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Research Article

The use of Quadruple-D score for predicting the outcome of extracorporeal shock wave lithotripsy in less than 2cm renal stones

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Abstract

Introduction: The objective of the research is to assess the clinical use of the Quadruple D scoring technique for estimating the stone-free rate (SFR after extracorporeal shock wave lithotripsy (SWL) of renal stones less than 2 cm in diameter. **Patients and Methods:** 100 patients presented to the Minia Urology and Nephrology University Hospital SWL unit were studied. The skin to stone distance (SSD), stone density[HU], stone dimension (volume), and stone dispersion (distribution) are the four computed tomography-based parameters that make up the quadruple D scoring technique. The PiezoLith 3000Plus, a piezoelectric shockwave lithotripter, was used to conduct our investigation. Three weeks after the SWL session, SFR was assessed using the PUT. **Results:** The study found that, although age, gender, and stone laterality were not reliable predictors of SFR after SWL, stone size, stone density, stone distribution, patient BMI, and SSD were. The Quadruple-D score of the residual (n=29) group was significantly lower than that of the stone-free (n=71) group. Following the first SWL session, the Quadruple D score of 0, 1, 2, 3, and 4 points indicated SFRs of 0%, 0%, 46.15%, 84.21%, and 100%, respectively. The quadruple-D score is an important clinical assessment technique for predicting SFR after SWL. Regarding stone location, most groups with residual stones had lower calyceal stones, showing a statistically significant difference. **Conclusion**: The quadruple-D scoring system is an effective method for selecting the most qualified SWL candidates and a straightforward manual nomogram for predicting SFR after SWL.

Key words: SWL (extracorporeal shock wave lithotripsy), SFR (stone free rate), SSD (skin to stone distance), HU (Hounsfield unit), and PUT (Plain x-ray urinary tract).

Introduction

For kidney stones (10–20mm), shockwave lithotripsy (SWL) was created as a less invasive therapeutic alternative. Despite its well-documented efficacy and high patient satisfaction, SWL seems to be losing ground against endourologic therapies. Very different treatment outcomes (32%–90% for renal stones) have been blamed for the declining interest in SWL. One of the main reasons for this discrepancy in success rate -aside from technological difficulties and variations in reporting results- is poor patient selection. [1].

SFRs after SWL are influenced by several variables, including stone size and location, the composition of SWL-resistant stones (calcium oxalate monohydrate or cystine), stone attenuation values on computed tomography (CT), skin-to-stone distance

(SSD), spatial pelvicalyceal and lower pole anatomy of the kidney, patients' BMI and obesity, and shockwave delivery frequency. There is no consensus on the best prediction model, which is probably due to the complexity of modeling for clinical practice and/or heterogeneous recommenddations in practice guidelines when determining treatment modalities for renal stones, particularly those 10-20 mm in diameter.

Despite the fact that some combined parameters are useful for clinically predicting SWL outcomes, there is no consensus on the best prediction model. [2] There are several nomograms that may be used to forecast success after SWL. The Triple-D scoring system was proposed by Ichiyanagi et al.,[2] and as an extension of the Triple-D scoring system, Sengupta et al described a novel and simple nomogram approach was Quadruple-D score[3]. The objective of the research is to assess the clinical use of the Quadruple D scoring technique for estimating the stone-free rate (SFR) after extracorporeal shock wave lithotripsy (SWL) of renal stones less than 2 cm in diameter.

Patients and methods

- **Study design**

A prospective observational study was conducted on 100 patients who presented the Minia Urology and Nephrology University Hospital SWL unit between January 2022 and January 2023. For assessing the stone-free rate (SFR) of extracorporeal shock wave lithotripsy of renal stones 1-2 cm in diameter, the clinical efficacy of the Quadruple D score was evaluated.

The ethics committee registered, evaluated, and authorized this study, and each patient gave their written, informed consent.

Target Population:

100 people with SWL with renal stones ranging in size from 1-2 cm participated in our study. The following were the inclusion and exclusion criteria for our study:

❖ **Inclusion criteria:**

(1) Patients were older than 18 years old
(2) Patients had negative urine cultures
(3) For the target stone, the patient received SWL for the first time.
(4) This patient has no anatomical abnormalities of the urinary system.

