Original Article

Journal of Iranian Medical Council, Volume 8, Issue no. 1
0http://dx.doi.org/10.18502/jimc.v8i1.17073

Which is More Accurate? Urologist or STONE Nomogram: An Original Study

Behnam Shakiba[1], Mohammad Mehdi Atarod[2], Seyyed Ahmad Reza Hoseini[3], Ali Faegh[4]*, Robab Maghsoudi[1] and Asaad Moradi[1]

1. Department of Urology, Firoozgar Hospital, School of Medicine, Iran University of Medical Sciences, Tehran, Iran

2. Department of Urology, School of Medicine, Hasheminejad Kidney Center, Iran University of Medical Sciences, Tehran, Iran

3. Department of Endourology, Hashemi Nejad Kidney Center (HKC), Iran University of Medical Sciences, Tehran, Iran

4. School of Medicine, Alborz University of Medical Sciences, Karaj, Iran

Abstract

Background: Comparing and determining the accuracy of -urolo gists and STONE nomogram prediction about the Percutaneous Nephrolithotomy (PCNL) outcomes in urolithiasis patients.

Methods: This retrospective cohort study was performed on 70 patients who underwent PCNL in Firoozgar Hospital (Tehran, Iran) from March 2019 to April 2020. Two expert urologists, who were not informed about the actual result of the procedure and did not have access to the post-operative data, were asked to predict the success rate of PCNL based on pre-operative imaging. The remaining stone size of less than 4 *mm* was considered as stone-free in PCNL. On the other hand, the STONE nomogram calculated the stone-free rate, and if the predicted success rate was over 60%, PCNL was considered successful based on the STONE nomogram.

Results: The accuracy of the urologist's prediction was 76.42%. The STONE nomogram correctly predicted the PCNL result in 59 cases (84.28%). There was a significant correlation between the actual success rate of the PCNL and the nomogram's prediction (p-value= 1.013×10^{-5}). There was no significant difference between the surgeons and the nomogram's prediction (p-value=0.336). The number of stones did not significantly affect the correct prediction of surgical results (p-value<0.05). Upper calyx stones caused a significant difference between correct prediction of surgical results by surgeons and nomograms (p-value<0.05).

Conclusion: No significant difference was found between surgeons' prediction and STONE nomogram, but only in patients with kidney stones in the upper calyx; the nomogram's prediction accuracy was higher.

Keywords: Kidney calculi, Nomograms, Percutaneous nephrolithotomy, Urologists

*** Corresponding author**

Ali Faegh, MD
Alborz University of Medical Sciences (ABZUMS), Karaj, Iran
Tel: +98 26 3256 3318
Email: faeghali1999@gmail.com

Received: Dec 25 2023
Accepted: May 6 2024

Citation to this article:
Shakiba B, Atarod M, Hoseini SAR, Faegh A, Maghsoudi R, Moradi A. Which is More Accurate? Urologist or STONE Nomogram: An Original Study. *J Iran Med Counc.* 2025;8(1):175-81.

Introduction

As one of the most common urological disorders, kidney stones have approximately 10% prevalence in males and 7% in females, leading to one-third of urological surgeries allocated to nephrolithiasis treatment (1–3). Percutaneous Nephrolithotomy (PCNL) is the standard treatment of large kidney stones, which has a post-operative stone-free rate of about 85 to 93% (4).

Nowadays, to predict the outcome of PCNL, nomograms have been created that can predict the stone-free rate of a patient with kidney stones to a great extent. Guy's Stone Score (GSS), Stone-Tract Length-Obstruction-Number of involved calyces-Essence of stone density (STONE) nephrolithometry, and Clinical Research Office of the Endourological Society nephrolithometric nomogram (CROES) are the frequently used prognostic nomograms with high reliability and accuracy (5–7). The STONE nomogram is one of the scoring systems that is easy to calculate with a high accuracy of about 83% to predict the stone-free rate after PCNL. In addition to the stone-free rate, the STONE nomogram using the stone size, tract length, obstruction, number of stones, and stone density can predict the estimated blood loss, operation time, and length of hospital stay (6).

