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COMPARING THE EFFICACY OF CONVENTIONAL S.T.O.N.E. SCORING SYSTEM (SS) & MODIFIED S.T.O.N.E. SCORING SYSTEM (MSS) IN PREDICTING THE OUTCOMES OF PCNL

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Abstract

Background: *PCNL is the standard procedure for managing renal stones, with various scoring systems developed to predict its outcomes. This study utilized the Modified S.T.O.N.E. Scoring System (MSS), based on U/S KUB and X-ray KUB, in contrast to the conventional S.T.O.N.E Scoring System (SS), which relies on CT KUB.*

Objective: *To compare the efficacy of Conventional S.T.O.N.E. Scoring System (SS) and Modified S.T.O.N.E Scoring System (MSS) in predicting the stone free rate (SFR) and post-operative complications in patients undergoing percutaneous nephrolithotomy (PCNL).*

Methodology: *This prospective, interventional comparative study was conducted at Tabba Kidney Institute on adult patients clinically and radiologically diagnosed with renal stones. Using randomization software, patients were assigned to two groups: Group A underwent CT KUB, while Group B had U/S KUB and X-ray KUB. Demographic and perioperative data were recorded, and all patients underwent prone PCNL. Procedure efficacy was assessed by the stone-free rate (SFR) on U/S KUB at 4 weeks postoperatively. Statistical analysis was performed using SPSS version 23.*

Results: *The mean age was 42.8 ± 14.6 years and 57% were males. 90% patients were presented with flank pain. Overall stone free rates were reported as 86% in SS and 90% in MSS. The p-value was reported as significant for all variables except MSS residual stone as 0.598.*

Conclusion: *The Modified S.T.O.N.E. Scoring System (MSS) demonstrated higher stone-free rates and greater efficacy in predicting PCNL outcomes, with reduced radiation exposure and improved cost-effectiveness compared to the conventional S.T.O.N.E. Scoring System (SS). Therefore, MSS is recommended as a first-line tool in renal stone management.*

INTRODUCTION

Renal stone disease is known as one of the most attributed clinical conditions in the field of urology, especially in low-income and developing countries including Pakistan, India, Bangladesh and Nepal with comparatively higher incident rates with 12% chances of getting diagnosed with renal stone in a life time [1]. Late diagnosis of renal stones is associated with severe morbidities including renal failure with significant

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financial strains as well [2]. Surgical techniques to remove renal stones are been modified in past two decades significantly, from open nephrolithotomy to mini and micro perc nephrolithotomy, the predications of surgery outcomes are also considered as significant to assess the risk of complications prior to surgeries. Plain CT KUB is the most commonly used imaging technique to assess renal stone size, location, and the degree of hydronephrosis or hydroureter. However, concerns about radiation exposure remain, especially in patients with high stone burden, complex stones, or recurrent stone disease who may require multiple scans[3]. However, CT KUB imaging is comparatively expensive and may cause unnecessary financial burden on patients as well [2].

Many researches form low-income countries have reported that exposure of CT radiations may cause more harm than expected benefits of identifying renal stone characteristics, while X-ray KUB and ultrasonography KUB can be used to assess the exact stone location, size and associated factors with lower radiation exposure and less financial burden [4].Unfortunately, there are not any commonly used standardized preoperative assessment tools to predict PCNL outcomes. For preoperative patient counselling and for comparing results across other institutions, these preoperative assessment tools are crucial. Different scoring systems are used to predict the outcomes of PCNL and compare the efficacy of alternate radiological approaches for predictability of stone free rate (SFR) and post-operative complications in adult patients [5].

The Smith Institute for Urology validated the S.T.O.N.E. Nephrolithometry Scoring System [6]. Only the five parameters derived from preoperative non-contrasted CT are used in this scoring system. Stone size (measured in mm^2), tract length in mm, hydronephrosis or obstruction, the number of calyces involved, and evaluation of stone density are some of these factors [7]. Stone free rates and/or presence of residual stones, size of residual stones, need of re-do surgery, need of post-operative medications to expel renal stones are frequently reported in patients with incomplete stone clearance [8].