❖ **Exclusion criteria:**

(1) Distal urinary system obstruction;
(2) Multiple kidney stones
(3) Stones were radiolucent
(4) Pregnant patients
(5) Stones in the calyceal diverticulum
(6) coagulopathy

Methodology:

All patients had baseline examinations to determine their suitability for therapy, the presence of renal stones, and the cause of SWL. Counseling was provided to patients who included for the study and a signed consent form was obtained.

❖ ***All patients were evaluated at baseline as follows*: -**

- **Medical and surgical history:** including DM, HTN, Coagulant diseases, anticoagulant drugs, and open or endoscopic surgery.
- **Physical examination:** especially, Abdomen and Genitalia.
- **Laboratory investigations:**

- Urine testing: eliminate urinary tract infection.
- Blood lab: CBC, Renal function tests and Coagulation profile.

- **Imaging**:

- Prior to SWL, renal stones were assessed with plain abdominal radiography (PUT) and a helical non-contrast CT (NCCT) scan of the kidney, ureter, and bladder region (CT-KUB).

- Stone Dimensions (stone volume=SV) was measured using the formula SV = $\pi/6$ × (anteroposterior × transverse × craniocaudal diameters) in millimeters.

- Three axial NCCT slices were used to compute the Stone Density [HU], one at the stone's largest diameter and two more, above and below the stone's poles.

- The average distance from the body surface to a particular stone on the NCCT

at 0°, 45°, and 90° was used to calculate SSD.

The sum of the number of components that met the cutoffs of 150 mm3 for SV, 600 HU for stone density, and 12 cm for SSD was added to generate the Triple-D (TrD-S) score. Combination the Triple-D score with location of the stones (i.e., distribution) is known as the Quadruple-D scoring method. The site scored a 0 point if the stone was placed at the lower calyx, whereas other locations received a 1 point [4] .

The score ranges from 0 (worst) to 3 (best) points and 0(worst) to 4(best), respectively, in the Triple-D and Quadruple-D scoring systems.

Table (1): Quadruple-D scoring system

Parameters	Score 1	Cutoff value	Score 0
Dimensions (mm^3)	<150	150	≥150
Density[HU]	400-600	600	≥600
Skin-stone distance (cm)	<12	12	≥12
Lower pole distribution	No		Yes

PiezoLith 3000 Plus, shockwave piezoelectric lithotripters were used.
The patient was told to lie supine on the lithotripsy table for the procedure after giving informed consent. An intravenous line was established, and analgesic were given.

The stone was focused using fluoroscopy, and it was adjusted using table movement. Patients were delivered 3000 shocks (max) at 60/90 shocks/min to each stone and the power of shocks was escalated gradually.

SWL was stopped when the stone seems to be completely free or after 3000 shocks have been given. Patients received analgesics, medical expulsive therapy, antibiotics, and antiemetic drugs after procedure.

All patients were assessed during post SWL: Every study patient was checked on 21 days following session. Follow up assessment included; history, clinical examination, PUT radiograph, and/or USG KUB were done after the procedure to assess SFR.

The patient had a second SWL session if any residual stones persisted after the procedure.

Treatment success and treatment failure for renal stones with SWL were defined as following for this study;

- Treatment success is defined as a kidney stone fragmenting to less than 2 mm in size or three weeks of stone-free status
- Treatment failure may stem from any of the following outcomes- :
  a) After two SWL sessions, the patient still had any significant residual stones.
  b) Patient needed any further kidney stone procedures, such as PCNL or ureteroscopy.

The paired T-test, independent T-test, Wilcoxon signed ranks test, and Mann-Whitney test were all performed using SPSS version 16. Significant is defined as $P < 0.05$.

Results

Table (2): Sociodemographic and baseline data of studied patients' group

Variable	Value Total 100 (100%)
Age (mean ± SD) Range	36.46± 13.45 (18-65)
Gender N (%) Male Female	 64(64%) 36(36%)
BMI N (%) < 25 25-29.9 30-34.9 ≥35	 47 (47%) 20 (20%) 24 (24%) 9 (9%)

In table (2), Mean age of study population was 36.46± 13.45 years, ranged from (18-65) years. (64%) of them were males. Regarding BMI (47%) of studied group had BMI less than 25.

