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Original Research Article

A Prospective Study on Percutaneous Nephrolithotomy (PCNL) Outcomes using "S.T.O.N.E. Score"

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Abstract:

Objective: To assess the outcomes of percutaneous nephrolithotomy (PCNL) using the 'STONE' nephrolithometry score, assessing stone size, tract length (skin-to-stone distance), degree of obstruction, number of calyces involved and stone essence (density).

Materials and Methods: This was a prospective study of patients undergoing PCNL, from November 2020 to October 2021 in the Department of Urology at Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala. All patients had preoperative computed tomography and the five variables of the STONE nephrolithometry score were calculated before the procedure. The descriptive statistics including the frequencies, percentages, mean and standard deviation were calculated. Chi square test was applied to assess the extent of association between two variables. ANOVA and linear regression was used to investigate the cause and effect relationship. Outcome of PCNL was evaluated in each of three sub- groups of patients as per S.T.O.N.E. Score and their association with various outcome parameters like Number of punctures, Operating time, Complications as per modified Clavien Dindo grading, Residual stone and Hospital stay was compared. The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 22.0.

Results: The study included a total of 79 patients who underwent PCNL after having met the inclusion criteria. Complete clearance was achieved in 81% cases in the first session. Outcome of PCNL was evaluated in each of three sub-groups of patients as per S.T.O.N.E. Score. The stone score was found to be significantly correlating with- Number of punctures ($p<0.01$); Operating time ($p<0.01$); Complications ($p<0.01$); Residual stone ($p<0.01$); Hospital stay ($p<0.01$)

Conclusion: Stone score is a reliable method to preoperatively assess the outcome of PCNL and therefore valuable for preoperative counselling of patients & the family.

Keywords: Percutaneous Nephrolithotomy, Renal stones, Stone nephrolithometry score.

Introduction

Early research has revealed increasing prevalence of urolithiasis in the past few decades. This trend is found to be associated with the lifestyle changes namely, lack of physical activity (sedentary lifestyle) and eating habits [1,2,3] and global warming [4]. Approximately12% of Indian population has urinary stones, and a big chunk (50%) may end up with loss of kidney functions [5].

Though most of the times renal stones pass spontaneously but 10–20% require surgery. RIRS and Extracorporeal shockwave lithotripsy are the primary surgical techniques for treating small stones but percutaneous nephrolithotomy (PCNL) is the best approach for larger stones i.e. greater than 2.0 cm. [6] Stone characteristics significantly affect surgical outcomes. The features namely, size, extent of calyceal involvement and stone density play an important role in the decision making process about the approach to be used. [6]

Researchers have made many efforts to characterize stones in the kidney in a standard and reproducible manner. Various scoring systems have been designed for preoperative prediction of stone free status (SFS) and complications by assessment of

the renal stones complexities before using percutaneous nephrolithotomy. The S.T.O.N.E. nephrolithometry score, the Guy's stone score (GSS), Clinical Research Office of the Endourology Society (CROES) nomogram, and Seoul National University Renal Stone Complexity (S-ReSC) score are the most commonly used nephrolithometry scoring systems now a days. [6]

The S.T.O.N.E. nephrolithometry is a scoring system that uses stone size (S), tract length (T), obstruction (O), number of calyces involved (N), and essence/stone density (E). The researcher's objective is to develop a standard reporting system for PCNL to assess and predict stone-free rates and pre- operative measures namely, estimated blood loss, operative time, number of punctures, complication rate, and length of hospital stay. The scoring system serves as a stratification tool for the disease, which permits the surgeon to accurately predict the outcomes of PCNL for better counselling of the patient as well as surgical planning. [7]

The scoring system can be used as a standard technique for judging the stone- free rate (SFR) after PCNL. It also helps in pre-operative counselling of the patient, surgical planning and standard reporting of the outcomes.

S.T.O.N.E. Score

Variable	Score			
	1	2	3	4
Stone size (mm2)	0-399	400-799	800-1599	>1600
Tract length (mm)	</=100	>100		
Obstruction	No/mild Hydronephrosis	Moderate/severe hydronephrosis		
Number of calyces with stone	1	2-3	>3 and staghorn	
Essence (HU attenuation)	</=950	>950		

Material and Methods

This prospective observational study was carried out in Department of Urology w.e.f November 2020 to October 2021 at Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala. 79 Patients of renal stone disease undergoing percutaneous nephrolithotomy and fulfilling the inclusion criteria were included in this study.

Inclusion Criteria was all patients with renal stone undergoing Percutaneous Nephrolithotomy for renal stones, Age > 15 years.