Accurate prediction of surgical outcomes is essential for effective patient counselling and optimized clinical decision-making. To support these goals, we developed the **Modified S.T.O.N.E. Scoring System (MSS)** by adapting the original, validated S.T.O.N.E. system that not only aid in anticipating results but also help minimize radiation exposure and reduce the financial burden of preoperative imaging. Our modification replaces CT KUB with ultrasound and X-ray KUB, aiming to lower both radiation risk and diagnostic costs. This study aims to evaluate and compare the effectiveness of the **Conventional S.T.O.N.E.** and **Modified S.T.O.N.E.** scoring systems in predicting the stone-free rate (SFR) and postoperative complications in patients undergoing percutaneous nephrolithotomy (PCNL). The stone free rate (SFR) is defined as percentage of patients having no stone or residual stone fragment of size ≤ 4mm on follow up imaging after 4 weeks of PCNL.

METHODOLOGY

This is a Prospective, Interventional; Comparative Study conducted at Department of Urology at Tabba Kidney Institute, Karachi from 1st September, 2024 to 1st March, 2025. The study spanned 6 months following approval from the institutional Ethics Review Committee (ERC). Adult patients diagnosed with renal stones and planned for PCNL were requested to sign and informed consent in the language of understanding to enroll in this study. Sample size was calculated with the help of RaSoft sample size calculator, keeping total number of patients operated in last 6 months as population (n=134), confidence interval as 95%, margin of error as 5% and population proportion as 50% the required sample size was n=100. Purposive, non-probability sampling technique was used. The inclusion criteria encompassed patients aged between 18-65 years with renal stones diagnosed on imaging, both genders, solitary functioning kidney or chronic kidney disease were included in the study. Patients with renal anatomical abnormalities such as horseshoe kidney, PUJO, partial or complete duplex, reported coagulopathies, require some other endourological procedure under same anesthesia and / or diagnosed with bilateral renal stones were excluded from the sample population.

The diagnostic and investigative procedures primarily focused on radiographic imaging for the identification of renal calculi. Patients were randomly divided into two groups with the help of randomization software.

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Group A patients had CT KUB, while group B patients underwent U/S KUB and X-ray KUB. In group A patients, the **S.T.O.N.E. Score (SS)** was calculated using these parameters (Table IA), and the risk level (Low, Moderate, High) is determined based on the SS total score. (Table IB)

Features	1 Point	2 Points	3 Points	4 Points
Stone Size (mm^2)	0–399	400–799	800–1599	>1600
Tract Length (mm)	≤100	>100	–	–
Obstruction	No/Mild	Moderate/Severe	–	–
Calyces Involved	1–2	3	Complete staghorn	–
Hounsfield Units (HU)	≤950	>950	–	–

(Table IA- S.T.O.N.E Score)

Total SS	Risk Level
1–5	Low Risk
6–10	Moderate Risk
>10	High Risk

(Table IB)

In group B patients, **Modified S.T.O.N.E. Score (MSS)** was calculated using U/S KUB and X-ray KUB; shown as below (Table IIA) and risk assessment was done on the basis of MSS total score (Table IIB).

Feature	1 Point	2 Points	3 Points	4 Points
Size (mm^2)	0–399	400–799	800–1599	>1600
Tomography/Location	Pelvis	Calyx	–	–
Degree of Obstruction	No/Mild	Moderate/Severe	–	–
Number of Calyces Involved	1–2	3	Complete staghorn	–
Evaluation of Density	Radiolucent	Faintly Radio-opaque	Radio-opaque	–

(Table IIA- Modified S.T.O.N.E. Score)

Total MSS	Risk Level
1–5	Low Risk
6–10	Moderate Risk
>10	High Risk

(Table IIB)

Data collection was divided into several steps. Complete demographic details, medical history, laboratory investigations and other relevant details were obtained and documented when patient admitted for surgical intervention. All the details of radiological investigations for the diagnosis of renal stones were documented including plain CT KUB or ultrasound KUB and X-ray KUB. Intra-operative details including operative time, sheath size, nephroscope size, blood loss, need for transfusion, and complications etc. were documented at the time of surgery. Post-operative details including stone free rates, residual stones presence, post-operative complications (fever, hematuria, pleural injury, febrile UTI, sepsis, septic shock, nephrocutaneous fistula, wound infection), emergency room visits, need for re-

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admission within 4 weeks of procedure were reported as well. The encountered complications were graded on the basis of Clavein-Dindo System. Patients were requested for follow up visit in outpatient department after 4 weeks of procedure to perform U/S KUB to assess residual stones as per standard protocol.