Table (3): Data related to stones among studied cases

Variable	Value Total 100 (100%)
SSD (cm) (mean ± SD) Range	12.59±4.1 (8-20)
Stone laterality Right Left	 61 (61%) 39 (39%)
Stone Site Pelvic Upper calyx Mid calyx Lower calyx	 50 (50%) 2 (2%) 14 (14%) 34 (34%)
Stone volume mm3 (mean ± SD) Range	126.45± 37.7 (80-220)
Stone density -HU (mean ± SD) Range	945.5± 351.43 (480-1600)
Quadruple –D score Total (mean ± SD) Score 0 Score 1 Score 2 Score 3 Score 4	 2.41± 1.05 4 (4%) 13 (13%) 26(26%) 38 (38%) 19 (19%)

SSD: Skin-to-stone distance

Table (3) showed that Mean of SSD among studied sample was 12.59±4.1. More than half of study population (61%) had stones at right side. Fifty percentage (50%) patients had stones at the renal pelvis where (14%) had stones at middle calyx, (34%) at lower calyx, only (2%) at upper calyx. The mean ±SD for stone volume (mm^3) was 126.45± 37.7. Mean ± SD of stone density was 945.5± 351.43. The mean ±SD (score) Quadruple –D score was 2.41± 1.05. about (4%) of cases had score 0, (13%) had score 1, (26%) had score 2, (38%) had score 3 and (19%) had score 4.

Table (4): Stone free rate among all cases after 1st session, for 2nd session and after 2nd session

Time	Stone Free	Residual stone	Total
After 1st session	63 (63%)	37 (37%) (Needing for 2nd session)	100 (100%)
After 2nd session	8 (8%)	29 (29%)	100(100%)

Regards table (4), About (63%) of cases were stone free, while (37%) had residual stone and needed 2nd session. After 2nd session (29%) of cases had residual stones.

Table (5): Univariate analysis for association between sociodemographic, baseline data and SFR after 1st session of SWL

Parameters	Group (A) Stone Free N=63 (100%)	Group(B) Residual stone N=37 (100%)	Significance
Age (mean ± SD)	34.57± 13.47	39.68±12.97	P=0.07
Gender N (%)			
Male	36 (57.1%)	28 (75.7%)	P=0.07
Female	27(42.9%)	9 (24.3%)	
BMI N (%)			
< 25	43 (68.3%)	4 (10.8%)	**P=0.001***
25-29.9	20 (31.7%)	0 (0%)	
30-34.9	0 (0%)	24 (64.9%)	
≥35	0(0%)	9(24.3%)	

Independent sample t –test was used to compare means; Chi-square was used to compare qualitative variables.

In table (5), age and gender were not significant for prediction of stone-free status. There was significant difference (P=0.001*) regarding BMI between both groups, most of stone free group (68.3%) had BMI < 25, while (64.9%) of residual stone group had BMI of (30-34.9). Lower BMI was indicator for SWL success (after 1st session)

Table (6): Univariate analysis for association between data related to stones and SFR after 1st session of SWL

Parameters	Group (A) Stone Free N=63 (100%)	Group(B) Residual stone N=37 (100%)	Significance
SSD (cm) (mean ± SD)	9.89±1.18	17.19±3.04	**P=0.001***
Stone laterality			**P=0.09**
Right 61	41 (65.08%)	20 (54.05%)	
Left 39	22 (34.92%)	17 (45.95%)	
Stone site			**P=0.005***
Pelvic	38 (60.32%)	12(32.4%)	
Upper calyx	1 (1.6%)	1 (2.7%)	
Mid calyx	10(15.87%)	4 (10.81%)	
Lower calyx	14(22.22%)	20(54.1%)	
Stone volume mm3 (mean ± SD)	121.51±23.26	144.86±44.73	**P=0.02***
Stone density -HU (mean ± SD)	871.43±363.83	1071±0.62	**P=0.005***

Table (6) demonstrated that Mean of SSD was significantly lower among stone free group (9.89±1.18) than residual stone group (17.19±3.04), the difference was statistically significant (P =0.001). Regards stone laterality, there was no significant difference between both groups. Stone density was higher among residual stone group than free stone group. The difference regarding stone site in both groups was statistically significant, most of stone free group (60.32%) were at renal pelvis where (54.1%) of group (B) were lower calyx stones. The difference in the SV among both groups was statistically significant (P=0.02) (after 1st session).

