Shock-wave Lithotripsy for Pediatric Patients: Which Nomogram Can Better Predict Postoperative Outcomes?

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OBJECTIVE To evaluate and to compare the accuracy of the Onal and Dogan nomograms for prediction of stone-free rate after shock-wave lithotripsy (SWL) in children.

MATERIALS AND METHODS We retrospectively analyzed the medical records of children <18 years old who had been treated with SWL for kidney stone in our department between January 2014 and December 2016. A single observer reviewed the records and both Onal and Dogan nomograms were calculated and compared with respect to their predictive capability for stone-free status.

RESULTS A total of 219 patients with a mean age of 82.7 months fulfilled the study inclusion criteria. In patients who were stone free and those with residual stones after completion of the first session, the mean Onal score was 2.83 and 4.12 (P = .01), and the mean Dogan score was 120.87 and 167.44 (P = .01), respectively. In patients who were stone free and those with residual stones after the third session, the mean Onal score was 3.02 and 4.14 (P = .01), respectively. Multivariate regression analysis identified both Onal and Dogan nomograms as independent preoperative factors for SWL outcome in pediatric patients (P = .001 and P = .001)

CONCLUSION Our study demonstrates that Onal and Dogan nomograms are independent predictors of stone-free rate following SWL in pediatric patients. UROLOGY ■■: ■■–■■, 2018. © 2018 Elsevier Inc.

Shock-wave lithotripsy (SWL) is a noninvasive and outpatient treatment option for management of pediatric stone disease. Current European Association of Urology guidelines recommend SWL as first-line therapeutic modality for most renal and upper ureteral calculi <20 mm.[1] SWL offers many advantages over endourological interventions, including noninvasive nature, outpatient procedure, and high patient compliance.[2] Several variable factors can affect the treatment outcome including size, number, localization, and composition of the stones and renal anatomy.

Nomograms can be used to improve surgical planning, patient counseling, and evaluation of outcomes and uniform academic reporting.[3] Especially for pediatric patients, it is important to obtain predictive information for stone-free rates before the procedure. Until recently, a useful nomogram for prognostic evaluation of pediatric SWL was unavailable. Onal et al and Dogan et al proposed a nomogram in 2013 and 2015, respectively.[4,5] These nomograms aimed to predict the success rates of SWL procedures in pediatric patients, by assessing age, stone size, history of stone treatment, gender, stone location, and stone number. Yet, the aforementioned nomograms have not been externally validated or compared.

The aim of present study is to evaluate and to compare the accuracy of the Onal and Dogan nomograms for prediction of stone-free rate after SWL in children. To the best of our knowledge, we present the first report that compares these two nomograms.

MATERIALS AND METHODS

After obtaining institutional approval, the medical records of children under the age of 18 and who had been treated with SWL for kidney stone in our department between January 2014 and December 2016 were retrospectively analyzed. Patient's characteristics, SWL related parameters, and postoperative outcomes were recorded prospectively. Patients with abnormal renal anatomy, nonopaque stones, known cystine stone disease, and urinary diversion (internal or external) were excluded from the study. Before the procedure, all patients were evaluated with ultrasonography (US) and intravenous urography. Sterile urine culture was obtained from each patient before SWL. Stone size was calculated

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by multiplying the longest diameter by the perpendicular diameter of the stone. The cumulative stone size for multiple stones was calculated as the sum of the size of each stone.

SWL Technique

The procedure was performed with a Compact Sigma (Dornier MedTech, Wessling, Germany) lithotripter under general anesthesia or intravenous sedation. All procedures were performed by a single experienced urologist. US and fluoroscopy were used for focusing. SWL therapy was started at a low voltage of 13 kV followed by a gradual increase of the voltage to a maximum of 20 kV. In each session, the average number of shocks was between 1800 and 2000. Follow-up plain films of the kidneys, ureters, and bladder and US were performed 1 week and 3 months after SWL. A repeat SWL session was performed after a minimum of 2 weeks after the initial procedure if incomplete fragmentation of the stone was noted. Children were considered to be stone free if complete stone clearance was achieved. Failure of SWL was defined as the persistence of stones with no fragmentation after 3 sessions, and these patients were referred for surgery.

