

STONE CLEARANCE RATE OF TRANSURETHRAL NEPHROSCOPIC PNEUMATIC LITHOTRIPSY FOR THE MANAGEMENT OF LARGE URINARY BLADDER CALCULI USING THE PNEUMATIC SWISS LITHOCLAST

Muhammad Azam Khan¹, Riaz Ahmad Khan^{2*}, Ikram Ullah², Maaz Khan¹, Zahid Majeed¹, Asad Riaz¹

¹Postgraduate Resident, Department of Urology, Institute of Kidney Diseases MTI-Hayatabad Medical Complex, Peshawar, Pakistan

²Associate Professor, Department of Urology, Institute of Kidney Diseases MTI-Hayatabad Medical Complex, Peshawar, Pakistan

*Corresponding Author: Riaz Ahmad Khan, Email: riaz286@yahoo.com

ABSTRACT

Background: large urinary bladder calculi can require effective endoscopic fragmentation while avoiding the morbidity of open surgery. transurethral nephroscopic pneumatic lithotripsy using the swiss lithoclast is a minimally invasive technique described for this purpose. this study assessed stone clearance and perioperative outcomes in patients treated at a tertiary urology unit.

Materials and Methods: A descriptive study was performed at Institute of Kidney Diseases, Hayatabad Medical Complex, Peshawar on 86 patients aged 18–65 years with large urinary bladder calculi (>2.5 cm) treated by transurethral nephroscopic pneumatic lithotripsy. Consecutive non-probability sampling was used. Stone clearance was defined as complete absence of stone on postoperative CT at 14 days. Demographic, stone, operative, hospital-stay, and complication data were analyzed using descriptive statistics. Stratified comparisons used chi-square or Fisher's exact test, with $p < 0.05$ considered significant.

Results: Mean age was 50.56 ± 8.29 years, mean BMI 28.30 ± 2.76 kg/m², and mean stone size 37.66 ± 8.14 mm. Complete stone clearance was achieved in 83/86 patients (96.5%; 95% CI 90.2–98.8%). Clearance was 100% for single stones and 86.4% for multiple stones (Fisher's exact $p = 0.015$). Intraoperative complications occurred in 7 (8.1%) and postoperative complications in 15 (17.4%). Non-clearance was observed in three patients, all with multiple stones, and these patients had larger stones, longer lithotripsy time, and longer hospital stay.

Conclusion: Transurethral nephroscopic pneumatic lithotripsy using the Swiss Lithoclast achieved a high stone clearance rate of 96.5% in this dataset, with acceptable reported perioperative complications. Multiple-stone disease was associated with the observed failures and may identify patients requiring particular procedural planning.

KEYWORDS: bladder calculi; pneumatic lithotripsy; Swiss Lithoclast; transurethral nephroscopy; stone clearance; cystolithotripsy

INTRODUCTION

Urinary bladder calculi remain an important urological problem and may cause lower urinary tract symptoms, recurrent infection, hematuria, obstruction, and impaired quality of life. Although bladder stones represent a smaller proportion of urinary calculi than renal and ureteric stones, large or hard calculi can create substantial treatment challenges, particularly when a minimally invasive approach is preferred (1,2).

The management of bladder stones has evolved with advances in endoscopic equipment and intracorporeal lithotripsy. Transurethral approaches avoid the abdominal incision associated with open cystolithotomy and can provide effective stone fragmentation with shorter recovery. Pneumatic lithotripsy uses mechanically generated ballistic energy to fragment the calculus into removable pieces and is valued for its relative simplicity, availability, and cost-effectiveness (2–4).

The Swiss Lithoclast pneumatic system has been used for urinary stone fragmentation, including large bladder calculi. Its combination with a nephroscope provides a relatively large working channel and direct visualization, facilitating fragmentation and evacuation of stone debris (5,6). Published experience has reported high clearance rates. In particular, the study cited in the present synopsis reported a 94.1% clearance rate after transurethral nephroscopic pneumatic fragmentation of large bladder calculi using the pneumatic Swiss Lithoclast (6).

Despite encouraging results, outcomes can vary according to stone burden, number of calculi, patient characteristics, equipment, and operator experience. The synopsis for the present study therefore proposes assessment of stone clearance in patients with large bladder calculi treated at the Institute of Kidney Diseases, MTI-HMC, Peshawar,

using a standardized transurethral nephroscopic pneumatic technique. The study objective was to determine the stone clearance rate of transurethral nephroscopic pneumatic lithotripsy for the management of large urinary bladder calculi using the pneumatic Swiss Lithoclast.