Table (7): Comparison between Stone free and stone residual groups after 1st session of SWL regarding stone stent and complications

Parameters	Group (A) Stone Free N=63 (100%)	Group(B) Residual stone N=37 (100%)	Significance
Complications			**P=0.30**
Sub capsular hematoma	0 (0%)	1 (2.7%)	
Septicemia	3 (4.8%)	0 (0%)	
Steinstrasse	3 (4.8%)	1 (2.7%)	
No complication	57 (90.5%)	35 (94.6%)	

There was no significant difference between groups (A) and (B) regarding complications.

Table (8): Univariate analysis for association between Quadruple –D score and SFR after 1st session of SWL

Variable	Group (A) Stone Free N=63 (100%)	Group(B) Residual stone N=37 (100%)	Significance
Quadruple –D score			P=0.0001*
Total (mean ± SD)	3.03±0.65	1.35±0.68	
Score 0	0 (0%)	4 (10.81%)	
Score 1	0 (0%)	13(35.14%)	
Score 2	12(19.05%)	14(37.84%)	
Score 3	32 (50.79%)	6 (16.22%)	
Score 4	19(30.16)	0 (0%)	

In table (8) the mean ±SD (Score) quadruple –D was 3.03±0.65 and 1.35±0.68 in Groups A and B, respectively. The P value was 0.0001 (< 0.05), so the difference in the quadruple –D score in both groups was statistically significant. Quadruple –D score can be used as important clinical assessment tools to predict success rate of SWL (after 1st session).

Table (9): Univariate analysis for association between sociodemographic, baseline data and SFR after 2nd session of SWL

Parameters	Group (A) Stone Free N=8 (100%)	Group(B) Residual stone N=29 (100%)	Significance
Age (mean ± SD)	37.5±1.6	40.21± 13.6	P=0.09
Gender N (%)			
Male	8 (100%)	20(69%)	P=0.07
Female	0(0%)	9(31%)	
BMI N (%)			
< 25	4(50%)	0 (0%)	P=0.02*
25-29.9	0 (0%)	0 (0%)	
30-34.9	3 (37.5%)	21 (72.42%)	
≥35	1 (12.5%)	8 (27.58%)	

As regarding table (9) age and gender were not significant for prediction of stone-free status after 2nd session SWL. BMI showed significant difference between both groups, half of stone free group (50%) had BMI < 25. About (72.42%) of group (B) had BMI (30-34.9).

Table (10): Univariate analysis for association between data related to stones and SFR after 2nd session of SWL

Parameters	Group (A) Stone Free N=8 (100%)	Group (B) Residual stone N=29 (100%)	Significance
SSD (cm) (mean ± SD)	16.41±2.99	20 ± 0.01	**P=0.001***
Stone laterality			**P=0.06**
Right	4 (50%)	5 (17.2%)	
Left	4 (50%)	24 (82.8%)	
Stone site			**P=0.024***
Pelvic	4 (50%)	8 (27.6%)	
Upper calyx	0 (0 %)	1 (3.45%)	
Mid calyx	2 (25%)	2 (6.89%)	
Lower calyx	2 (25%)	18 (62.07%)	
Stone volume mm3 (mean ± SD)			**P=0.001***
Range	95.01± 5.35	145.86±44.56	
Stone density -HU (mean ± SD)	1036.21± 318.3	1200± 106.9	**P=0.03***

In table (10) regarding SSD, the mean ±SD was **(**16.41±2.99) compared to (20 ± 0.01) in group (B), using independent sample t test, the difference was statistically significant. Stone laterality was not statistically significant for the prediction of stone free- status. Stone volume was statistically significant for prediction of stone free- status after 2nd session of SWL, Stone density was significantly higher among group (B) than group (A). Regarding stone site, there was statistically significant difference among both groups, higher percentage of residual stones (62.07%) were in lower calyx.

Table (11): Comparison between Stone free and stone residual groups after 2nd session of SWL regarding complications

Parameters	Group (A) Stone Free N= 8 (100%)	Group(B) Residual stone N= 29 (100%)	Significance
Complications			**P=0.14**
Sub capsular hematoma	-	-	
Septicemia	-	-	
Steinstrasse	1 (12.5%)	0 (0%)	
No complication	7 (87.5%)	28 (96.6%)	

There was no significant difference within two groups regarding complications after 2nd session of SWL.