On the other hand, a urologist can predict the result of the surgery by relying on experience and imaging findings without using nomograms. The present study compares the accuracy of a pre-operative urologist's evaluation and STONE nomogram to predict the post-operative stone-free rate after PCNL surgery.

Materials and Methods

This retrospective cohort study was performed on 70 patients who underwent PCNL in Firoozgar Hospital (Tehran, Iran) from March 2019 to April 2020. Patients data were obtained by reviewing the patients documents. Iran University of Medical Sciences (IUMS) ethics committee approved this study. All over 16 years patients who underwent PCNL by an expert urologist due to larger than 20 *mm* kidney stones, staghorn, and partial staghorn calculi with complete pre-operative and post-operative information, including laboratory tests, non-contrast Computed Tomography (CT) imaging, *etc*., were included in this study. Patients with incomplete hospital documents and renal anomalies (horseshoe kidney, kidney with rotation, or single kidney) were excluded.

Information and patient characteristics, including age, gender, history of kidney stones, and imaging, were extracted by reviewing the patient's documents. By reviewing pre-operative non-contrast enhanced CT-scan, kidney stone data, including stone's type, stone's size (dimensions), number of stones (single stone, multiple or staghorn), and stone's location (upper calyx, middle calyx, lower calyx, kidney pelvis), were achieved and analyzed.

Patients with completely removed stones and patients with post-operative remaining stone sizes less than 4 *mm* were considered as having successful PCNL surgery. Otherwise, the surgery was considered unsuccessful (3). If the predicted success rate was over 60%, PCNL was considered successful based on the STONE nomogram. PCNLs with a predicted success rate of less than 60% were considered unsuccessful. The pre-operative non-contrast CT scan, stone morphology, and kidney anatomy of the patient were given to two expert urologists, who did not know the result of the surgery and did not have access to the post-operative images and information. Urologists were asked to predict the PCNL's success rate based on their experience and not using nomograms.

STONE nomogram predicts the success rate of PCNL based on stone size, tract length, obstruction, number of stones, and stone's Hounsfield. The stone size is scored from 1 to 4 based on the estimated size. Tract length is defined as the mean of the mean vertical distance between the skin and the center of the stone in the supine position, which non-contrast CT-scan estimates in 3 different angles (0°,45°, and 90°). For patients who have a Body Mass Index (BMI) ≥30 kg/m^2 The tract length is scored 1 for 100 *mm* and less and 2 for distances above 100 *mm*. The obstruction is scored based on the degree of hydronephrosis. Patients who do not have hydronephrosis and mild dilation are scored 1, and patients with moderate to severe dilation are scored 2. In cases of only one calyx involvement, patients get 1 point, patients with 2 or 3 calyx involvement get 2 points, and patients with staghorn calculi get 3 points. The last variable is stone essence, defined as the stone density. Patients with stone's Hounsfield unit of 950 or less scored 1, and

Table 1. STONE nomogram predictor

Score	1	2	3	4
Stone size (mm^2)	0-399	400-799	800-1599	≥1600
Access length (*mm*)	≤100	>100		
Obstruction (hydronephrosis)	None or mild	Moderate to severe		
Stone number	1 - 2	3	Staghorn calculi	
Essence (Hounsfield units)	≤950	>950		

Success rate of the surgery based on overall score									
Score	5	6	7	8	9	10	11	12	13
Success rate (%)	94	88	92	83	64	42	27	27	25

those with denser stones (higher than 950 Hounsfield units) scored 2. As the sum of each variable, patients get 5 to 13 scores. As shown in table 1, patients with higher scores are predisposed to have more complex surgery with a lower post-operative stone-free rate.

Ethics

Iran University of Medical Sciences Ethics Committee approved the study protocol (IR.IUMS.FMD.REC.1401.196).

Statistical analysis

Patients were divided into two groups by gender (male and female group) and two groups by age (16 to 64 and ≥65 years). After analyzing the data and comparing the prediction of the STONE nomogram and the urologists with the final result of the surgery, the accuracy of the surgeon's prediction without using the nomogram and the STONE nomogram prediction was measured.

