# Predicting Outcome Of Mini Percutaneous Nephrolithotomy Using STONE Nephrolithometry Score – A Single Centre Experience

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# Abstract

**Objective:** To predict stone free rate and complication rate following mini-percutaneous nephrolithotomy (m-PCNL) using STONE nephrolithometry score.

**Methods:** This was a prospective observational study conducted in Department of Surgery, Urology Unit, Patan Hospital. All the patients undergoing m-PCNL were included. The cases were conducted in prone position, single tract less than 18 french was made and pneumatic lithotripsy was done. Stone free rates were assessed with plain X-ray kidney, ureter and bladder (X-ray KUB) at first post-operative day or at 15 days follow up. Complication within 30 days were graded using modified Clavien grading.

**Results:** Total of 106 patients were included in the final analysis. The overall stone free rate was 83%. Among the individual variables, only staghorn calculus was associated with residual stone ($p = 0.007$). Patients who were rendered stone free had statistically significant lower STONE score than those with residual stone ($p < 0.001$). The complication rate was 23%, majority were Clavien grade I complications. Higher STONE score had greater risk of having complications but was not statistically significant ($p = 0.11$).

**Conclusion:** STONE nephrolithometry score can predict stone complexity pre-operatively and subsequent stone free status and thus helps in pre-operative surgical planning and counseling for possible outcomes following m-PCNL.


# Introduction

Percutaneous nephrolithotomy (PCNL) is a well-established treatment for large and complex renal stone.Turk et al. [1],[2] Miniaturization of instruments has allowed PCNL to be performed with much smaller access sheaths, the technique being called mini-PCNL (m-PCNL) with equal success and fewer complications.[3] Therefore, m-PCNL had gained popularity among urologists. Several scorings have been developed to predict the success rate following PCNL but none have gained universal acceptance.[4,5] In 2013, Okhunov et al. at Arthur Smith Institute for Urology, proposed and validated the STONE score based on the preoperative non-contrast computed tomography (NCCT) and found that STONE score significantly correlated with postoperative stone free status, overall complications, operative time and hospital stay.[6,7] This scoring system is based on five variables, abbreviated using acronym STONE, including stone size, tract length, obstruction (degree of hydronephrosis), number of involved calyces and stone essence. This scoring system can be used as a standard method to predict stone free status and complication following PCNL, and helps in preoperative surgical planning, patient counseling and uniform reporting of the outcome. Many prospective studies have been done to validate STONE score to predict post PCNL outcomes.[6,8,9] However, this scoring system has not been used with m-PCNL. Hence, this study was conducted to predict stone free rate and complication rate following m-PCNL using STONE nephrolithometry score.

# Patients And Methods

This was a prospective observational study conducted in Department of Surgery, Urology Unit, Patan Hospital from November 2018 to December 2019 after obtaining clearance from institutional review committee. All patients aged more than 14 years who underwent single tract m-PCNL were included. Patients with radiolucent calculi, concomitant ureteral stone, previous surgery in ipsilateral kidney, active urinary tract infection and untreated coagulopathy were excluded. All patient had computed tomography (CT) urography done (Philips Ingenuity Core® 128 multi-slice CT scan) and CT variables proposed by Okhunov et al. i.e stone size, tract length, obstruction, number of involved calyces and stone essence, were measured by experienced radiologist. Each of the variables was scored according to predefined system proposed by Okhunov et al, and STONE nephrolithometry score was calculated using sum of individual variables scores. (Table 1) The demographic, clinical and operative data were collected. The cases were done by two consultant urologists with similar experience with m-PCNL.

All the cases were conducted in prone position using Amplatz sheath size less than 18 F under fluoroscopic guidance. The semi rigid nephroscope (7 degree, 6mm, 11 F Olympus®) was used to locate stone and disintegrated using pneumatic lithotripter (Niddhi®). The procedure was continued until no stones could be identified by on table fluoroscopy. Nephrostomy tube and/or double J (DJ) stent or externalized uretheral catheter was kept at surgeon discretion (includes prolong surgery, intraoperative bleeding, perforation and in staghorn calculus). Patients were followed up with plain X-ray KUB on first post-operative day or at 15 days follow up. Stone free status was defined as absence of stone residue or presence of clinically insignificant radiological fragments (i.e less than 4 mm of non-infectious and non-obstructive stone residue) on X-ray KUB on first post-operative day (POD) or on 15th day follow up. Complications within 30 days were graded using modified Clavien grading.[10] As for complications, the complication satisfying the higher grade was considered.