Table (12): Univariate analysis for association between Quadruple –D score and SFR after 2nd session of SWL

Variable	Group (A) Stone Free N=8 (100%)	Group(B) Residual stone N=29 (100%)	Significance
Quadruple –D score			**P= 0.002***
Total (mean ± SD)	2 ± 0.01	1.17±0.66	
Score 0	0 (0%)	4 (13.79%)	
Score 1	0 (0%)	13 (44.83%)	
Score 2	6 (75%)	8 (27.59%)	
Score 3	2 (25%)	4 (13.79%)	
Score 4	0 (0%)	0 (0%)	

Mean score of quadruple–D score was 2 ± 0.01, 1.17±0.66 among groups (A) and (B) respectively. The p value was 0.0002 using independent sample t test, so the difference in quadruple –D score in both groups was statistically significant.

Discussion

SFR after SWL is affected by a number of factors, in addition to technical ones; Appropriate selection of patients is one of the most prominent reasons for success. Stone proportions (stone volume, density, quantity of stones, load of stones, and stone composition), renal proportions (degree of hydronephrosis, intra-renal anatomy, pelvic calyceal system abnormalities, and renal function, and other patient variables (such as obesity all affect SFR following SWL.

Enhanced computed tomography (NCCT) has been used in a number of studies to predict SWL outcomes, and CT based nomograms have also been developed for this purpose. By evaluation the stone volume (SV), skin-to-stone distance (SSD), and stone density [HU] from NCCT trials. Recently, Tran et al., and collagues suggested a straightforward scoring method "Triple-D score " and concluded that this scoring system may increase the success rates of SWL[5]. The main advantage of (TrD-S) is that it does not need complex calculations and may be included in routine radiological reports.[6].

The objective of this study was to carry out external validation of the Quadrable D score as a dependent predictor of SFR after SWL for renal stones measuring 10 to 20 mm in size.

In our study, 24% of patients had a BMI between 30 and 34.9 and 47% of patients had a BMI less than 25, which are clinical indications of obesity. The majority of the stone-free group (68.3%) had a BMI of 25, whereas the group with residual stones (64.9%) had a BMI of (30-34.9). There was a significant difference in BMI between the two groups. Lower BMI was indicator for SWL success after 1st session. BMI after

the second session showed a significance difference between both groups, with 50% of the stone-free group having a BMI < 25 and BMI of (30-34.9) was seen in 72.42% of the residual group.

Our results were comparable to those of Pareek et al., who found that 28 of the 100 patients were left with residual stones, whereas 72 of the patients were in the stone-free group. After the first session, there was a significant difference; the mean of BMI between the Stone Free group was (26.9 ± 0.5) versus among the Residual group was (30.8 ± 0.9)[7].

Stone characters, in our study, showed that 50% of the patients had pelvic stones, 14% had mid-calyx stones, 34% had lower-calyx stones, and just 2% had upper-calyx stones. After the first session, 20 patients (54.1%) in the residual group had lower calyx stones, compared to 36 patients (60.32%) in the stone-free group who had pelvic stones. (62.07%) of patients in the residual group had lower calyx stones, while (50%) of patients in the stone-free group had pelvic stones after 2nd session, demonstrating that the difference in stone location is statistically significant.

As stated in Sengupta et al., study population, 69 patients (57.5%) had stones at the pelvi-ureteric junction, 14 (11.66%) had stones in the renal pelvis, 22(18.33%) had stones in the lower calyx, 12 (10%) had stones in the middle calyx, and three (2.5%) had stones in the upper calyx. 50(65.78%) of the patients in the free group had stones at the pelvi-ureteric junction after the first SWL session, 10(13.15%) had stones in the renal pelvis, and 15(34.09%) had stones in the lower calyx.[3]

According to Ichiyanagi et al., the study population of 131 patients (58%) had stones at the pelvi-ureteric junction,

renal pelvis stones in 27 patients (11.9%), lower calyx stones in 41 patients (18.33%), middle calyx stones in 22 patients (9.7%), and upper calyx stones in 5 patients (2.2%).