All patients were admitted one day prior to surgery. Preoperative urine cultures were obtained and any infections were treated according to culture sensitivity. Patients received 2–3 doses of intravenous antibiotics (a combination of cefoperazone and sulbactam) at 12-hour intervals prior to the procedure. All patients subsequently underwent prone-position percutaneous nephrolithotomy (PCNL). Prior to shifting the patient to the prone position, retrograde pyelography (RPG) was performed in the lithotomy position to reassess stone characteristics and obtain a detailed view of the pelvicalyceal system anatomy. A 4 Fr ureteric stent was inserted and secured alongside a Foley catheter. Considering stone burden, various sheath sizes of 14Fr to 22Fr were used. Telescopic dilatation using fascial and metallic dilators was performed in all patients, followed by the insertion of a soft Amplatz sheath under fluoroscopic guidance. Depending on the requirements for optimal stone clearance, either a subcostal or supracostal approach was utilized. At the end of procedure, stone clearance was confirmed either by direct visualization using a nephroscope within the pelvicalyceal system or with the assistance of C-arm fluoroscopy. The skin at the puncture site was approximated using surgical glue.

Patient data was carefully managed by assigning each individual a unique **MR#**, ensuring that their information was securely stored in a **password-protected computerized database.** Access to this database was restricted to authorized personnel only, minimizing the risk of unauthorized access or data breaches.

Statistical package for social sciences version 22 was used to enter, sort and analyze the data, Normality of data was analyzed with the help of Shapiro Wilk test, and categorical variables were reported as frequency and percentages, while continuous variables were reported as mean and standard deviation. Comparative analysis between mean values of two variables was reported with the help of chi-square test keeping p-value of ≤ 0.05 as significant.

RESULTS

A total of 100 patients were enrolled in the study, with a randomized distribution of 50 patients each in Group A and Group B. The mean age of the participants was 42.8 ± 14.6 years, and the mean body mass index (BMI) was 20.7 ± 2.76 kg/m^2. The study population included 57% male and 43% female patients. The most common presenting symptom was flank pain, reported in 90% of cases. Hematuria was noted in 6% of patients, while 4% were diagnosed incidentally during investigations for unrelated issues. Regarding comorbid conditions, 6% of patients had diabetes mellitus, 5% had hypertension, and 8% presented with both. Renal stones were more frequently located on the right side (57%). In terms of hydronephrosis, mild cases were seen in 22%, moderate in 21%, and gross hydronephrosis in 17%, while 40% showed no hydronephrosis. X-ray KUB was performed exclusively in Group B patients (n=50). Among them, 22% (11) had radiolucent stones, 20% (10) had faintly radio-opaque stones, and 58% (29) had radio-opaque stones. The mean stone size, measured using CT KUB in Group A and ultrasound (U/S KUB) in Group B, was 718 ± 382 mm^2. In Group A patients who underwent CT KUB, the mean Hounsfield Unit (HU) was 1037 ± 240, and the mean skin-to-stone tract length was 94.4 ± 14.6 mm. Demographic and pre-operative details are summarized in Table 1.

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Table 1: Demographic and Pre-operative details

Parameter		Value
1.	Mean Age (years)	42.8 ± 14.6
2.	Mean BMI (kg/m²)	20.7 ± 2.76
3.	Gender Distribution	57% Male , 43% Female
4.	Presenting Complaints	Flank pain 90%, Hematuria 6%, Incidental Diagnosis 4%
5.	Laterality of Renal Stones	Rt sided 57% , Lt sided 43%
6.	Hydronephrosis	None 40%, Mild 22%, Moderate 21%, Gross 17%
7.	Mean Stone Size (mm²)	718 ± 382
8.	Mean Hounsfield Unit (HU) *(Group A only)*	1037 ± 240
9.	Mean Tract Length (mm) *(Group A only)*	94.4 ± 14.6
10.	X-ray KUB Findings *(Group B only, n=50)*	
	– Radiolucent Stones	22% (11)
	– Faintly Radio-opaque Stones	20% (10)
	– Radio-opaque Stones	58% (29)