Fisher's exact test was used to analyze relation between two categorical variables. Independent t test and Mann Whitney U test were used for continuous variables. Multivariate analysis using logistic regression model was performed to predict variables associated with stone free rate. P values less than 0.05 was considered statistically significant. A receiver operator characteristics (ROC) curve was constructed and area under the curve was used to derive the cut off for STONE score and its diagnostic accuracy.

# Results

A total of 106 patients were included in the study. Out of 106, 65(61%) were males and 41(39%) were females. The patient's demographics and stone characteristics evaluated for the STONE score are shown in table below. (Table 2)

Majority of patients had STONE score of 6 (40%) followed by 5 (22%) and 7 (20%), no one had score of 13. Out of 106, 87 patients (83%) were rendered stone free and 19(17%) had residual fragments. The mean STONE score for stone free group was 6.10±1.01 and for stone residue group 9.31±1.76. Patients

who were rendered stone free had statistically significant lower overall STONE score than those with residual stone ($p < 0.001$).

On univariate analysis, stone size, obstruction, number of calyceal involvement and stone essence were identified as significant between two groups. On multivariate analysis, only number of calyceal involvement was independent predictor for stone clearance status after m-PCNL. (Table 3) Logistic regression predicting stone free status using STONE score showed every single unit increase in STONE score increases the odds of having stone residue by 3.89.

Eighty-one had normal post-operative trajectory without any unexpected deviation and 25 (23%) encountered complications. Out of 25, 13 had grade I, 7 had grade II and 5 had grade IIIA complication and were managed accordingly in the ward. (Table 4) Only one case required blood transfusion for hematuria that resolved on conservative management.

On logistic analysis, single unit increase in STONE score increased the odd of having post-operative complications by 1.2, but this value was statistically insignificant.

STONE score was found to have excellent diagnostic accuracy to predict stone free status after m-PCNL as shown by ROC curve (Area under curve – 0.953). The maximum cut off value for STONE score was 8. (Figure 1)

# Discussion

The present study tried to predict the stone free rate and complication following m-PCNL using STONE score. The study demonstrated a correlation between STONE score and stone free rate but not with complication rates following m-PCNL. In line with the hypothesis, lower STONE score had a higher stone free rates probably owing to low complexity stone (smaller stone size with 1-2 calyceal involvement) and easy procedure. STONE score 5,6 and 7 had more than 80 % stone free rate and STONE score of 11 and 12 had 100% residual stones. The difference between mean STONE score of the stone free and stone residual group was significant. The CROES PCNL global study reported a success rate of 75.5% and complication rate of 20.5%.[11] Our study showed overall stone free rate of 83% and complication rate of 23%, which were comparable to similar studies done by Okhunov et al. and Farhan et al.[9,6] Further, the analysis confirmed cut off STONE score of 8 to predict stone free rate following m-PCNL.

Among the individual variables, multivariate analysis confirmed staghorn calculus correlated with stone free rate, similar to studies by Okhunov et al. and Farhan et al. Patients with staghorn calculus or more than three calyx involvement had residual stones in the study and possibly explained by difficulty in large stone fragmentation and subsequent removal from all the involved calyx using single tract. Similar to our study, El Nahas et al. showed higher incidence of residual stone in complete staghorn calculus following PCNL and need for auxiliary procedures.[12] Contrary to Okhunov et al. and Farhan et al., stone size did not correlate with stone free rate in the present study. This result might be explained by uneven sample distribution between stone size subgroups, only 23 participants had stone size more than 400mm$^2$. In

present study, tract length and stone density did not affect stone free rate. The results also contradict the claims of Zhu et al. who reported presence of hydronephrosis lead to residual stone.[13] This variable did not affect stone free rate in present study as dilated system were easy to puncture and to manipulate nephroscope for removal of stone fragments.

The finding in the study showed increased risk of having complication with higher STONE score but failed to prove statistically ($p = 0.11$). Higher STONE score corelated with a longer operative time and duration of hospital stay but it was not reflected in greater likelihood of complications. Majority of complications were minor (Grade I and II), bleeding was the most common complication followed by post-operative fever similar to CROES PCNL global study.[14] There were no intensive care unit admission and mortality. These results were built on existing evidence of safety of m- PCNL but difficulty of the procedure must not be underestimated. The procedure should be performed by experienced endourologist well versed in gaining percutaneous access, stone disintegration and removal.