After 1st SWL session, there were 76 (61%) free patients who had stones at the pelvi-ureteric junction, 19(15.3%) free patients who had stones at the renal pelvis, and 28 (27.5%) patients in residual Group had stones in lower calyx who were (68%) of lower calyceal stone patients. So Lower pole position was hence a significant factor in the worse SFRs after SWL.[2]

The stone volume in our study ranged from 80 to 220 mm^3, with a mean of 126.45±37.7. There was a considerable difference between both groups regarding to stone dimensions. Following the first SWL session, the mean ±SD were (121.51±23.26) and (144.86±44.73) for free group and residual group respect-tively. After the second session, the mean ±SD for the free group was (95.01± 5.35) and for the residual group was (145.86±44.56), with a statistically signi-ficant difference between both groups.

Sengupta et al., study reported that the mean ± (SD) (in mm3) ellipsoid Stone volume was (396.44 ± 163.23) and (395.81 ± 227.52) for free and residual groups, respectively. The difference was statisti-cally significant and a dependent predictor of SWL success[3]. The differrence in stone volume, a strong factor in predicting SFR, was statistically significant, according to Wagenius et al., study.[8]

With Mean (±SD) of (945.5± 351.43), the stone density in our sample ranged between 480-1600 HU. According to our research, Density has a crucial role in predicting SFR and the difference between the free and residual patient groups was statistically significant. After the first SWL session, the mean densities were (871.43±363.83) and (1071±0.62) for free group and residual group, respectively. The mean densities were (1036.21± 318.3) and (1200± 106.9) for free group and residual group, respectively after the second session and the difference was statistically significant.

Sengupta et al., study reported that the mean ± SD (in HU) of stone density was (724.28 ± 210.90) and (814.56 ± 190.63) in

the free and residual groups respectively. The difference was statistically significant and a positive predictor of SWL effectiveness.[3]

Ouzaid and colleagues reported a 96% success rate for stones were less than 970 HU, however 62% of patients were more than that failed treatment.[9] Tran et al., reported that stones with HU densities higher than 900 are much more likely to fail SWL[5].

The SSD (Skin to Stone Distance) in our study ranged between 8 to 20 cm, with mean ± SD (12.59±4.1) cm. After the first SWL session, there was a significant difference in SSD between the two groups. The mean of SSD in the free group was (9.89±1.18) cm which lower than SSD in residual stones (17.19±3.04) cm. The mean (±SD) in the free group was (16.41±2.99) cm compared to (20 ± 0.01) cm in the residual group after the second session and the difference was statistically significant.

In contrast to our results, Sengupta et al., study reported that the mean of free group was (11.39±0.94)cm and (11.79±0.86)cm of residual group .The difference was negligible since the patients studied in his country were of low socioeconomic state.[3]

Our results are analogous to those of Pareek et al., study, who showed that the mean of SSD was (8.12 ±1.74) cm for the stone free group and (11.53 ±1.89) cm for the residual group .The difference was significant and SSD was effective predictor of SFR status after SWL.[7]

Seven individuals in our study sample had ureteric stents placed before starting treatment. Two patients were residual (6% of the residual group) and five patients were free (8% of the free group) after the first SWL session. One patient (12.5% of the free group) was free after the second session, whereas another (4% of the residual group) had residual stones. After the first and second SWL sessions, there was no statistically significant correlation between the ureteric stent and SFR, despite the fact that numerous patients had stent-related complaints. Our results closely resemble those of Wagenius et al., who reported that many people have bothersome symptoms from indwelling stents. The favorable effect of reducing stone-related symptoms after SWL is small and uncertain in terms of complications and SFR. Additionally, there was no correlation between maximum stone size and pre-operative stenting, and ureteral stenting had no effect on SFR after SWL.[8]

According to quadrable-D score of renal stones at our study, after 1st session of SWL, the Quadruple-D score of 0,1,2,3 and 4 points showed SFRs of 0%, 0%, 46.15%, 84.21% and 100%, respectively. The mean ±SD (Score) Quadruple –D was 3.03±0.65 of free group and 1.35±0.68 in residual group and the difference in the Quadruple – D score in both groups was statistically significant.