The information extracted from the patient's documents was converted into an Excel file, then entered as a data frame in Python 3.8 software and cleaned by the Pandas library. Statistical tests were performed by the SciPy library, and graphs were drawn using Mat-Plot-Lib and Seaborn libraries. The analysis results were reported as values and percentages for qualitative variables and mean and Standard Deviation (SD) for quantitative variables. The Shapiro test was used to check the normality of data distribution. The p-value < 0.05 was considered statistically significant.

Results

Data from 70 patients who fulfilled the study inclusion criteria were analyzed. The mean age was 49.97 with an SD of ±12.32. Fifty-three patients (75.71%) were male, and 17 (24.28%) were female. 48.57% had left kidney involvement, and 51.42% had right. Forty-nine patients (70%) had successful PCNL according to the mentioned criteria, and 21 (30%) had unsuccessful PCNL. Twenty-eight patients (40%) had single stones, 29(41.42%) had multiple stones, and 13(18.57%) had staghorn calculi. Upper calyx was involved in 18 patients (25.71%), 26(37.14%) had middle calyx, and 45(64.28%) had lower calyx involvement. Also, 61 patients (87.14 %) had renal pelvis involvement. Patient's and stone characteristics are summarized in table 2.

As shown in table 3, the STONE nomogram predicted a stone-free rate of 72.95 % (SD:±21.29) after PCNL. The first urologist estimated that 44 patients (62.85 %) had successful PCNL, while the second surgeon predicted a successful PCNL for 59 (84.28%). On the other hand, the STONE nomogram for 17.14% of cases predicted an unsuccessful PCNL and 82.86% predicted a successful procedure.

Comparison of the accuracy of surgeons and STONE nomogram in predicting the outcome of PCNL surgery

The first surgeon predicted the results of 53 surgeries (75.71%), and the second correctly predicted the results of 54 surgeries (77.14%). The average of correct prediction of surgery results among the two

Table 2. Patient's and stone characteristics

Variable	N(%)
Age (years)	
16 – 64	63(90)
65 ≤	7(10)
Gender	
Male	53(75.71)
Female	17(18.57)
Stone laterality	
Left	34(48.57)
Right	36(51.42)
Stone location	
Upper C	18(25.71)
Middle C	26(37.14)
Lower C	45(64.28)
Pelvis	61(87.14)
Stone number	
Single	28(40)
Multiple	29(41.42)
Staghorn	13(18.57)

Footnote:SD= Standard Deviation; C= Calyx

Table 3. Surgeon's and nomogram predictions

	Result	N(%)	Correct prediction(%)
First surgeon prediction	Successful	44(62.85)	75.71
	Unsuccessful	26(37.14)	
Second surgeon prediction	Successful	59(84.28)	77.14
	Unsuccessful	11(15.81)	
Average of two surgeons			76.42
Simultaneous correct prediction by surgeons			62.85
Surgery result	Successful	49(70)	
	Unsuccessful	21(30)	
Prediction of STONE nomogram	94%	3(4.28)	84.28
	92%	16(22.85)	
	88%	8(11.42)	
	83%	14(20)	
	64%	17(24.28)	
	42%	5(7.14)	
	27%	7(10)	
	25%	0(0)	
	Mean	72.95	
	SD	±21.29	

Footnote: SD= Standard deviation

Table 4. Accuracy of predictions based on stone number

		Single stone	Multiple stones	Staghorn calculi
Prediction of surgeons	Correct	22	17	5
	Incorrect	6	12	8
	Accuracy	78.57%	58.62%	38.46%
Prediction of nomogram	Correct	27	21	11
	Incorrect	1	8	2
	Accuracy	96.42%	72.41%	86.61%
p-value		0.478	0.315	0.248