MATERIALS AND METHODS

This descriptive study was conducted in the Department of Urology, Institute of Kidney Diseases, MTI-HMC, Peshawar from April 2026 to July 2026. The study protocol specified completion after the required sample size following synopsis approval. The calculated sample size was 86, based on an anticipated stone clearance rate of 94.1%, 5% margin of error, and 95% confidence level. Consecutive non-probability sampling was specified in the protocol (6).

Patients of either sex aged 18–65 years were eligible when they had large urinary bladder calculi. Large urinary bladder calculus was operationally defined on CT as a calculus measuring >2.5 cm, with a very bright intravesical focus, round/oval configuration, and sharp margins. Patients with coagulopathy or bleeding diathesis, neurogenic bladder, bladder malignancy, or urosepsis were excluded.

Patients underwent clinical and medical assessment, with age, sex, BMI, residence, stone characteristics, hospital stay, lithotripsy time, complications, and stone clearance recorded on the study proforma. Surgical treatment was performed under spinal anesthesia after preoperative antibiotic prophylaxis. Cystoscopy was initially used to document stone characteristics. A 26-French nephroscopic sheath with obturator was introduced transurethraly into the bladder, followed by removal of the obturator and continuous sterile irrigation. A rigid nephroscope was advanced through the sheath. The Swiss Lithoclast pneumatic energy device was used to fragment the calculi into particulate debris, which was evacuated with irrigation and suction. Final cystoscopic inspection was performed to assess clearance, and a 16-French urinary catheter was placed for postoperative drainage (6).

Stone clearance was defined as complete freedom from stone confirmed by postoperative CT 14 days after surgery. The supplied dataset contained 86 records, corresponding exactly to the protocol-calculated sample size. For analysis, categorical variables were summarized as frequencies and percentages. Continuous variables were assessed for normality; because the principal continuous variables were not normally distributed by Shapiro–Wilk testing, they are presented as median (interquartile range [IQR]) where appropriate, while overall means and standard deviations are also provided for descriptive completeness. Associations between stone clearance and categorical variables were assessed using chi-square or Fisher's exact test. Continuous variables according to clearance status were compared using the Mann–Whitney U test. Statistical significance was set at $p < 0.05$.

For stratification, age was grouped as <50 versus ≥ 50 years, BMI as <30 versus ≥ 30 kg/m², and stone laterality as single versus multiple, consistent with clinically interpretable groupings for the supplied dataset. No values were imputed or altered. Ethical approval and institutional permissions were specified in the source synopsis and should be documented in the final submission record before publication.

RESULTS

A total of 86 patients were included. There were 43 males and 43 females, with equal representation of rural and urban residents. Mean age was 50.56 ± 8.29 years and mean BMI was 28.30 ± 2.76 kg/m². The mean stone size was 37.66 ± 8.14 mm, mean hospital stay was 2.87 ± 1.03 days, and mean lithotripsy time was 57.07 ± 14.60 minutes.

Single stones were recorded in 64 patients (74.4%), whereas 22 (25.6%) had multiple stones. Complete stone clearance was achieved in 83 patients (96.5%), while three patients (3.5%) had residual stone on postoperative assessment. The 95% confidence interval for the observed clearance proportion was 90.2%–98.8%.

Intraoperative complications were recorded in 7 patients (8.1%) and postoperative complications in 15 (17.4%). Four patients had both intraoperative and postoperative complications. The dataset did not specify complication type beyond the binary fields used in analysis; therefore, individual complication diagnoses were not inferred.

Stone clearance was 100% among patients with single stones compared with 86.4% among those with multiple stones; this difference was statistically significant by Fisher's exact test ($p = 0.015$). Clearance did not differ significantly by sex ($p = 0.241$) or residence ($p = 0.241$). Patients aged ≥ 50 years had 93.3% clearance compared with 100% among those aged <50 years ($p = 0.243$). Patients with BMI ≥ 30 kg/m² had 88.9% clearance compared with 100% among those with BMI <30 kg/m² (Fisher's exact $p = 0.029$).

Patients without clearance had a median age of 64 years, BMI 33.8 kg/m², stone size 53 mm, hospital stay 5 days, and lithotripsy time 86 minutes, compared with medians of 50 years, 27.8 kg/m², 36 mm, 2 days, and 54 minutes, respectively, among patients with successful clearance. These differences were statistically significant by Mann–Whitney testing, although the non-clearance group contained only three patients and therefore these comparisons should be interpreted cautiously.

Table 1. Baseline demographic, stone, and procedural characteristics.

