. According to the results of Naoya et al. [7], the size of the stone was a significant and independent predictor of SWL success in patients with a single proximal ureteral stone. In all, 70% (223/319 patients) had no stones. The patients were divided into two groups: successful and unsuccessful. The mean and standard deviation for each group were 9±0.2 mm and 11±0.3 mm, respectively ($p<0.001$).They noticed that the failure rate increased with the size of the stone. Ozgur et al. studied 160 individuals with a single ureteral stone ranging in size from 5 to 15 mm. They underwent SWL. He divided the patients into two groups: success 110 (68.2%) and failure 50 (31.8%). Each group's median stone size was 9 mm, whereas the other was 10 mm ($p=0.349$). They discovered that stone size was not the main factor of SWL performance, which may explain the narrow range of stone diameters. Our research included 102 patients divided into two groups: success and failure. The average stone size in each group was 9.3±2.2 mm and 11±2.2 mm, with stones ranging from 6 mm to 17 mm. Patients in the success group had significantly smaller mean stones than those in the failure group ($p<0.001$). Yusuke et al. [9] studied 464 patients with ureteral stones who had SWL; based on the density of the stone, 324 (69.8%) were in the success group and 140 (30.2%) were in the failure group. The success and failure groups had mean HU values of 978.5 and 1280.5, respectively. Significant variations were seen among the factors influencing CT attenuation value ($p=0.01$). The success rate increased when HU fell below 1000. Goel et al. [5] divided 110 patients into two groups: successful (84, or 76%) and unsuccessful (26, or 24%). Patients were divided into three groups depending on HU: A (<750 HU), B (750-1000 HU), and C (>1000 HU) for success and failure. HU was not statistically significant ($p = 0.06$), however it was consistently low in the successful group (85% of patients had HU < 1000). Müllhaupt et al. [10] divided their 104 patients into two groups: success (52%) and failure (52%) for the objectives of their research. The mean HU value for the successful group was 956.7, whereas the failed group had a score of 944.6. ($P = 0.373$) The mean attenuation value was not a significant predictor of SWL performance. He hypothesized that the explanation was a small sample size and a narrow HU range. In a study of 50 patients who received a second-generation electrohydraulic lithotripter, Pareek et al. [12] found a correlation between calculus density and clearance. The study found that 36% of patients with residual calculi had a mean calculus density of ≥900 HU or less, whereas 74% of patients who obtained clearance had a mean of 500 HU. In our research, 102 patients were divided into two groups: successful (63 patients, or 62%) and failed (39 patients, or 38%). Each group was divided into three categories based on HU: <700, 700-1000, and >1000. Each group had a mean SD of 855±219 and 1039±267, respectively. The success group had reduced density compared to the failure group ($p<0.001$), indicating a strong independent predictor for SWL outcomes. 90% of patients with HUs less than 1000 achieved success. In a study of 464 patients with ureteral stones who underwent SWL, Yusuke et al. [9] discovered that 324 (69.8%) had effective results while 140 (30.2%) had unsatisfactory outcomes. SSD substantially predicted SWL outcomes ($p<0.001$). Each group had an

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average SSD of 9.6 cm or 9.9 cm. Goel et al. [5] found that SSD was not a significant predictor of SWL outcome (P = 0.913) after dividing 110 patients into success (84%) and failure (26%) groups. The averages for the success and failure groups were 90.0 mm and 96.0 mm. Ozgur et al. [8] shown that SSD was insignificant in determining the outcome of SW. They enrolled 160 patients with a single ureteral stone in their research and divided them into two groups: success (110 patients = 68%) and failure (50 patients = 32%). In the success group, the mean SSD was 125±23 mm, whereas in the failure group, it was 126±26 mm (p = 0.75). Choi et al. [11] divided 153 patients into two groups: group A had stones less than 10 mm and group B had stones larger than 10 mm. The success rates for groups A and B were 90.2% and 68.6%, respectively. SSD was shown to be a significant predictor of SWL result (P < 0.05), with mean SDs of 102.4±12.88 mm, 110.8±5.66 mm, 97.8±12.97 mm, and 107.9±13.02 mm, respectively. In our research, 102 patients were divided into two groups: 63 in the success group (62%), and 39 in the failure group (38%). In our research, the SSD on SWL results did not approach statistical significance (p>0.05). The success group had a mean SSD of 10.1±0.8 cm, whereas the failure group had 10.1±0.9 cm. The SSD's restricted range was to fault for this. Goel et al. [5] reported that the presence of secondary modifications was statistically significant (P = 0.023) between success and failure groups in univariate and multivariate analyses based on secondary changes (hydronephrosis, perinephric fat stranding, and tissue rim sign). In the success group, 27 patients had the adjustments, whereas 57 did not. In the failure group, 15 patients showed the changes, whereas only 11 did not (5). Choi et al. [11] divided 153 patients into two groups based on stone size: group A (≤10 mm) and group B (>10 mm). All secondary variables showed significant changes in SWL outcomes (p < 0.05). Boulay et al. [13] assessed 99 people retrospectively to assess the presence and severity of secondary obstruction symptoms. The presence and severity of secondary obstruction symptoms had no effect on treatment since they did not vary significantly between the two groups. A total of 102 individuals in our research were divided into success and failure groups. We observed that the results of SWL and secondary changes did not vary substantially (P > 0.05). The small sample size might be the culprit. Goel et al. [5] found that the existence of JJ between the success and failure groups was statistically insignificant (P = 0.06). JJ was present in the success group in 5 patients (7.2%), but not in the failure group in 64 patients (92.8%), or in 8 patients (19.5%), but not in 33 patients (80.5%). [5]. Müllhaupt et al. [10] reported no significant differences in predicting SWL performance (P = 0.825). There were 104 patients in all, 28 of whom got JJ stents. He divided JJ patients into two groups: successful and failed. The failure group consisted of 13 patients, whereas the success group included 15 patients. According to Ghoneim et al. [14], seventeen patients (28.3%) had just one session, with seven (23.3%) in the stented group and ten (33.3%) in the unstented group. 43 patients (71.7%), including 23 (76.7%) in the stented group and 20 (66.7%) in the unstented group, needed several sessions. Although the group with stenting had a higher incidence of re-treatment. The change was statistically insignificant. El-Assmy et al. [15] found that unstented patients had a higher success rate (91.4%) than stented patients (84.9%). The change was minimal. 102 individuals in our research were divided into success and failure groups. JJ was found in 14 (22.22%) of the patients in the success group and 9 (23.07%) in the failure group. We detected no differences in SWL outcomes between patients who underwent stenting and those who did not (P=0.920).

Conclusion

According to the research, individuals with upper ureteral stones exhibited substantial and independent prognostic factors based on stone size and density. However, SSD and impaction markers still need to be evaluated.

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