

Single Stage Extracorporeal Shock Wave Lithotripsy: A New Formula to Predict Outcome

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Abstract:

Introduction: Ensuring stone free status after ESWL is still difficult. Objective assessment of stone characteristic using noncontrast computed tomography (NCCT) like skin to stone distance (SSD), stone size and Hounsfield unit (HU) might help to predict the outcome. These factors were combined to develop a formula that could predict the success of single stage ESWL.

Objective: To evaluate the role of NCCT in predicting ESWL outcome using a formula that has been computed as 'Stone size x SSD x HU /100'.

Methods: Eighty patients with uncomplicated renal or upper ureteric stones who underwent NCCT prior to ESWL were included in this study and the formula was analysed. Stones of size 0.5 to 2.5 cm, measured in maximum diameter were included in the study. About 2500-3000 shocks were given (1Hz/18kvs) by Electrohydraulic machine. Stone remnant >4mm in size by NCCT after 6 wks was considered as residual stone.

Results: The mean SSD, Stone size & HU were 8.9 cm SD 1.67 (6.6-14), 1.3 cm SD 0.4 (0.6 -2.3) and 709.52 HU SD 296 (240-1440) respectively. The mean score was 86.35 SD 51.2 (19.97 to 259). The sensitivity, specificity, positive predictive value and negative predictive value were 94.44 %, 82.25 %, 85.00 % and 98.07 % respectively (P=0.007 by Chi square test).

Conclusion: Pre ESWL score less than 100 have the probability of stone free rate more than 98 percent. This formula can be considered for optimising patients for single stage ESWL in renal and upper ureteric stones with stone size < 2.5cm.

Keywords – ESWL, formula, HU, score, SSD

I. Introduction

More than 90% of stones in adults might be suitable for SWL treatment. However, success depends on the efficacy of the lithotripter and the following factors, like stone size, its location (ureteral, pelvic or calyceal) and composition (hardness) of the stones, patient's habitus, performance of SWL, and recently the stone-attenuation value. Each of these factors has an important influence on retreatment rate and final outcome of SWL (1). Even after the advanced technologies in the management of renal stones ensuring stone free status after ESWL is still difficult. Failure of ESWL results in unnecessary exposure to shock waves and radiation, and alternative treatments are needed to clear the stones, incurring additional expense.

Objective assessment of stone characteristic like skin to stone distance (SSD), stone size and Hounsfield unit (HU), stone composition, patient factor like obesity may affect stone fragmentation. Pareek et al found that skin to stone distance >10cm ESWL likely to fail (2). Ouzaid et al found out importance of HU. When HU was less than 970 HU the stone free rate were close to 96% and above which the stone free rate (SFR) reduces to 38% (3). Stone size, HU of stone and SSD were combined to develop a formula that could predict the success of single stage ESWL.

Figure 1. Combination of factors contributing to the Prediction score

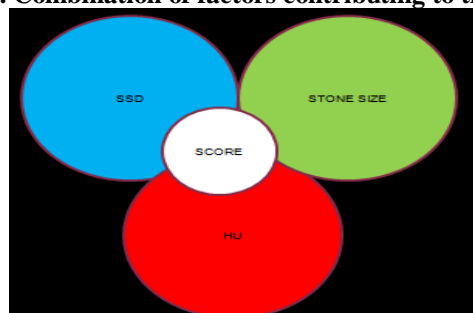


Fig.1 shows combination of factors contributing to the Prediction score which includes HU (attenuation score), SSD (skin to stone distance), Stone size in cms. These factors were directly proportional and cumulative to the fragmentation. Hence all were multiplied to include in the score. The calculation is simple. They were divided by 100 to reduce the digits and for easy applicability in practice like percentage as shown in fig. 2.