The major limitation of the study was CT urography was not used to determine stone free status postoperatively. The choice of CT urography for postoperative follow up was constrained by financial issues and was not practical for the study. We also felt doing routine post-operative CT would result in unnecessary radiation exposure. Further study using strict stone free criteria might be considered for validation of scoring system. The generalizability of the result was limited by uneven sample distribution between STONE score groups. Many other factors accounting for PCNL outcome notably abnormal renal anatomy and surgeon’s experience were not included in the study.

# Conclusion

STONE nephrolithometry score can predict stone complexity pre-operatively and subsequent stone free status, thus can help in pre-operative surgical planning and counseling for possible outcomes following m-PCNL.

# Declarations


### Acknowledgements

None


### Conflict of interest

Nothing to declare

# References


1. Turk C, Petrik A, Sarica K, Seitz C, Skolarikos A, Straub M, Knoll T (2016) EAU Guidelines on Interventional Treatment for Urolithiasis. Eur Urol 69 (3):475-482. doi:10.1016/j.eururo.2015.07.041

2. Preminger GM, Assimos DG, Lingeman JE, Nakada SY, Pearle MS, Wolf JS, Jr., Panel AUANG (2005) AUA guideline on management of staghorn calculi: diagnosis and treatment recommendations. J Urol 173 (6):1991-2000. doi:10.1097/01.ju.0000161171.67806.2a

3. Thapa BB, Niranjan V (2020) Mini PCNL Over Standard PCNL: What Makes it Better? Surg J (N Y) 6 (1):e19-e23. doi:10.1055/s-0040-1701225

4. Labadie K, Okhunov Z, Akhavein A, Moreira DM, Moreno-Palacios J, Del Junco M, Okeke Z, Bird V, Smith AD, Landman J (2015) Evaluation and comparison of urolithiasis scoring systems used in percutaneous kidney stone surgery. J Urol 193 (1):154-159. doi:10.1016/j.juro.2014.07.104

5. Kumsar S, Aydemir H, Halis F, Kose O, Gokce A, Adsan O (2015) Value of preoperative stone scoring systems in predicting the results of percutaneous nephrolithotomy. Cent European J Urol 68 (3):353-357. doi:10.5173/ceju.2015.552

6. Okhunov Z, Friedlander JI, George AK, Duty BD, Moreira DM, Srinivasan AK, Hillelsohn J, Smith AD, Okeke Z (2013) S.T.O.N.E. nephrolithometry: novel surgical classification system for kidney calculi. Urology 81 (6):1154-1159. doi:10.1016/j.urology.2012.10.083

7. Akhavein A, Henriksen C, Syed J, Bird VG (2015) Prediction of single procedure success rate using S.T.O.N.E. nephrolithometry surgical classification system with strict criteria for surgical outcome. Urology 85 (1):69-73. doi:10.1016/j.urology.2014.09.010

8. Noureldin YA, Elkoushy MA, Andonian S (2015) External validation of the S.T.O.N.E. nephrolithometry scoring system. Can Urol Assoc J 9 (5-6):190-195. doi:10.5489/cuaj.2652

9. Farhan M, Nazim SM, Salam B, Ather MH (2015) Prospective evaluation of outcome of percutaneous nephrolithotomy using the ‘STONE’ nephrolithometry score: A single-centre experience. Arab Journal of Urology 13 (4):264-269. doi:10.1016/j.aju.2015.07.006

10. de la Rosette JJ, Opondo D, Daels FP, Giusti G, Serrano A, Kandasami SV, Wolf JS, Jr., Grabe M, Gravas S, Group CPS (2012) Categorisation of complications and validation of the Clavien score for percutaneous nephrolithotomy. Eur Urol 62 (2):246-255. doi:10.1016/j.eururo.2012.03.055

11. de la Rosette J, Assimos D, Desai M, Gutierrez J, Lingeman J, Scarpa R, Tefekli A (2011) The Clinical Research Office of the Endourological Society Percutaneous Nephrolithotomy Global Study: indications, complications, and outcomes in 5803 patients. J Endourol 25 (1):11-17. doi:10.1089/end.2010.0424

12. el-Nahas AR, Eraky I, Shokeir AA, Shoma AM, el-Assmy AM, el-Tabey NA, Soliman S, Elshal AM, el-Kappany HA, el-Kenawy MR (2012) Factors affecting stone-free rate and complications of percutaneous nephrolithotomy for treatment of staghorn stone. Urology 79 (6):1236-1241. doi:10.1016/j.urology.2012.01.026