Table 5. Accuracy of predictions based on stone location

		Upper calyx	Middle calyx	Lower calyx	Pelvis
Prediction of surgeons	Correct	9	12	26	40
	Incorrect	9	14	19	21
	Accuracy	50%	46.15%	57.77%	65.57%
Prediction of nomogram	Correct	13	20	35	52
	Incorrect	15	6	10	9
	Accuracy	72.22%	76.92%	63.63%	85.24%
p-value		0.035	0.106	0.840	0.068

urologists was 76.42%. For 44 patients (62.85%), both surgeons correctly predicted the outcome of the procedures simultaneously. STONE nomogram predicted the result of the PCNL in 59 cases (84.28 %) correctly. There was a significant correlation between the actual success rate of the PCNL and the nomogram's prediction (p-value<0.001). There was no significant difference between the surgeons and the nomogram's prediction (p-value=0.336) (Table 3). As shown in table 4, the number of stones did not significantly affect the correct prediction of surgical results by surgeons and nomograms (p-value=0.478 for single stone, 0.315 for multiple stones, and 0.248 for staghorn calculi). Nevertheless, the presence of stones in the upper calyx caused a significant difference between correct prediction of surgical results by surgeons and nomograms (p-value=0.035) (Table 5).

Discussion

This study revealed that the accuracy of the urologist's prediction about PCNL's outcomes is about 76% based on pre-operative assessments. Also, in this study, for approximately 62 patients, both surgeons correctly predicted the outcome of the procedures simultaneously. In comparison, the STONE nomogram prediction's accuracy is about 84.28. There was a significant correlation between the actual success rate of the PCNL and the nomogram's prediction. However, there was no significant difference between the surgeons and the nomogram's predictions. The number of stones did not affect the correct prediction of surgical results. However, the presence of stones in the upper calyx caused a significant difference between the correct prediction of surgical results by surgeons and nomograms.

In patients with kidney stones in the upper calyx, nomogram prediction accuracy was higher. Based on our comprehensive review, this study appears to be the inaugural investigation within the existing body of literature to evaluate the comparative accuracy of nomograms and surgeons' predictions regarding PCNL outcomes.

PCNL can be a complex or easy procedure based on the patient's and stone characteristics. So, predicting the surgical results and complications can be challenging (7). Several predictors scoring systems were previously introduced for predicting the success rate and the procedure's complications, such as Guy's stone score (GSS), Stone-Tract Length-Obstruction-Number of involved calyces-Essence of stone density (STONE) nephrolithometry, and Clinical Research Office of the Endourological Society nephrolithometric nomogram (CROES) (5–7).

Bibi M *et al* revealed that Guy's stone score, STONE nephrolithometry, and CROES score are significant factors for stone-free rate prediction (8). Kumar U *et al* reported the accuracy of the STONE nomogram about 86.29% (9). However, Sfoungaristos S *et al* found the STONE nomogram to be the only predictor of atone-free rate in staghorn calculi (10).

Labadie *et al* analyzed the 246 patient's data retrospectively (11). Their study revealed that GSS, STONE nephrolithometry, and CROES can predict stone-free rate accurately (p-value=0.02, 0.004, and <0.001). However, GSS and STONE nephrolithometry are superior to CROES in estimating estimated blood loss and length of hospital stay. Ayranci*et al* revealed that the CROES and STONE nomograms can predict mini-PCNL stone-free rate (p=0.043, p=0.018) in contrast with Guy's stone score (p=0.415). However, none of these scoring systems and nomograms can predict post-operative complications (p=0.584, p= 0.823, p = 0.189) (12). There are new scoring systems for predicting PCNL complications and stone-free rate. Sahan *et al* introduced a scoring system based on parenchymal thickness, nephroscopy length, and hydronephrosis to predict urinary leakage after PCNL (13). Seoul National University Renal Stone Complexity (S-ReSC) scoring system predicts the stone-free rate based on the stone's portion and does not consider the stone's size and number. Choo *et al* assessed the reliability and validity of the S-ReSC and revealed that this scoring system is useful for stone-free rate prediction (14).