Exclusion Criteria was Patients not fit for surgery – bleeding diathesis, infection/ sepsis and bilateral PCNL.

Methodology: Patients were enrolled in the study after taking written informed consent. They were assigned as per working proforma [Annexure 1]. S.T.O.N.E. score was ascertained on CT urography in every patient preoperatively. The patients were planned for PCNL after confirming sterile urine culture and anaesthetic fitness.

Operative Technique

Under general anaesthesia and in lithotomy position using 20 F cystoscopy sheath, a 5Fr open ended ureteric catheter was inserted over a terumo guide wire under fluoroscopic guidance. The ureteric catheter was secured with indwelling 14 Fr Foleys catheter. Patient was turned prone for the further procedure. The pelvicalyceal anatomy was identified with retrograde contrast instillation. PCS puncture was made with two part 18 gauze 'diamond tip' initial puncture needle. A 0.035 inch hydrophilic terumo guide wire was then inserted, after ensuring proper puncture of PCS.

Dilatation was performed first with facial dilators till 10 Fr over the guide wire followed by single step dilation over central guide rod using appropriate size Amplatz dilator and corresponding size Amplatz sheath was placed.

Terumo guide wire was kept as safety guide wire. Nephroscope was introduced into the PCS. The stone was identified and pulverized with the help of pneumatic lithoclast. The fragments were retrieved out with the help of bipronged or tripronged stone grasper or the water pressure itself. After satisfactory stone clearance, a JJ stent was placed and an appropriate sized nephrostomy tube was placed if required and amplatz sheath was removed.

Intraoperative parameters like duration of surgery, stone clearance and complications were noted. Post-operative monitoring was done for post-surgical complications such as fever, pain etc. Nephrostomy tube was removed once the X-Ray KUB done next day documented satisfactory stone clearance, properly positioned ureteral stent, patient was afebrile and urine was clear. The urethral catheter was removed on next day of nephrostomy tube removal after ensuring no leak from nephrostomy site.

Patients were discharged once patients were afebrile and pain free. They were followed up after 2 weeks, X ray KUB and USG KUB were done to look for any clinically significant residual calculus i.e. more than 4mm before removal of DJ stent.

Data was collected and entered in excel sheet. Demographic data, preoperative and intraoperative findings as well as postoperative outcomes were recorded. Intraoperative events like duration of surgery, stone clearance and any complication were noted. Bleeding was considered as a complication when it was severe enough to lead to procedural termination or requiring blood transfusion. All post-operative complications like Fever, pain, nausea and vomiting, Transient Renal Dysfunction, nephrostomy site leakage, Sepsis, Other organ injury, death due to procedure was noted and graded using Clavien-Dindo Grading.

If any patient required any ancillary procedure like ESWL, Redo PCNL, RIRS was also recorded and finally data of all parameters were compiled and compared with different grades of S.T.O.N.E. score.

Statistical Analysis

The data was statistically analysed to get inferable results. Descriptive statistics had been used to get the frequency distribution for the study based variables which helped to assess the results in the percentage form. In nutshell the descriptive statistics included frequencies, percentages, mean and standard deviation.

Further bivariate analysis had been conducted to assess the extent of association between two variables. Chi square test had been applied for the same.

Further multivariate analysis was conducted in case of more than 2 categories namely operative time, hospital stay, complications etc. In this context ANOVA and linear regression was used to investigate the cause and effect relationship e.g. the effect of stone score on operating time, etc.

The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 22.0.

Observations and Results

This study was conducted on a total of 79 patients who underwent PCNL which included 56 males and 23 females with mean age of 44.71 ± 14.49 years (range 20-80 years). Majority of patients were in the prime of their life (41 – 50 years of age). Out of 79 patients 19 (24%) patients had a history of previous surgery. 12 (15%) patients in the study had deranged renal function tests. The kidney on left side was affected by stone disease in 45 (57%) patients and on right side by 34 (43%) patients.

The size of stone ranged from 150 to 2000 mm^2.Maximum number of patients had stone size in range of 400-799 mm^2which was seen in 25.3 % patients. Tract length was calculated as the skin to stone distance in mm. Out of seventy nine patients 96.2% patients had a tract length less than 100 mm and only 3.8% had more than 100mm.

Out of seventy nine patients, 60.8% patients had mild dilatation of PCS due to obstruction whereas 39.2% patients had moderate to severe dilatation of PCS due to obstruction.

In 62% patients only 1 calyx was involved by the stone and in 29.1% patients 2-3 calyces were involved by the stone. 8.9% patients had staghorn stone disease. 78.5% patients had stone density of more than 950 HU and it was less than or equal to 950 HU in 21.5% patients.