Sheath size used during the procedure was 14 Fr in 4% of patients, 16 Fr in 83%, 18 Fr in 10%, and 20 Fr in 3%. Nephroscope sizes were reported as 12 Fr in 91% of cases and 14 Fr in 9%. The surgical approach was supracostal in 7%, subcostal in 92%, and both approaches were used in 1% of patients. A single tract was utilized in 97% of cases. The most commonly punctured calyx was the lower calyx, reported in 89% of patients, followed by the upper calyx in 7% and 4% patients had dual calyx puncture. The modality of lithotripsy was pneumatic in 91% of cases, laser in 4%, and a combination of pneumatic and laser lithotripsy was used in 5% of patients. Double J stenting was done in 17% of the study population. The mean total operative time was observed to be 55 ± 14.14 minutes, while mean scope in to scope time was noted to be 37.5 ± 17.68 minutes. Mean blood loss was estimated as 89.6 ± 79.5ml. Blood transfusion was required in 17% of patients. Of these, **8% received transfusions intraoperatively,** while **9% patients** required transfusion during the postoperative period.

Postoperative complications were classified according to the Clavien-Dindo system. The majority of patients recovered uneventfully, with complications reported in only 11 patients. Among these, **5 patients** experienced hematuria, and **2** required angioembolization, while the rest were managed conservatively. Additionally, **2 patients** developed electrolyte imbalances, **2** had febrile urinary tract infections (UTI), and **1** patient developed pleural effusion necessitating chest tube thoracostomy. 1 patient presented with a perinephric collection on the **8th postoperative day**, for which a **percutaneous nephrostomy (PCN)** was inserted under local anesthesia. The postoperative complications are graded on the basis of Clavien-Dindo system (figure 1) Hospital discharge was achieved on the **2nd postoperative day in 87% of patients**, on the **3rd day in 9%**, and on the **6th day in 4%** of cases. The Foley catheter was routinely removed on the day of discharge in all patients. Post-discharge follow-up revealed that **4% of patients required emergency department visits**, while 3% **necessitated hospital readmission.**

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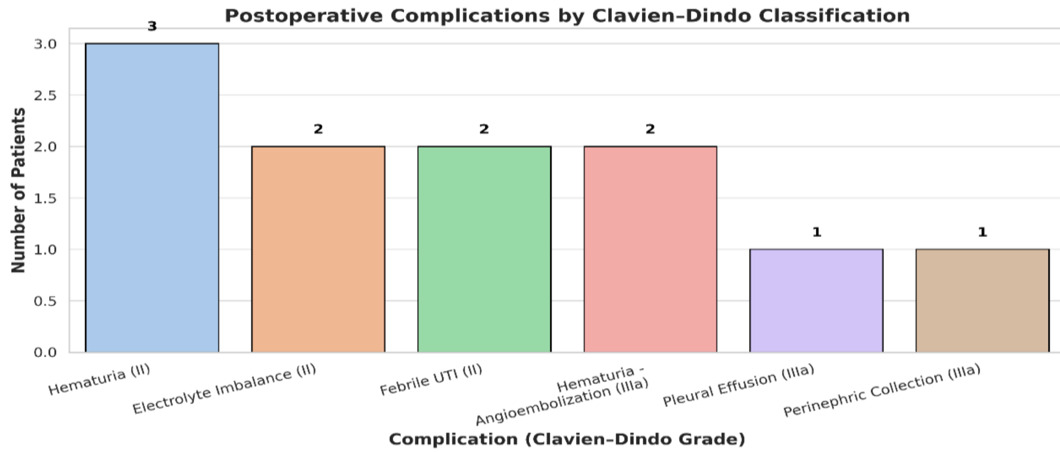
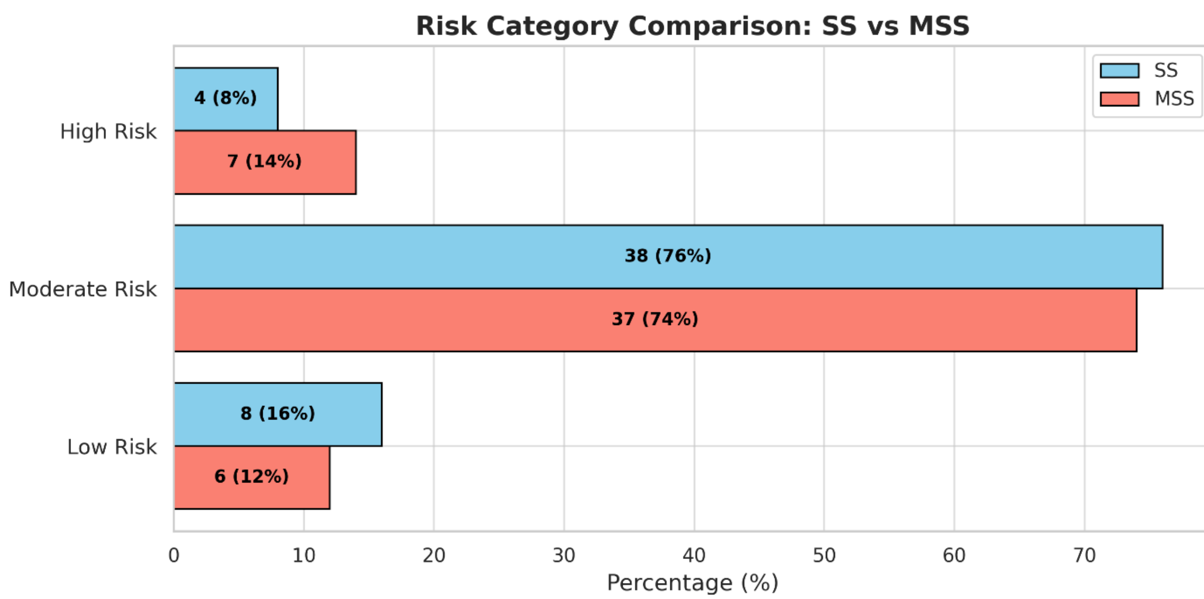