Conclusion

To the best of our knowledge, this study is the first study that compares a urologist's prediction and STONE nomogram. This study revealed no significant difference between surgeons' prediction and STONE nomogram, but only in patients with kidney stones in the upper calyx nomogram prediction accuracy was higher. This study acknowledges a number of limitations. It is confined to a single-center analysis and restricts its comparison to one currently established nomogram against the prognostications of surgeons. For a more comprehensive understanding, it is imperative that future research undertakes multicenter studies to compare various nomograms to enhance the predictive precision for PCNL outcomes.

Acknowledgement

The Firoozgar Clinical Research Development Center, Iran University of Medical Sciences, Tehran, Iran, supported this study.

References

1. Scales CD, Smith AC, Hanley JM, Saigal CS, Urologic Diseases in America Project. Prevalence of kidney stones in the United States. Eur Urol 2012;62(1):160-5.

2. Tanriverdi O, Boylu U, Kendirci M, Kadihasanoglu M, Horasanli K, Miroglu C. The learning curve in the training of percutaneous nephrolithotomy. Eur Urol 2007;52(1):206-11.

3. Egilmez T, Goren MR. Predicting Surgical Outcome of Percutaneous Nephrolithotomy: Validation of the Guy's Stone Score and Nephrolithometric Nomogram in Terms of Success and Complications. Annals of Clinical and Analytical Medicine 2015;06.

4. Ganpule AP, Vijayakumar M, Malpani A, Desai MR. Percutaneous nephrolithotomy (PCNL) a critical review. Int J Surg 2016;36(Pt D):660-4.

5. Smith A, Averch TD, Shahrour K, Opondo D, Daels FPJ, Labate G, et al. A nephrolithometric nomogram to predict treatment success of percutaneous nephrolithotomy. J Urol 2013;190(1):149-56.

6. Okhunov Z, Friedlander JI, George AK, Duty BD, Moreira DM, Srinivasan AK, et al. S.T.O.N.E. nephrolithometry: novel surgical classification system for kidney calculi. Urology 2013;81(6):1154-9.

7. Thomas K, Smith NC, Hegarty N, Glass JM. The Guy's stone score--grading the complexity of percutaneous nephrolithotomy procedures. Urology 2011;78(2):277-81.

8. Bibi M, Sellami A, Chaker K, Ouanes Y, Kheiredine MD, Ben Chehida MA, et al. [Do the nephrolithometry scoring systems predict the success of percutaneous nephrolithotomy. Comparison of 4 scores: The Guy's stone score, STONE Score, CROES nomogram and S-ReSC score]. Prog Urol 2019;29(8-9):432-9. French.

9. Kumar U, Tomar V, Yadav SS, Priyadarshi S, Vyas N, Agarwal N, et al. STONE score versus Guy's Stone Score - prospective comparative evaluation for success rate and complications in percutaneous nephrolithotomy. Urol Ann 2018;10(1):76-81.

10. Sfoungaristos S, Gofrit ON, Pode D, Landau EH, Duvdevani M. Percutaneous nephrolithotomy for staghorn stones: Which nomogram can better predict post-operative outcomes? World J Urol 2016;34(8):1163-8.

11. Labadie K, Okhunov Z, Akhavein A, Moreira DM, Moreno-Palacios J, del Junco M, et al. Evaluation and Comparison of Urolithiasis Scoring Systems Used in Percutaneous Kidney Stone Surgery. J Urol 2015;193(1):154-9.

12. Ayranci A, Ucpinar B, Caglar U, Savun M, Sarilar O, Ozgor F. Does nephrolithometry scoring systems predict success and complications in miniPCNL? Int Urol Nephrol 2022;54(6):1207-13.

13. Sahan M, Yarimoglu S, Polat S, Nart B, Koras O, Bozkurt IH, et al. A novel nomogram and a simple scoring system for urinary leakage after percutaneous nephrolithotomy. Int Braz J Urol 2022;48(5):817-27.

14. Choo MS, Jeong CW, Jung JH, Lee SB, Jeong H, Son H, et al. External validation and evaluation of reliability and validity of the S-ReSC scoring system to predict stone-free status after percutaneous nephrolithotomy. PLoS One 2014;9(1):e83628.