13. Zhu Z, Wang S, Xi Q, Bai J, Yu X, Liu J (2011) Logistic regression model for predicting stone-free rate after minimally invasive percutaneous nephrolithotomy. Urology 78 (1):32-36. doi:10.1016/j.urology.2010.10.034

14. Labate G, Modi P, Timoney A, Cormio L, Zhang X, Louie M, Grabe M, Rosette On Behalf Of The Croes Pcnl Study Group J (2011) The percutaneous nephrolithotomy global study: classification of complications. J Endourol 25 (8):1275-1280. doi:10.1089/end.2011.0067

# Tables

**Table 1**. STONE Nephrolithometry score [6]

| Variables | Score | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Stone size ($mm^2$) | 0-399 | 400-799 | 800-1599 | >1600 |
| Tract length(mm) | <100 | >100 | | |
| Obstruction | None or mild hydronephrosis | Moderate or severe hydronephrosis | | |
| Calices | 1-2 | 3 | Staghorn | |
| Essence (HU) | <950 | >950 | | |

**Table 2.** Clinical data and stone characteristics of the study population

| Variables | | Stone Free Status | | p value |
|---|---|---|---|---|
| | | Stone free | Stone residue | |
| Outcome | | 87 | 19 | |
| Age(years) | | 37.95 ± 13.24 | 43.47 ± 15.41 | 0.113 |
| | | | | |
| Gender (%) | Male | 54 (62.1) | 11 (57.9) | 0.797 |
| | Female | 33 (37.9) | 8 (42.1) | |
| | | | | |
| Stone size ($mm^2$) (%) | 0-399 | 76 (87.4) | 6 (31.6) | **<0.001** |
| | 400-799 | 9 (10.3) | 6 (31.6) | |
| | 800-1599 | 2 (2.3) | 4 (21.1) | |
| | >1600 | 0 (0.0) | 3 (15.8) | |
| | | | | |
| Tract length(mm) (%) | <100 | 76 (87.4) | 15 (78.9) | 0.465 |
| | >100 | 11 (12.6) | 4 (21.1) | |
| | | | | |
| Obstruction (%) | No/Mild | 70 (80.5) | 8 (42.1) | **0.001** |
| | Moderate/Severe | 17 (19.5) | 11 (57.9) | |
| | | | | |
| No of calyces involved (%) | 1-2 | 82 (94.3) | 4 (21.1) | **<0.001** |
| | 3 | 3 (3.4) | 2 (10.5) | |
| | Staghorn | 2 (2.3) | 13 (68.4) | |
| | | | | |
| Essence (%) | <950 HU | 40 (46.0) | 2 (10.5) | **0.004** |
| | >950 HU | 47 (54.0) | 17 (89.5) | |
| | | | | |
| Length of hospital (days) | | 4 | 6 | **<0.001** |
| | | | | |
| Operative time | | 82.70 ± 30.66 | 107.89 ± 25.34 | **0.001** |

| (minutes) |
|---|

**Table 3**. Multivariate analysis of variables associated with stone clearance

| Factor | Odds ratio | p value |
|---|---|---|
| Number of calyces involved [3] | 9.77 (0.77-124.00) | 0.079 |
| Number of calyces involved [Staghorn] | 21.40 (2.30-200.00) | **0.0071** |
| | | |
| Essence [>950 HU] | 13.30 (0.90-196.00) | 0.06 |
| | | |
| Stone size [400-799] | 5.09 (0.51-50.80) | 0.16 |
| Stone size [800-1599] | 6.30 (0.51-77.40) | 0.15 |
| Stone size [>1600] | 163000000.00 (0.00-Inf) | 0.99 |
| | | |
| Obstruction [Moderate/Severe] | 2.72 (0.37-19.80) | 0.32 |

**Table 4**. Complications graded as per Modified Clavein grading.

| Grade | Complications | No. of cases | Percentage |
|---|---|---|---|
| None | Normal post-operative trajectory | 81 | 76.4% |
| Grade I | Bleeding managed with single episode of nephrostomy clamp | 7 | 12.2% |
| | Post-operative pain managed with opioid analgesics | 5 | |
| | Post-operative fever managed without change in antibiotics | 1 | |
| | Deranged renal function managed with iv fluids only | 1 | |
| Grade II | Post-operative fever managed with change in antibiotics | 6 | 6.6% |
| | Culture positive urinary tract infection | 1 | |
| Grade III A | Bleeding managed with multiple bladder irrigation/washout | 3 | 4.7% |
| | Bleeding requiring multiple episodes of nephrostomy clamp > 4 hour apart | 1 | |
| | Pneumothorax managed with intercostal drainage | 1 | |