Measurements

A single observer who was blinded to the SWL outcomes calculated the Onal and Dogan nomograms. Also, the observer was thoroughly informed regarding each nomogram as defined by the original articles. Patients were categorized into 3 groups according to Onal nomogram (low: 0-2, medium: 3-6, and high: > 6), and into 8 groups according to Dogan nomogram (points between 37 and 331).

The Statistical Package of Social Sciences for Windows version 20 was used for statistical analysis. We divided the patients into 2 groups based on postoperative stone-free status. Categorical variables were presented as numbers and percentages and compared with the chi-square test. Continuous variables were presented as means and standard deviations and compared with the independent sample *t* test. Correlation analyses were evaluated using Pearson's correlation coefficient. Logistic regression analyses were used to examine the possible association between the Onal and Dogan scores and the stone burden and stone-free status. Statistical significance was considered when 2-tailed *P* value was <0.05. Receiver operating characteristic curves were generated to assess the predictive role of both scoring systems and stone burden on stone-free rate after the first and third sessions.

RESULTS

A total of 219 patients (108 male and 111 female) fulfilled the study inclusion criteria and the mean age was 82.7 months. The mean stone size was 1.07 cm^2 and 16 patients (7.3%) had multiple calculi. The stone-free rates after the first and third sessions were 62.5% and 73.5%, respectively. The mean Onal and Dogan score were 3.3 ± 1.7 (range, 0-7) and 138.3 ± 69.9 (range, 0-313), respectively (Table 1).

When the patients were stratified according to stone-free status after 1 session of SWL, the gender, stone number, stone location, and the history of stone treatment were comparable between the 2 groups (*P* = .49, *P* = .11, *P* = .78 and *P* = .34, respectively). The mean age and mean stone size were significantly higher in patients who were not stone free (*P* = .02 and *P* = .01, respectively). In patients who were stone free and in those with residual stones after completion of the first session, the mean Onal score was 2.83 and 4.12 (*P* = .01), respectively, and the mean Dogan score was 120.87 and 167.44 (*P* = .01), respectively (Table 2). After the third session, the mean Onal score was 3.02 and 4.14 (*P* = .01), in patients who were stone free and those with residual stones, respectively (Table 2). The numbers of patients in each score subgroup are listed in Table 3. Also in univariate analysis, the present study has demonstrated that these 2 nomograms had a predictive value to foresee the stone-free rate following pediatric SWL (Table 3).

Multivariate regression analysis identified stone size, Onal, and Dogan nomogram as independent preoperative factors for SWL outcome in pediatric patients (*P* = .001, *P* = .001, and *P* = .001, respectively) (Table 3). The receiver operating characteristic curves of the 2 nomograms, stone volume, and SWL outcomes are demonstrated in Figure 1. The Dogan and Onal nomograms predicted SWL success with good accuracy, area under the curve (AUC) = 0.699, and AUC = 0.793 respectively (Fig. 1A and B).

Table 1. Demographic and perioperative characteristics of the patients

Gender (male/female)	108/111
Age* (month)	82.7 ± 64.3 (5-210)
History of stone treatment	
SWL	31 (14.1%)
URS	11 (5.0%)
PNL	8 (3.6%)
Open surgery	4 (1.8%)
Stone size* (cm^2)	1.07 ± 0.32 (0.48-2.2)
Stone number	
Single	203 (92.7%)
Multiple	16 (7.3%)
Operation side (right/left)	116/103
Stone location	
Upper calyx	28 (12.7%)
Middle calyx	66 (30.1%)
Lower calyx	44 (20.0%)
Renal pelvis	74 (33.7%)
Multiple site	7 (3.1%)
SWL session*	1.26 ± 0.56 (1-5)
Stone-free rate (after first session)	137 (62.5%)
Stone-free rate (after third session)	161 (73.5%)
Onal score*	3.3 ± 1.7 (0-7)
Dogan score*	138.3 ± 69.9 (0-313)

PNL, percutaneous nephrolithotomy; SWL, shock-wave lithotripsy; URS, ureterorenoscopy.
* Mean.

COMMENT

Previous reports have reported that SWL is highly effective in children with stone-free rate varying between 50% and 90%.[1,6] This diversity implies that many factors influence success, and appropriate patient selection is important. Factors such as size, location, and composition of