S.T.O.N.E. Score was calculated for each. A score of 5–6 which reflected less complex stone was seen in 59.5% patients, 7–8 was moderately complex which was seen in 8.9% patients and 9–13 was a highly complex stone which was calculated in 31.6% patients.

Establishment of a single tract was adequate in 71% of patients while 21.5% patients required two and 7.6% patients required three punctures for stone clearance. Mean operative time was 116.2 minutes (range 60 – 210 minutes).

Complete clearance was achieved in 81% cases in the first session. Out of fifteen patients with residual stones, 8 patients needed ancillary procedures (repeat PCNL – 6, RIRS– 1 and ESWL – 1) for management of residual stone fragments.

Mean hospital stay was 5.1 days (range 4 – 12 days). 29% patients had uneventful recovery. Complications were recorded in 71% of patients. As per Clavien-Dindo classification these were Grade I in 44%, Grade II in 17%, Grade III in 3.8% and Grade IV in 5.1% patients.

Outcome of PCNL was evaluated in each of three sub-groups of patients as per S.T.O.N.E. Score. The stone score was found to be significantly correlating with various outcome parameters as follows: -Number of punctures ($p<0.01$); Operating time ($p<0.01$); Complications ($p<0.01$); Residual stone ($p<0.01$); Hospital stay ($p<0.01$)

Table 1: Distribution of Stone Score parameters

Stone score parameters		Number of patients	Percentage
Stone burden (mm^2)	0-399	51	64.6
	400-799	20	25.3
	800-1599	6	7.6
	>1600	2	2.5
Tract Length (mm)	< /= 100	76	96.2

	> 100	3	3.8
Obstruction	Mild	48	60.8
	Moderate to Severe	31	39.2
Number of calyces involved	1	49	62
	2-3	23	29.10
	Staghorn	7	8.90
Essence/ Stone density	</=950 H.U	17	21.5
	>950 H.U	62	78.5

Table 2: Demographic and preoperative parameters

Age (Mean ± S.D)		**44.71 ± 14.49**
Gender	F	23 (29.10 %)
	M	56 (70.90 %)
Stone Laterality	Left	45 (57%)
	Right	34 (43%)
Previous Renal surgery	Yes	19 (24.10 %)
	No	60 (75.90 %)
Renal Function	Deranged	12 (15.20)
	Normal	67 (84.80)

Table 3: Stone Score and Punctures Analysis

Stone Score	**Puncture**			**Total**	**ANOVA Results**	**Regression Results**
	1	**2**	**3**			
5-6	47	0	0	47	F=83.545	Beta=.822
7-8	6	1	0	7	P<.001	t=12.674
9-13	3	16	6	25		P<.001
Total	56	17	6	79		R^2=.676

Table 4: Stone Score and Residual stone Analysis

Stone Score	**Residual stone**		**Total**	**Chi-square Results**
	No	**Yes**		
5-6	47	0	47	29.146
7-8	5	2	7	P<.001
9-13	12	13	25	
Total	64	15	79	

Table 5: Stone Score and Operating Time Analysis

Stone Score	**Operating Time**						**Total**	**ANOVA Results**	**Regression Results**
	30-60	**61 to 90**	**91 to 120**	**121 to 150**	**151 to 180**	**above 180**			
5-6	9	21	14	2	1	0	47	F=83.545	Beta=.767
7-8	0	1	5	0	1	0	7	P<.001	t=10.505
9-13	0	0	5	5	14	1	25		P<.001
Total	9	22	24	7	16	1	79		R^2=.589

Table 6: Stone Score and Complications Analysis

Stone Score	**Complications**											**Total**	
	NC	**F**	**P**	**BT**	**UT**	**NSL**	**ICU**	**JJ stent**	**NV**	**TI**	**RIC**		
5-6	22	3	17	0	0	0	0	0	5	0	0	47	Chi-square=
7-8	0	1	0	0	0	3	0	1	1	0	0	6	82.962, P<.001
9-13	1	5	2	4	1	7	4	0	0	1	1	25	
Total	23	9	19	4	1	10	4	1	6	1	1	79	

Key: NC= No complication, F= fever, BT=blood transfusion, UT= urinary retention, NSL= Nephrostomy site leakage, ICU=Intensive care unit admission, NV= Nausea and vomiting, RIC= rise in creatinine, TI= ICT Tube insertion

Table 7: Stone Score and Modified Clavien Dindo Grade Analysis

Stone Score	Stone Score and Modified Clavien Dindo Grade					Total	
	0	1	2	3	4		
5-6	22	25	0	0	0	47	Chi-square=
7-8	0	2	3	1	1	7	46.065, P<.001
9-13	1	8	11	2	3	25	
Total	23	35	14	3	4	79	