# Figures

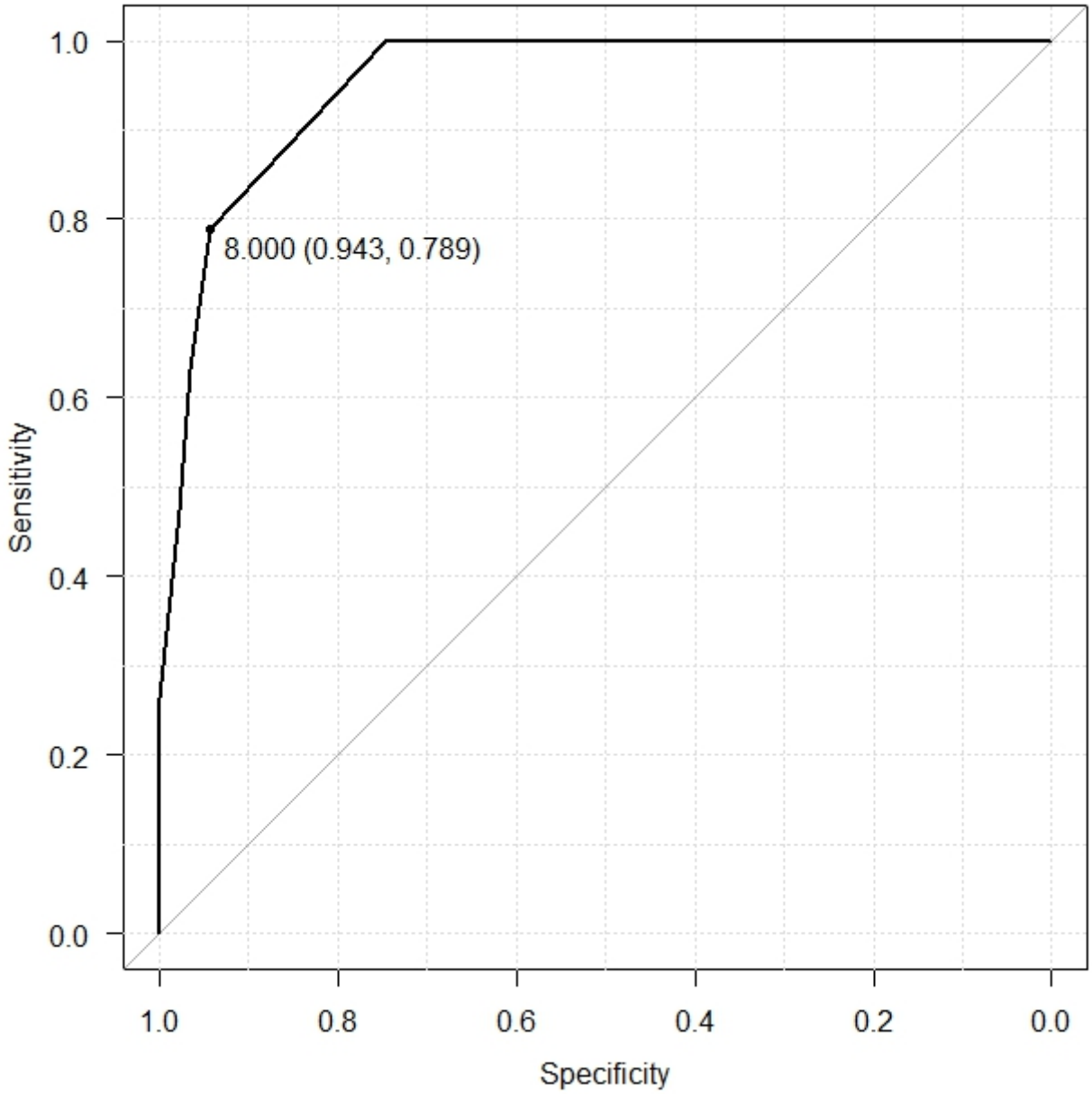


**Figure 1**

ROC curve for accuracy of STONE score