Variable	Value
Total Patients	86 (100.0%)

Age, Mean±SD	50.56±8.29 years
BMI, Mean±SD	28.30±2.76 kg/m ²
Stone size, Mean±SD	37.66±8.14 mm
Hospital stay, Mean±SD	2.87±1.03 days
Lithotripsy time, Mean±SD	57.07±14.60 min
Male	43 (50.0%)
Female	43 (50.0%)
Urban residence	43 (50.0%)
Rural residence	43 (50.0%)
Single stone	64 (74.4%)
Multiple stones	22 (25.6%)

Table 2. Stone clearance and reported perioperative complications.

Outcome / complication	n (%)
Stone clearance: Yes	83 (96.5%)
Stone clearance: No	3 (3.5%)
Intraoperative complication: Yes	7 (8.1%)
Intraoperative complication: No	79 (91.9%)
Postoperative complication: Yes	15 (17.4%)
Postoperative complication: No	71 (82.6%)
Both intra- and postoperative complications	4 (4.7%)
Any reported intra-/postoperative complication	18 (20.9%)

Table 3. Stone clearance according to selected patient and stone characteristics.

Stratification	Clearance Yes n/N (%)	Clearance No n/N (%)	p value
Sex: Male	43/43 (100.0)	0/43 (0.0)	0.241*
Sex: Female	40/43 (93.0)	3/43 (7.0)	
Residence: Urban	43/43 (100.0)	0/43 (0.0)	0.241*
Residence: Rural	40/43 (93.0)	3/43 (7.0)	
Age <50 years	41/41 (100.0)	0/41 (0.0)	0.243*
Age ≥50 years	42/45 (93.3)	3/45 (6.7)	
BMI <30 kg/m ²	59/59 (100.0)	0/59 (0.0)	0.029*
BMI ≥30 kg/m ²	24/27 (88.9)	3/27 (11.1)	
Single stone	64/64 (100.0)	0/64 (0.0)	0.015*
Multiple stones	19/22 (86.4)	3/22 (13.6)	

*Fisher's exact test; two-sided. p<0.05 was considered statistically significant.

Table 4. Continuous variables according to stone-clearance status.

Variable	Clearance Yes (n=83), median (IQR)	Clearance No (n=3), median (IQR)	Mann–Whitney p
Age, years	50 (43.5–57.0)	64 (64.0–64.5)	0.003
BMI, kg/m ²	27.8 (25.95–30.25)	33.8 (33.65–34.0)	0.004
Stone size, mm	36 (30–44)	53 (52.5–53.5)	0.003
Hospital stay, days	2 (2–3)	5 (5–5)	0.004
Lithotripsy time, min	54 (44.5–68)	86 (85.5–87)	0.004

DISCUSSION

The present analysis of 86 patients demonstrated a stone clearance rate of 96.5% following transurethral nephroscopic pneumatic lithotripsy with the Swiss Lithoclast. This result is consistent with the high clearance reported in previous experience and is numerically higher than the 94.1% rate cited in the study synopsis (6). The difference should not be interpreted as superiority because the present dataset is small, single-center, and contains only three unsuccessful cases.

The high clearance rate supports the technical feasibility of the transurethral nephroscopic approach for large bladder calculi. The endoscopic route avoids the incision and tissue disruption associated with open cystolithotomy, while pneumatic energy provides controlled mechanical fragmentation. Previous literature has similarly described

transurethral endoscopic treatment as an effective alternative to open surgery, particularly with modern endoscopic equipment (2–5,9).

Stone number was the clearest factor associated with treatment success in this dataset. All 64 patients with a single stone achieved clearance, compared with 19 of 22 patients with multiple stones (86.4%), yielding a significant Fisher's exact *p* value of 0.015. Multiple calculi may create a greater cumulative stone burden and can require repeated repositioning, prolonged fragmentation, and more extensive evacuation. The association observed here is clinically plausible, although the dataset does not permit causal inference.

Stone size also appeared important. The three patients without clearance had a median stone size of 53 mm, whereas the clearance group had a median of 36 mm. The same unsuccessful cases had longer median lithotripsy time and hospital stay. These findings suggest that greater stone burden may increase procedural complexity. However, because all three failures occurred in older patients with multiple stones and high BMI, the individual contribution of each factor cannot be separated reliably.

BMI showed a statistically significant association after dichotomization at 30 kg/m², with 100% clearance below 30 kg/m² and 88.9% clearance at or above 30 kg/m². This result should be interpreted cautiously because only three patients experienced failure and all three were in the BMI ≥30 kg/m² group. The study was not powered for multivariable analysis, and therefore BMI cannot be regarded as an independent predictor on the basis of these data.