Sengupta et al., reported that SFRs of 0%, 45.83%, 68.05%, 82.35%, and 100% were produced, respectively, by a quadruple D score of 0, 1, 2, 3, and 4 points. The mean of the quadruple-D score was (2.09 ± 0.65) and (1.54 ± 0.79) in free group and residual group respectively. The difference in quadruple D score was statistically significant in both groups. The quadrable D score is essential for predicting SFR after SWL as a consequence.[3]

It is believed that the triple D score, to some extent, is a good indicator for predicting SFR independently of stone position. According to Ichiyanagi et al., study, the SFR was 40%, 51%, 73%, and 100% for the scores 0, 1.2.3, respectively. Statistics supported the significance of the difference.[2]

As a consequence, the Triple D scoring system has been proven accurate because the SFR showed a parallel increase with every positive component of Triple-D scoring system. The quadruple D scoring approach with a simple addition of stone location (non-lower polar vs. lower polar) may further simplify and increase the

validity of triple D scoring by enhancing SFR while maintaining a straightforward, keeping the calculation simple and easy to use.

In terms of complications, three instances (3%) of UTI in our study were treated with urine culture and antibiotics based on culture and sensitivity. One patient in our sample (1%) had a sub capsular hematoma after the first session and was treated conservatively. In our study, steinstrasse occurred in 5 patients (5%); we tried to treat all instances with alpha blockers, and after two weeks of follow-up, 2 cases were stone-free, with the other 4 requiring ureteroscopy URS. According to Abdel-Khalek et al., study, 4.9% of individuals had steinstrasse, 0.2% had septicemia, and 0.1% had subcapsular hematoma.[10]

After the second SWL session, 29 people still had residual stones. In our study, 13 patients needed PCNL, 7 needed RIRS, and 9 individuals were missed.

We come to the conclusion that the quadrable D score system is an effective method for identifying the most qualified SWL candidates and is a straightforward manual nomogram for predicting SFR after SWL. Therefore, limiting the use of SWL to patients who are anticipated to have positive outcomes using the quadrable D Score may boost SWL cost effectiveness. To assess the clinical relevance and accuracy of the quadrable D score in various patient categories, further studies with a higher number of populations are required.

References

1. Junbo, L., et al., Retrograde intrarenal surgery vs. Percutaneous nephrolithotomy vs. Extracorporeal shock wave lithotripsy for lower pole renal stones 10-20 mm: A Meta-analysis and systematic review. Urology journal, 2019. **16**(2): p. 97-106.
2. Ichiyanagi, O., et al., Reinforcement of the Triple D score with simple addition of the intrarenal location for the prediction of the stone-free rate after shockwave lithotripsy for renal stones 10–20 mm in diameter. International Urology and Nephrology, 2019. **51**: p. 239-245.
3. Sengupta, S., et al., An observational study on the predictability of the Triple-D score in the success rate of extracorporeal shock wave lithotripsy in renal stones 1–2 cm in diameter. Medico Research Chronicles, 2021. **8**(1): p. 55-63.
4. Assimos, D., et al., Surgical management of stones: American urological association / endourological society guideline, PART I. The Journal of urology, 2016. **196**(4): p. 1153-1160.
5. Tran, T.Y., et al., Triple D Score is a reportable predictor of shockwave lithotripsy stone-free rates. Journal of Endourology, 2015. **29**(2): p. 226-230.
6. Gökce, M.I., et al., External validation of triple D score in an elderly (≥ 65 Years) population for prediction of success following shockwave lithotripsy. Journal of Endourology, 2016. **30**(9): p. 1009-1016.
7. Pareek, G., et al., Extracorporeal shock wave lithotripsy success based on body mass index and Hounsfield units. Urology, 2005. **65**(1): p. 33-36.
8. Wagenius, M., et al., Factors influencing stone-free rate of Extracorporeal Shock Wave Lithotripsy (ESWL); a cohort study. Scandinavian journal of urology, 2022. **56**(3): p. 237-243.
9. Ouzaid, I., et al., A 970 Hounsfield units (HU) threshold of kidney stone density on non-contrast computed tomography (NCCT) improves patients' selection for extracorporeal shockwave lithotripsy (ESWL): evidence from a prospective study. BJU international, 2012. **110**(11b): p. E438-E442.
10. Abdel-Khalek, M., et al., Prediction of success rate after extracorporeal shockwave lithotripsy of renal stones A multivariate analysis model. Scandinavian journal of urology and nephrology, 2004. **38**(2): p. 161-167.