Table 8: Stone score and hospital stay analysis

Stone Score	Hospital Stay			Total	ANOVA	Regression Results
	4 to 6 days	7 to 9 days	10 to 12 days			
5-6	47	0	0	47	F=24.531	Beta=.492
7-8	5	2	0	7	P<.001	t= 4.953
9-13	15	8	2	25		P<.001
Total	67	10	2	79		R^2=.242

Discussion

The need for pre-operative patient counselling has lead urologists to devise scoring systems to assess outcomes of PCNL. The S.T.O.N.E. score is one such nephrolithometry scoring system. The aim of the current study was to to score patients into categories according to S.T.O.N.E score and to assess the outcomes of PCNL in patients with renal stone. The present study was carried out in Department of Urology at Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala from 1stNovember 2020 to 31st October 2021. A total of 79 patients of renal stone disease treated by percutaneous nephrolithotomy were included in this study.

Age and Gender Distribution

In the present study the minimum age of the patient which was operated was 20 years and maximum age of the patient was 80 years. The maximum number of patients was in the age group of 41-50 (24%) years and mean age of patients was 44.71 which show that the stone disease is more common in adult age group. The results of our study were similar to the studies done by Farhan M et al., [8] Kumsar S et al., [9] and Jaipuria J et al., [10] which had the mean age of presentation of 45.2, 48.9 years and 44.5 years. However in the studies done by Akhavein A et al., [11] and Noureldin YA et al., [12] the mean age of presentation was 55 and 57 years respectively which was slightly more than that in the present study.

Our study had predominant male patients (70.9%) as compared to females (29.10%) which was similar to the studies done by Noureldin YA et al., [12] Kumsar S et al., [9] Farhan M et al., [8] and Jaipuria J et al., [10] which also had predominantly male patients in their studies which was more than 60% where as in the study done by Akhavein A et al., [11] there were nearly equal number of male and female patients.

Laterality of stone

In our study 57% patients were operated for left sided stone as compared to right sided which was seen in 43% of patients which shows the stone disease is more common on left side. The results of our study were similar to the studies done by Noureldin YA et al., [12] Tailly TO et al., [13] and Akhavein A et al., [11] which had 56.2%, 53.4%and 55.7% left sided stones. However, Kumsar S et al., [9] had 57%, Farhan M et al., [8] had 51%, Poudyal S et al.,[14] had 51% and Jaipuria J et al., [10] had 57.4% right sided stones in their respective studies. The results of these studies were different from those of our study.

Stone score

In the present study stone score was calculated for each patient after adding the five parameters: stone size, tract length, obstruction, number of calyces involved, and stone density. The scoring was as per computed tomography which was done preoperatively. The range of S.T.O.N.E. score can be between 5 to13. A score of 5–6 was seen in 59.5% patients and it reflected less complex stone, 7–8 was moderately complex which was seen in 8.9% patients and 9–13 was a highly complex stone which was calculated in 31.6% patients. In our study maximum number of patients had a stone score of 5-6 i.e. less complex stone which was seen in 47(59.6%) patients. In the study done by Kumsar S et al., [9] also maximum number of patient that is 59.8% had a score of 5-6 which was similar to the present study, and 23.5% patients with a score of 7-8 and 16.6% patients with a score of 9-13.

In the study by Noureldin YA et al., [12] 29.2% patients had a score of 5-6, 42.2% patients had a score of 7-8 and 28.6% patients had a score of 9-13. In the study by Jaipuria J et al., [10] 37.3% patients had score of 5-6, 33% had score of 7-8 and 29.7% patients had a score of 9-13. In the study by Labadie K et al., [15] 13.9% patients had a score of 5-6, 32.8% patients had a score of 7- 8 and 53.3% patients had a score of 9-13. In their studies more number of patients had a higher stone score that is

had more complex stone which was different from our study.

Number of calyces punctured

In the present study the mean of punctures was 1.37. Maximum number of patients were operated with single calyceal puncture i.e. 56(71%). But some patients required more than one puncture because of stone pelvicalyceal anatomy and stone in different calyces. Maximum punctures made were three in total number of 6(7.6%) patients out of 79.

In the studies by Okhunov Z et al., [16] Tailly TO et al., [13] Kumar U et al., [17] and Labadie K et al., [15] mean number of punctures taken was 1.6, 1.06, 1.35 and 1 which was similar to our study.