(Figure 1)

The mean pre-operative haemoglobin (Hb) was 10.6 ± 2.0 g/dL, with a mean urea level of 21.6 ± 18.6 mg/dL and a mean creatinine level of 0.768 ± 0.678 mg/dL. Post-operatively, the mean Hb decreased to 9.3 ± 1.85 g/dL, and the mean creatinine level rose to 0.946 ± 0.37 mg/dL. The mean drop in haemoglobin (Hb) was 0.81 ± 0.03 g/dL, while the difference between pre-operative and post-operative creatinine levels was 1.32 ± 0.44 mg/dL.

Risk category comparison between **Conventional S.TO.N.E. Score (SS)** and **Modified S.TO.N.E. Score (MSS)** revealed that the majority of patients fell into the moderate risk group. In contrast, both low-risk and high-risk categories comprised relatively smaller portions of the study population. The comparative distribution of risk categories according to both scoring systems is illustrated in Figure 2.



(Figure 2- Distribution of Stone Scoring Systems:

S.T.O.N.E. Score vs. Modified S.T.O.N.E. Score)

The overall **stone-free rate (SFR)** was 86% (43 patients) in the S.T.O.N.E. Score (SS) group and 90% (45 patients) in the Modified S.T.O.N.E. Score (MSS) group. However, this difference was not statistically significant ($p = 0.76$), suggesting comparable effectiveness between the two scoring systems in predicting stone-free outcomes. (Table 2). Residual

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stones were observed in 14% (7 patients) of the SS group and 10% (5 patients) of the MSS group. The mean residual stone size was 10.8 ± 3.9 mm² in the SS group and 9.41 ± 4.11 mm² in the MSS group.

Group	Stone-Free Patients (n)	Stone-Free Rate (%)	p-value
SS	43	86%	0.76
MSS	45	90%	

Table 2: Stone free rates in SS and MSS patients

Correlation analysis demonstrated a positive association with the Modified S.T.O.N.E. Score (MSS), suggesting that higher MSS values were linked to an increased risk of residual stones, thereby reflecting a stronger predictive value for actual patient risk. This analysis confirmed the efficacy of MSS to assess post-operative risk of residual stones. Hazard ratio was reported as 1.72 (CI 95% ~ 0.14—6.6) for residual stones and 0.07 (CI 95%- - 0.44—0.15) for stone clearance in SS while 0.22 (CI 95% ~ 0.66-0.59) for residual stones and 1.68 (CI 95% ~14.3—6.78) for stone clearance in MSS respectively. The p-value was reported as significant for all variables expect MSS residual stone as 0.598 (Table 3)

Variables		Correlation	Sig.	HR	Lower	Upper	P-Value
Stone Score	Residual stone	-0.139	0.701	1.72	-0.14	-6.6	≤ 0.005
	Stone clearance	-0.209	0.040	0.07	-0.44	-0.15	≤ 0.005
Modified Stone Score	Residual stone	0.139	0.701	0.22	-0.44	0.66	0.598
	Stone clearance	0.209	0.040	1.68	-14.3	-6.78	≤ 0.005

Table 3: Hazard ratio and Correlation analysis of residual stone and stone clearance within SS and MSS.