Figure 2. Formula to predict outcome

$$\text{SCORE} = \frac{\text{Stone size} \times \text{SSD} \times \text{HU}}{100}$$

II. Methods

Inclusion criteria:

- ⊙ Stones of size 0.5 to 2.5 cm
- ⊙ Renal or upper ureteric stones

Exclusion criteria:

- ⊙ Radiolucent stones not detected by C-arm
- ⊙ Could not tolerate the procedure
- ⊙ Multiple stones
- ⊙ Lost follow up

SPSS version 20.0 was used for statistical analysis. The prospective study was conducted for duration of 1 year (2013-2014). Eighty patients with uncomplicated renal or upper ureteric stones who underwent NCCT prior to ESWL were included in this study and the formula was analysed. About 2500 -3000 shocks were given (1Hz/18kvs) by Electrohydraulic machine. Stone remnant >4mm in size by NCCT after 6 wks was considered as significant residual stone.

III. Results

The mean SSD was 8.9 cm with SD 1.67(6.6-14), the mean Stone size was 1.3 cm with SD 0.4 (0.6 - 2.3), and the mean HU was 709.52 HU with SD 296 (240-1440). The mean calculated prediction score was 86.35 with SD 51.2 (19.97 to 259) in our study. The fig. 3 shows distribution of score with relation to location of stones in kidney which did not vary significantly.

The sensitivity, specificity, positive predictive value and negative predictive value were 94.44 %,82.25 %,85.00 % & 98.07 % respectively as shown in table 1.

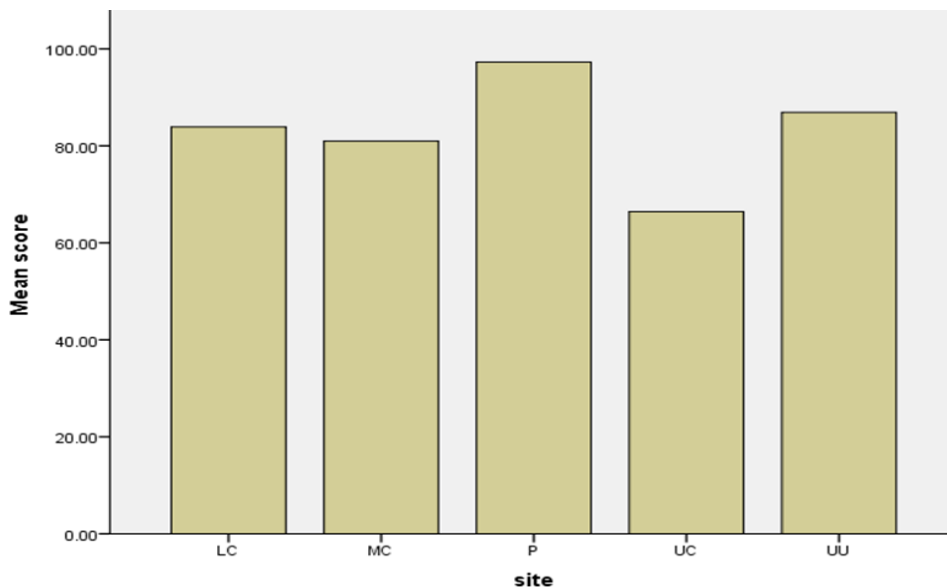


Figure 3. Distribution of score with relation to location

Table 1. The sensitivity, specificity, PPV and NPV are depicted here.

	RESIDUAL STONE	NO RESIDUAL STONE	
SCORE >100	17	11	28
SCORE <100	1	51	52
	18	62	80

The sensitivity	94.44 %
Specificity	82.25 %
Positive predictive value	85.00 %
Negative predictive value	98.07 %