Operating time

Operating time was calculated from completion of anaesthesia till nephrostomy tube fixation. The range was from 60 minutes till maximum 210 minutes. 9 patients with pickup stone in pelvis were operated in 60 minutes. The mean operating time was 116.20 minutes. Out of seventy nine patients, in maximum number of patients operative time was 90 to 120 minutes which was seen in 30.40% patients while in only one patient operative time was more than 180 minutes.

In the studies by Okhunov Z et al., [16] and Labadie K et al., [15] mean operating time were 119 and 122 minutes respectively which were nearly equal to our study.

In the studies by Kumar U et al., [17] Noureldin YA et al., [12] Poudyal S et al., [14] and Tailly TO et al., [13] the mean operating time was75 minutes, 98.7 minutes, 91 minutes and 100 minutes which was less than the operative time in our study.

Kumsar S et al., [9] in their study had mean operative time of 128 minutes which was slightly more than the time taken in our study

Complications

In our study no complication was observed among 29% patients.

Fixed dose of analgesia was given to all patients in postoperative period, still if any patient required extra dose or other form of analgesia was noted down. 24.05% patients had postoperative pain which was managed conservatively. 11.3% patients had fever which was managed by antipyretics +/- up gradation of antibiotics (according to culture and sensitivity report).Akhavein A et al., 11 had 2.4% patients with postoperative fever. Labadie K et al., [15] in their study had 17% complications out of which 9.5% had fever and pain, 3.3% had fever treated with antibiotics. Kumsar S et al., [9] had 19.6% complications. 12.7% patients had fever, pain management with non-steroid anti- inflammatory drugs. Farhan M et al., [8] reported fever (UTI) requiring change of antibiotic in 0.9% patient. Poudyal S et al., [14] had 29 (27.9%) patients developing complications. Fever was seen in maximum number of patients-15 (14.4 %), followed by a fever which was managed by a change of antibiotics seen in 7.7% patients.

In our study 1.3% patients had elevation of serum creatinine in post-operatively period which was managed conservatively. Akhavein A et al., [11] had 0.8% patients with rise in creatinine in postoperative period. Labadie K et al., [15] had 3.3% with AKI which was managed with IV fluids. Farhan M et al., [8] had transient elevation of creatinine in 0.9% patient which was also managed conservatively.

7.6% of patients in our study had nausea and vomiting in postoperative period which was managed by anti-emetics.

Cut off value before surgery for haemoglobin was set at 10 gm%. Five percent of patients required blood transfusion in post-operative period. Multiple factors were contributing (Intra operative bleeding, postoperative bleeding and borderline haemoglobin). Kumsar S et al., [9] had 5.9% patients with bleeding requiring blood transfusion. Farhan M et al., [8] required blood transfusion in 7.5% patients postoperatively.

1.3% of patients required JJ stent exchange in postoperative period in our study. Labadie K et al., [15] reported that 2% patients had obstruction requiring nephrostomy tube placement, double JJ stent causing infundibular rupture. Kumsar S et al., [9] had 1% patient with renal pelvic perforation which was managed by ureteric stenting without general anaesthesia. Farhan M et al., [8] had prolonged leakage which required JJ stenting in 0.9% patients.

In the present study 1.3% patient had Urinary retention in post-operative period, which was managed conservatively by per urethral Foley's catheter insertion and voided well after 5 days. Farhan M et al., [8] reported urinary retention+ colic due to blood clots in 0.9% patient, Cystoscopic evacuation of clots was done in 1.8% patients. Akhavein A et al., [11] had 0.8% patients with urinary retention.

12.6% patients in the present study had nephrostomy site leakage in the postoperative period after removal of nephrostomy. Farhan M et al., [8] had urine leakage <24 h in 1.8% patients and prolonged leakage requiring JJ stenting which occurred in 0.9% patients.

In our study 1.3% patient required ICT tube insertion for pleural effusion which was later removed after the patient recovered. Akhavein A et al., [11] also had a need for ICT placement in 0.8% patients.

5% of patients had ICU admission in the postoperative period in the present study. 1 patient developed perinephric collection postoperatively and was admitted in ICU, 1 patient had intraoperative bleeding which led to abandonment of procedure and ICU admission. 1 patient developed septic shock and was shifted to ICU and 1 patient had AKI on CKD postoperatively and was admitted in ICU and required renal replacement therapy.

None of the patients died in hospital and were discharged after they recovered. Poudyal S et al., [14] had 1.9% patients with pseudoaneurysm which required angioembolisation. 1(0.96%) patients developed abdominal compartment syndrome which required pigtail drainage and ICU monitoring.