DISCUSSION

The incidence of renal stones have been increased by three folds in last 4 decades, representing 19% prevalence rates in Asian countries [9]. The main concern of urologists in middle and low income countries are treatment of renal stones without developing postoperative complications, prolonged hospital stay and re-intervention due to poor stone free rates [10]. The use of pre-operative imaging techniques, especially non-contrast Computed Tomography scan (CT KUB), has had a major impact on the management of renal stones in the Pakistani population [11]. According to studies, CT KUB is an essential diagnostic tool for assessing acute renal colic. Its high sensitivity and specificity are crucial for figuring out the best course of treatment [12]. CT KUB is the gold standard for renal stone diagnosis, outperforming conventional techniques like X-ray and ultrasound due to its ability to detect stone size, location, and related anatomical abnormalities [13]. The cost of imaging and subsequent therapy is an important factor in developing countries [14]. The high prevalence is a significant public health concern, as kidney stones are responsible for about 40% of renal problems [15]. Although CT KUB has several diagnostic advantages, studies show that it also exposes patients to greater radiation doses, which is concerning, especially for recurrent stone formers when multiple scans may be required [16]. This highlights the necessity of weighing the radiation exposure and diagnostic utility of CT KUB against its financial impact, especially in populations with limited healthcare access[17].

Pre-operative imaging can also impact the therapeutic intervention choice, including whether to use PCNL (Percutaneous Nephrolithotomy) or ESWL (Extracorporeal Shock Wave Lithotripsy).[18] Important factors that are indicative of treatment outcomes, such as skin-to-stone distance and stone density, can be calculated with CT KUB only[19]. Clinicians can improve patient outcomes and reduce the need for repeat interventions by optimizing treatment procedures using thorough imaging [20].

Several scoring systems have been developed and used by urologists to predict post-operative outcomes of PCNL, including GUY's stone score and S.T.O.N.E scoring system are most widely used to predict stone free rates, operative time, hospital stay and need of

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transfusion [21-22]. Need of plain CT KUB in S.T.O.N.E scoring system has a potential risk of radiation exposure, American Urological Association (AUA)[23] has indicated to avoid CT exposure to reduce radiation exposure, a study by Bos Denise[24] reported that careful evaluation of explanatory signs should be considered before CT to avoid risk of radiations.

In our study, the conventional S.T.O.N.E. Scoring System was modified by substituting CT KUB with X-ray KUB and ultrasound (U/S) KUB to predict PCNL outcomes while minimizing radiation exposure in the adult population. The stone-free rates were 86% with the conventional S.T.O.N.E. score (SS) and 90% with the Modified S.T.O.N.E score (MSS), with no statistically significant difference (p = 0.76). These findings align with a previous study by Hamza et al., which reported a stone clearance rate of 22.5% using X-ray and U/S, compared to 22% in the CT KUB group (p = 0.3).

The comparison of pre-operative stone sizes by ultrasonography and CT with intra-operative was another noteworthy finding of this study. These comparison results, which were similar to earlier research, demonstrated nearly identical accuracy between pre-operative and intra-operative stone sizes[25]. Patients who had ultrasonography in this trial had comparatively less radiation exposure than those in the CT group, and their stone clearance and stone size accuracy findings were comparable[26].

The distribution of conventional S.T.O.N.E. scores (SS) and Modified S.T.O.N.E. scores (MSS) across risk groups was similar, with 38% and 37% of patients classified as moderate risk, and 4% and 7% as high risk, respectively. The need for re-intervention and DJ stent placement was also comparable between the two groups. These findings support the efficacy of ultrasound (U/S) KUB and X-ray KUB in accurately predicting stone size, location, and stone-free rates in high-risk patients.