P=0.007 by Chi square test

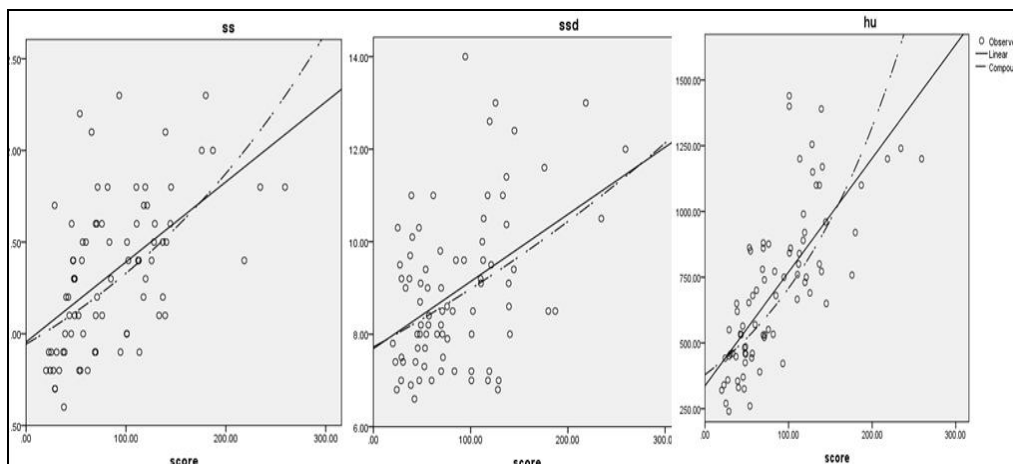


Figure 4 . Regression Curve Analysis for contributing factors of the Score which shows a steeper curve with HU showing its more weightage.

IV. Discussion

The Score used in the study is an objective assessment of stone fragmentability. Fig. 6 shows Regression Curve Analysis for contributing factors of the Breakability (1- Residual stone present, 0 is Residual stone absent on the y axis.). Among the factors the score its self is a significant predictor (p value = 0.000) and HU turned out to be independently an important influential factor (p value = 0.000) with the stone size being the least individually significant factor in our study (independent t test and ANOVA, p value = 0.35). When HU was less than 550 all the stone fragmented and when it was more than 550 other factors (SSD and SS) do decide the breakability.

Table 2

	rs10	N	Mean	Std. Deviation	Sig.
ss	1.00	18	1.4111	.44575	.353
	.00	62	1.3081	.40217	
hu	1.00	18	1034.0556	273.16370	.000
	.00	62	615.3065	230.12702	
ssd	1.00	18	10.5039	2.21674	.000
	.00	62	8.4823	1.16063	
score	1.00	18	146.5291	52.51618	.000
	.00	62	68.5473	35.18937	

RS- Residual stone 1 – present, 0 – Nil

Figure 5: Comparison of NCCT images before and after single stage ESWL showing clearance of upper ureteric stone. The score was 68.4 in this case 1.0 cm SS x 720 HU x 9.5 cm SSD.