Labadie K et al., [15] had 1.2% with significant bleeding requiring angioembolisation; bleeding requiring nephrectomy and renal abscess treated with nephrectomy in postoperative period and 1.2% patients had AKI with hemodialysis and had septic shock. There were no mortalities as in our study.

Distribution of Clavien-Dindo classification of complications

In our study all complications were graded according to Clavien-Dindo classification. Out of seventy nine patients 23(29%) patients had no complications. Majority of them had grade 1 complications (44.3%). No one suffered grade 5 complications. Labadie K et al., [15] in their study had 17% complications out of which 9.5% had grade 1, 3.3% had grade 2, 2% had grade 3a, 1.2% had 3b and 1.2% patients had 4a . There were no grade 5 complications similar to our study. In the study done by Akhavein A et al., [11] maximum patients had grade 1 complication 5.7% and none had grade 4 or 5 complication which was similar to the present study. Similarly, Kumsar S et al., [9] in their study had 19.6% complications. 12.7% patients had Clavien 1 (maximum number of patients), 5.9% patients had Clavien 2 and 1% patient had Clavien 3a. There were no grade 4 or 5 complications which was similar to the present study.

In the study by Noureldin YA et al., [12] maximum patients had grade 3b complication (5.9%) which was different from the present study. No one suffered grade 5. In the study by Farhan M et al., [8] 19 patients (18%) had peri/postoperative complications, including 0.9% of Clavien grade 1, 10.2% of Clavien grade 2, 3.7% of Clavien grade 3a, and 2.8% of Clavien grade 3b. The maximum number of patients had grade 2 complications which was different as in our study. There were no deaths within 30 days of surgery.

In the study by Okhunov Z et al., [16] 21% patients experienced postoperative complications. The postoperative events included 11.1% Clavien grade 2, 0.8% grade 3A and 3.4% grade 3B complications. The maximum number of patients had grade 2 complications which was different as in our study. Tailly TO et al., [13] in their study had a total complication rate of 29.2% with only 3.4% complications of Clavien grade 3 or higher which was different as in our study.

Hospital Stay:

Maximum number of patients stayed in hospital from 4 to 6 days (85%) with a mean hospital stay of 5.1 days in the study. Only two patients stayed for 10 to 12 days because of postoperative complication. All patients went home safely.

In the studies by Noureldin YA et al., [12] and Okhunov Z et al., [16] mean hospital stay was 4.5 and 4.8 days which was nearly equal to that in our study.

However, Kumsar S et al., [9] Tailly TO et al., [13] Kumar U et al., [17] and Labadie K et al., [15] in their studies had mean hospital stay of 3.8 days,3.2 days, 3.7 days and 3.1 days which was less than that seen in our study.

Residual stones

In our study 15 (19%) of patients had residual stone which was detected intraoperatively by fluoroscopy and postoperatively by X-ray KUB. Patient with residual stone were treated by ancillary procedure. Akhavein A et al., [11] Noureldin YA et al., [12] and Labadie K et al., [15] had 23.8%, 28% and 44% patients with residual stones which was more than that seen in our study. Kumsar S et al., [9] and Kumar U et al., [17] in their studies had 10.8% and 13.7% residual stones which were less than that seen in our study.

However, Farhan M et al., [8] and Jaipuria J et al., [10] had residual stones in 20% and 18.5% of patients which was similar to the present study.

Requirement of ancillary procedures

In our study complete clearance was achieved in 81% cases in the first session. Out of fifteen (19%) patients with residual stones, 8(10%) patients needed ancillary procedures. Repeat PCNL was done in 6(7.6%) patients, RIRS– 1(1.3%) patients and ESWL –1(1.3%) patients for management of residual stone fragments.

In the study by Farhan M et al., [8] among patients with residual stones, six (29%) had additional treatments, with shock-wave lithotripsy in four (3.7%) and semi-rigid ureteroscopy and JJ stenting in one each (0.9%).

None of the patients had a repeat PCNL. In the study by Jaipuria J et al., [9] 16.3% patients needed an auxillary procedure. The results of these studies were different to that seen in our study.

Stone score and puncture relationship

In our study maximum number of patient were operated with single puncture (70.9%).But some patient required two puncture (21.5%) and three punctures (7.6%) because of stone pelvicalyceal anatomy and stone in different calyx. Maximum puncture taken were three in total number of 6 patients out of 79. The ANOVA results revealed that all three categories of stone score are significantly different from each other (F= 83.545, p< .001). Further, regression analysis has been conducted to find out the impact of stone score on number of punctures required and results revealed significant impact (β= .822, p< .001). This signified that as the stone score increased, the patients with highly complex stones required more number of punctures as compared with mildly complex stones.