Our data further confirmed that X-ray and U/S imaging can effectively assess stone characteristics—including size, location, and calyceal involvement—as well as predict operative time and hospital stay. This predictive ability of the Modified S.T.O.N.E. score assists surgeons in counselling patients about potential postoperative complications following PCNL, particularly the risk of re-intervention.

However, this study has few limitations. It utilized a cross-sectional design with no long-term patient follow-up, and the data was collected from a single centre, limiting the generalizability of findings to broader populations. The use of a single surgeon's technique may also influence outcomes, as results could vary with different surgical approaches. Future multi-centre studies with extended follow-up periods and multiple operators are recommended to validate these findings.

CONCLUSION:

The Modified S.T.O.N.E. Score (MSS) demonstrated high stone-free rates, accurate prediction of stone characteristics, and lower radiation exposure, supporting its use as a first-line tool in renal stone management. MSS is also more cost-effective, reducing reliance on expensive CT imaging. Standardized, skill-based training for ultrasound operators is essential to ensure diagnostic accuracy and minimize operator-dependent errors.

REFERENCES:

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. https://doi.org/10.1016/j.aju.2015.07.006

Singla A, Khattar N, Nayyar R, Mehra S, Goel H, Sood R. How practical is the application of percutaneous nephrolithotomy scoring systems? Prospective study comparing Guy's Stone Score, STONE score and the Clinical Research Office of the Endourological Society (CROES) nomogram. Arab journal of urology. 2017 Mar 1;15(1):7-16. https://doi.org/10.1016/j.aju.2016.11.005

Jiang K, Sun F, Zhu J, Luo G, Zhang P, Ban Y, Shan G, Liu C. Evaluation of three stone-scoring systems for predicting SFR and complications after percutaneous nephrolithotomy: a systematic review and meta-analysis. BMC urology. 2019 Dec;19:1-9. https://doi.org/10.1016/j.aju.2015.07.006

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. https://doi.org/10.1186/s12894-019-0488-y

Çitamak B, Dogan HS, Ceylan T, Hazir B, Bilen CY, Sahin A, Tekgül S. A new simple scoring system for prediction of success and complication rates in pediatric percutaneous nephrolithotomy: stone-kidney size score. Journal of Pediatric Urology. 2019 Feb 1;15(1):67-e1. https://doi.org/10.1016/j.jpurol.2018.09.019

Withington J, Armitage J, Finch W, Wiseman O, Glass J, Burgess N. Assessment of stone complexity for PCNL: a systematic review of the literature, how best can we record stone complexity in PCNL?. Journal of Endourology. 2016 Jan 1;30(1):13-23. https://doi.org/10.1089/end.2015.0278

Mazzon G, Choong S, Celia A. Stone-scoring systems for predicting complications in percutaneous nephrolithotomy: A systematic review of the literature. Asian Journal of Urology. 2023 Jul 1;10(3):226-38. https://doi.org/10.1016/j.ajur.2023.01.005

Vernez SL, Okhunov Z, Motamedinia P, Bird V, Okeke Z, Smith A. Nephrolithometric scoring systems to predict outcomes of percutaneous nephrolithotomy. Reviews in urology. 2016;18(1):15.

Saleem, N., Balooch, S., Qayyum, A., Afzal, T., Niazi, N., & Adil, R. (2023). Evaluating unenhanced multidetector computed tomography of kidneys, ureters and bladder (ct kub) as the initial imaging service in suspected acute renal colic patients. Pakistan Armed Forces Medical Journal, 73(1), 207-10. https://doi.org/10.51253/pafmj.v73i1.6730

Şen, V., Ongün, Ş., Şahin, M., İrer, B., Kizer, O., Doğan, B., ... & Yıldız, G. (2020). The use of computed tomography as the first imaging modality in patients with renal colic and microscopic haematuria. International Journal of Clinical Practice, 75(3). https://doi.org/10.1111/ijcp.13826

Khan, Z., Yaqoob, A., & Bhatty, T. (2016). Spontaneous retrograde migration of ureterovesical junction stone to the kidney; first ever reported case in the english literature in human. Urology Annals, 8(2), 229. https://doi.org/10.4103/0974-7796.176869

Batool, F., Memon, W., Jat, J., Ram, S., Jatoi, T., & Ghangro, A. (2021). Hydroperitoneum: a complication of mini pcnl in pediatric age group? -a case report. Liaquat Medical Research Journal, 3(4), 116-120. https://doi.org/10.38106/lmrj.2021.3.04-07