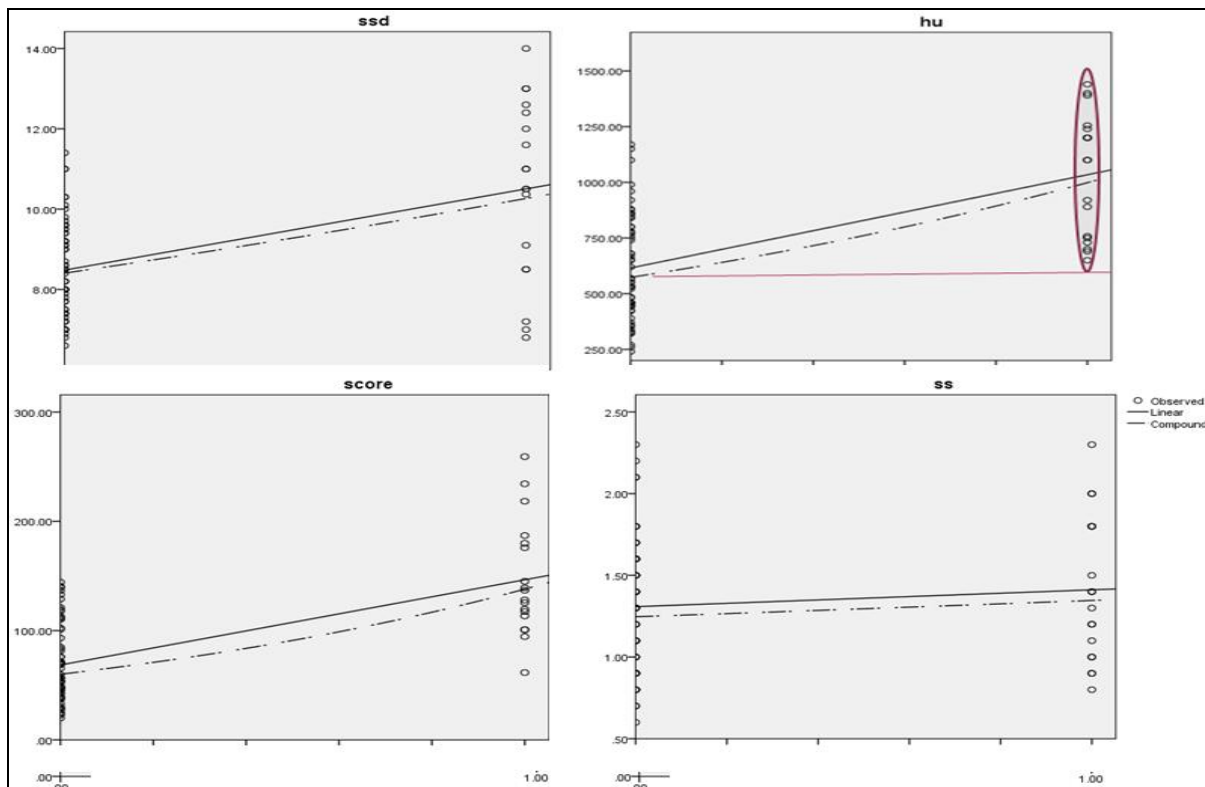
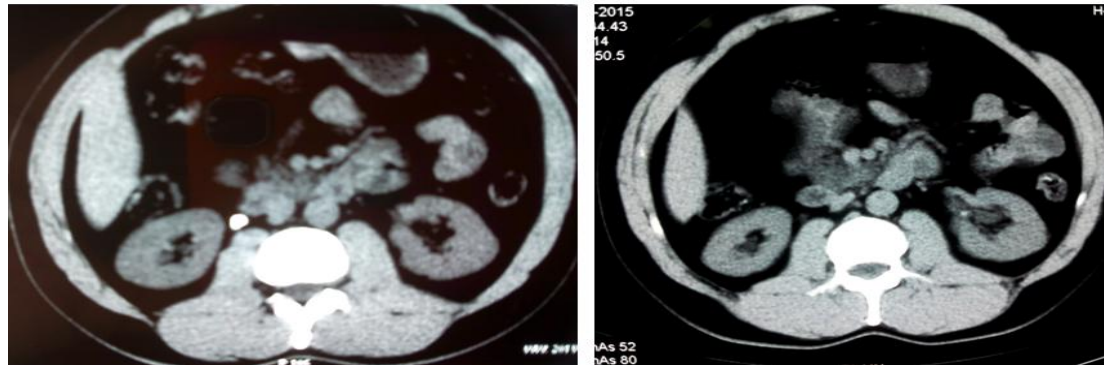


Figure 6. Regression curve analysis for contributing factors of the breakability

V. Conclusion

Pre ESWL score less than 100 have the probability of stone free rate more than 98 percent. If Score is more than 100, patient has to be counselled regarding the need for further intervention or opt out for PCNL in case of high chance of failure. Thus value of Score may aid in selecting patients for ESWL and thus improving the efficacy of ESWL. The Limitations of the study include smaller sample size, only easily calculable factors are considered and stone fragmentation is probably vary depending on shock-wave generating principle of the lithotripter. The score should be standardized for each type of machines. Multicentered large sample studies to validate and improve further.

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