In the study done by Akhavein A et al., [11] there was no statistically significant correlation between stone score and number of punctures and Okhunov Z et al., [16] also in their study showed no significant correlation between stone score and number of punctures. The results of both of these studies were different from our study which showed a significant correlation between the two.

Stone score and residual stone relationship

In our study there was complete clearance of stone in 81% of patient, which was decided intraoperatively under fluoroscopically and postoperatively by X-ray KUB. None of the patients had residual stones when the stone score was 5-6. 28.6% patients had residual stone when stone score was 7-8 but 52% patients had residual stone when stone score was 9-13. This showed that as the stone score increased, the residual stone also increased. There was a statistically significant correlation between stone score and stone free status. Patients with residual stone were treated by ancillary procedures.

In the studies by Kumsar S et al., [9], Noureldin YA et al., [12] Poudyal S et al., [14] Farhan M et al., [8] Kumar U et al., [17] and Okhunov Z et al., [16] there was a positive correlation between S.T.O.N.E. score and the stone free status which was similar to the results found in our study. As the stone score increases, the possibility of having residual stones increased.

Stone Score and Operating Time Relationship

Operating time was calculated from completion of anaesthesia till nephrostomy tube fixation. The range was from 60 minutes till maximum 210 minutes. 9 patients with pickup stone in pelvis were operated in 60 minutes. The mean operating time was 116.20 minutes. The ANOVA results revealed that all three categories of stone score were significantly different from each other (F= 83.545, p< .001). Further, regression analysis was conducted to find out the impact of stone score on operating time and results revealed significant impact (β= .822, p< .001). As the number of stone score increased the operating time also increased significantly. Akhavein A et al., [11] found no statistically significant correlation between stone score and duration of surgery which was different to the result found in our study.

However, Noureldin YA et al., [12], Kumsar S et al., [9], Tailly TO et al., [13] and Farhan M et al., [8] found a significant association between scoring system and operative time which was similar to the results found in our study.

Stone Score and Complications Relationship

In the present study the number of complications was associated with stone score. 49% patients had no complications when the stone score was 5-6 and rest reported only fever, pain, nausea and vomiting. In case of 9-13 stone score only 4% had no complications and rest had multiple complications. Further, these results were confirmed through chi-square test also and results revealed positive association between stone score and complications (chi-square= 82.962, p<.001)

Noureldin YA et al., [12], Farhan M et al., [8] ,Tailly TO et al., [13] and Okhunov Z et al., [16] found no significant association between stone score and postoperative complications. The results of these studies were different to that of the present study.

However, Kumsar S et al., [9] Poudyal S et al., [14] and Kumar U et al., [17] had a positive correlation between S.T.O.N.E. score and complications which was similar to the result found in our study.

Stone Score and Modified Clavien Dindo Grade Relationship

In our study 49% patients had no complications when the stone score was 5-6 and rest reported only Clavien grade 1. In case of 9-13 stone score only 4% had no complications and rest had multiple complications. Further, these results were confirmed through chi-square test also and result revealed positive association between stone score and complications (chi-square= 82.962, p<.001). The relationship was statistically significant (Chi-square= 46.065, p <.001) Farhan M et al., [8] and Okhunov Z et al., [16] found that there was no correlation between stone score and complications.

However, Kumsar S et al., [9] Poudyal S et al., [14] and Kumar U et al., [17] had a positive correlation between S.T.O.N.E. score and Clavien Dindo grade. The results of their studies were similar to that found in our study.

Stone score and hospital stay relationship

Stone score significantly predicts the hospital stay. Lesser the stone score, less is the stay in the hospi-

tal. In our study all the patients with stone score 5-6 stayed in the hospital only for 4 to 6 days, whereas patients with 9-13 stone score stayed for longer period in the hospital. Further regression analysis was conducted to assess the cause and effect relationship between stone score and hospital stay and results confirmed that stone score significantly predicted the hospital stay (β= .822, p< .001). ANOVA also signified the model (F=24.531, p<.001). Akhavein A et al., [11] and Kumar U et al., [17] found that there was no statistically significant correlation between stone score and length of hospital stay. The results of these studies were different to that of the present study.

However, Noureldin YA et al., [12] Poudyal S et al., [14] and Okhunov Z et al., [16] found a statistically significant association between stone score and length of stay in hospital. As the stone score increased in their studies so did the length of stay in the hospital. Their result was similar to that of the present study.