Batool, F., Rehman, H., Mughal, H., Rauf, K., Zia, K., & Abbas, F. (2023). Diagnostic validity of low dose ct kub in demonstration of genitourinary tract calculi compared to normal dose ct kub: a provisional study. Journal of Rawalpindi Medical College, 27(3). https://doi.org/10.37939/jrmc.v27i3.2277

Ashraf, H., Saulat, S., Saeed, S., Qadri, U., Ayub, A., Kiani, N., ... & Ejaz, M. (2022). All that glitter is not gold: computed tomography-kidney ureter bladder (ct-kub) is not necessary for a safe percutaneous nephrolithotomy. Pakistan Journal of Medicine and Dentistry. https://doi.org/10.36283/pjmd11-2/007

Ahmad, T., Khursheed, A., Khan, N., & Khan, L. (2023). Effectiveness of extracorporeal shockwave lithotripsy and percutaneous nephrolithotripsy for the management of moderate size kidney stone. PJMHS, 17(1), 300-301. https://doi.org/10.53350/pjmhs2023171300

Ather, M., Memon, W., Aziz, W., & Sulaiman, M. (2017). Non-contrast ct in the evaluation of urinary tract stone obstruction and haematuria.. https://doi.org/10.5772/intechopen.68769

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Muter, S., Abd, Z., & Saeed, R. (2022). Renal stone density on native ct-scan as a predictor of treatment outcomes in shock wave lithotripsy. Journal of Medicine and Life, 15(12), 1579-1584. https://doi.org/10.25122/jml-2022-0153

Ali, M., Abay, B., Ali, A., Saad, M., Al-Ghazawi, M., & Kamel, H. (2024). Improving guideline adherence for the radiological investigation of acute renal colic: a two-cycle quality improvement project. Cureus. https://doi.org/10.7759/cureus.73472

Islam, K., Shah, S., Minallah, N., Dad, N., Ullah, F., & Naz, S. (2023). Evaluation of skin to stone distance by non-contrast computed tomography as an independent predictor of stone-free rate of extra-corporeal shockwave lithotripsy for renal pelvic stones. PJMHS, 17(3), 655-657. https://doi.org/10.53350/pjmhs2023173655

Ullah K, Qamar T, Khan S, Ahmad B. Diagnostic Role of X-ray Imaging in Renal and Ureteric Calculi Keeping Computed Tomography as Gold Standard: Diagnostic Role of X-ray Imaging in Renal and Ureteric Calculi. Pakistan BioMedical Journal. 2025 Jan 31:18-22.

Asif M, Farooq K, Ullah MI, Azam A, Bibi R. Complications rate of conventional percutaneous nephrolithotomy (PCNL) in a tertiary care center. Pakistan Journal of Medical & Health Sciences. 2023 May 6;17(04):111-.

Xue SW, Zhang MB, Luo YK, Li N, Shi SY. A comparative study of ultrasound-guided percutaneous nephrolithotripsy and x-ray-guided percutaneous nephrolithotripsy in the treatment of complex renal calculi without hydronephrosis. Pakistan Journal of Medical Sciences. 2022 Nov;38(8):2259.

Arabzadeh Bahri R, Maleki S, Shafiee A, Shobeiri P. Ultrasound versus fluoroscopy as imaging guidance for percutaneous nephrolithotomy: A systematic review and meta-analysis. Plos one. 2023 Mar 2;18(3):e0276708.

Xiao B, Zeng X, Zhang G, Jin S, Hu WG, Li JX. Percutaneous nephrolithotomy with X-ray free technique in morbidly obese patients. Chinese Medical Journal. 2021 Oct 20;134(20):2500-2.

Singh S, Singhal SS. Comparative Analysis of Stone Prevalence in Right vs Left Kidney During Percutaneous Nephrolithotomy (PCNL) In A Tertiary Care Centre Cross-Sectional Study. Age.;18(30):57.

Sanjaya R, Soebadi DM, Djojodimedjo T, Suprijanto B. Comparison of STONE Score and Guy Score in predicting stone free rates of percutaneous nephrolithotomy procedures in the Soetomo General Hospital. Indonesian Journal of Urology. 2021;28(1):91-7