Conclusion

Based on the observations of our study, the following conclusions were drawn:

1. Urinary stone disease affects individuals in the prime of their life. Males are more commonly affected than females. Stones are slightly more predominant on left side.
2. PCNL is safe and successful method of treatment for renal stones. It is minimally invasive and easily reproducible.
3. Stone score is a reliable method to preoperatively assess the outcome of PCNL and therefore valuable for preoperative counselling of patients & the family.

Bibliography

1. Robertson WG, Heyburn PJ, Peacock M, Hanes FA, Swaminathan R. The effect of high animal protein intake on the risk of calcium stoneformation in the urinary tract. Clinical Science (London, England: 1979). 1979 Sep 1; 57(3):285-8.
2. Singh KB, Sailo S. Understanding epidemiology and etiologic factors of urolithiasis: an overview. Scientific Visualization. 2013 Oct; 13(4):169-74.
3. Sofia NH, Manickavasakam K, Walter TM. Prevalence and risk factors of kidney stone. Global Journal for Research Analysis. 2016 Mar; 5(3):183-187.
4. Romero V, Akpinar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. Reviews in urology. 2010; 12(2-3):e86.
5. Joseph KC, Parekh BB, Joshi MJ. Inhibition of growth of urinary type calcium hydrogen phosphate dihydrate crystals by tartaric acid and tamarind. Current Science. 2005 Apr 25; 88(8):1232-8. 63
6. Smith AD. Smith's textbook of endourology. . 4TH EDITION. Wiley-Blackwell; 2019. CHAPTER 7. Nephrolithometric Scoring Systems for Percutaneous Nephrolithotomy; p. 108-123.
7. Okhunov Z, Friedlander JI, George AK, Duty BD, Moreira DM, Srinivasan AK, Hillelsohn J, Smith AD, Okeke Z. STONE nephrolithometry: novel surgical classification system for kidney calculi. Urology. 2013 Jun 1; 81(6):1154-60.
8. Farhan M, Nazim SM, Salam B, Ather MH. Prospective evaluation of outcome of percutaneous nephrolithotomy using the 'STONE'nephrolithometry score: A single-centre experience. Arab journal of urology. 2015 Dec 1; 13(4):264-9.
9. Kumsar Ş, Aydemir H, Halis F, Köse O, Gökçe A, Adsan O. Value of preoperative stone scoring systems in predicting the results of percutaneous nephrolithotomy. Central European Journal of Urology. 2015; 68(3):353.
10. 10. Jaipuria J, Suryavanshi M, Sen TK. Comparative testing of reliability and audit utility of ordinal objective calculus complexity scores. Can we make an informed choice yet?. BJU international. 2016 Dec; 118(6):958-68. 70
11. Akhavein A, Henriksen C, Syed J, Bird VG. Prediction of single procedure success rate using STONE nephrolithometry surgical classification system with strict criteria for surgical outcome. Urology. 2015 Jan 1; 85(1):69-73.
12. Noureldin YA, Elkoushy MA, Andonian S. Which is better? Guy's versus STONE nephrolithometry scoring systems in predicting stone-69 free status post-percutaneous nephrolithotomy. World journal of urology. 2015 Nov; 33(11):1821-5.
13. Tailly TO, Okhunov Z, Nadeau BR, Huynh MJ, Labadie K, Akhavein A, Violette PD, Olvera-Posada D, Alenezi H, Amann J, Bird VG. Multicenter external validation and comparison of stone scoring systems in predicting outcomes after percutaneous nephrolithotomy. Journal of endourology. 2016 May 1; 30(5):594-601.
14. Poudyal S, Pradhan M, Chapagain S, Luitel BR, Chalise PR, et al. (2017) Comparison of Guy's Stone Score and S.T.O.N.E Nephrolithometry Score for Predicting Outcome of Percutaneous Nephrolithotomy. J Urol Res 4(2): 1082
15. Labadie K, Okhunov Z, Akhavein A, Moreira DM, Moreno-Palacios J, Del Junco M, Okeke Z, Bird V, Smith AD, Landman J. Evaluation and comparison of urolithiasis scoring systems used in percutaneous kidney stone surgery.

The Journal of urology. 2015 Jan; 193(1):154-9.

16. Okhunov Z, Friedlander JI, George AK, Duty BD, Moreira DM, Srinivasan AK, Hillelsohn J, Smith AD, Okeke Z. STONE nephrolithometry: novel surgical classification system for kidney calculi. Urology. 2013 Jun 1; 81(6):1154-60.
17. Kumar U, Tomar V, Yadav SS, Priyadarshi S, Vyas N, Agarwal N, Dayal R. STONE score versus Guy's Stone Score-prospective comparative evaluation for success rate and complications in percutaneous nephrolithotomy. Urology annals. 2018 Jan;10(1):76