Sex and residence were not significantly associated with clearance. The equal numbers of men and women and equal numbers of urban and rural participants make the descriptive comparisons straightforward, but the absence of statistical significance does not establish equivalence. Larger datasets would be required to determine whether demographic factors influence outcomes after adjustment for stone burden and other procedural characteristics.

Perioperative complications were reported in 8.1% intraoperatively and 17.4% postoperatively. Four patients experienced both categories. The supplied dataset does not identify the exact type or severity of each complication, so no further clinical classification has been made. Notably, complications were more frequent among the three patients without clearance, but this association is based on very small numbers and should not be interpreted as evidence that complications cause treatment failure.

The broader endourological literature supports the use of minimally invasive stone-treatment strategies selected according to stone burden, location, anatomy, available equipment, and operator expertise. Contemporary European and American guidance emphasizes individualized endoscopic management and careful assessment of stone characteristics before intervention (10-13).

For bladder calculi specifically, the literature describes stone size, number, urinary stasis, bladder outlet obstruction, infection, and underlying urological pathology as clinically relevant considerations in treatment planning (16-20). Endoscopic cystolithotripsy has progressively replaced open surgery in many appropriately selected patients because it can achieve effective fragmentation without an abdominal incision (4,20-22).

The choice of intracorporeal energy source also influences procedural characteristics. Pneumatic lithotripsy remains a practical mechanical fragmentation modality, while laser systems have expanded the range of endoscopic stone-treatment options. Comparative evidence suggests that the selection of pneumatic or laser technology should consider stone composition, size, equipment availability, operative efficiency, and surgeon experience rather than relying on a single modality for all patients (2,3,10,23-25).

Patient selection and prevention of recurrence are also important. Urolithiasis guidelines recommend evaluation for underlying metabolic and anatomical contributors, appropriate stone analysis, and prevention strategies after treatment, particularly in patients with recurrent or high-risk stone disease (13-15,26-28). In bladder-stone patients, assessment for bladder outlet obstruction, infection, foreign bodies, neurogenic dysfunction, and other predisposing conditions may be relevant to long-term outcomes (17-20,29,30).

The study has several strengths, including complete inclusion of the 86 records corresponding to the protocol-calculated sample size, direct assessment of stone clearance using the predefined postoperative CT criterion, and availability of stone size, number, lithotripsy time, hospital stay, and complication data. These variables permit a clinically meaningful description of the procedure and its immediate outcomes.

The limitations are important. The study is descriptive and single-center, with consecutive non-probability sampling, limiting generalizability. Only three treatment failures were present, preventing reliable multivariable prediction modelling. The dataset also contains binary complication fields without specific diagnoses or grading, and it does not provide information on stone composition, underlying bladder outlet obstruction, urinary tract infection status beyond the exclusion criterion, metabolic evaluation, prostate size, or long-term recurrence. The reported association between multiple stones and clearance therefore requires confirmation in larger prospective cohorts.

CONCLUSION

Transurethral nephroscopic pneumatic lithotripsy using the pneumatic Swiss Lithoclast achieved a high stone clearance rate of 96.5% among the 86 patients with large urinary bladder calculi included in this dataset. Single-stone disease had complete clearance, whereas clearance was lower among patients with multiple stones. The overall reported complication burden was acceptable within the limitations of the available data. Larger studies with

detailed complication classification, stone composition, underlying bladder pathology, and longer follow-up are needed to confirm predictors of successful clearance and recurrence.

Ethical Considerations

The source synopsis specifies institutional ethical approval and research permissions before commencement of data collection, as well as communication of study goals, risks, and benefits to participants. The final submitted manuscript should include the institutional approval/reference number and the date of approval when available.

Funding

No external funding information was provided in the source synopsis.

Conflict of Interest

No conflict-of-interest information was provided in the source synopsis. The authors should insert the final declaration before submission.

Data Availability

The individual-level dataset supplied for this manuscript contains 86 records. Access to underlying clinical records should comply with institutional confidentiality and ethical requirements.

REFERENCES

1. Ahmed F, Alyhari Q, Al-Wageeh S, Mohammed F. Giant urinary bladder calculi in a 60-year-old man: a case report. *Pan Afr Med J*. 2022;41(78):1-5.
2. Cerrato C, Frasccheri MF, Fernandez SN, Emiliani E, Arena P, Pietropaolo A, et al. Emerging role of laser lithotripsy for bladder stones: real-world outcomes from two European endourology centers with a systematic review of literature. *J Endourol*. 2025;39(3):285-291.
3. Brunaiova L, Sommer KG, Koneval L, Willi D, Mohr MN, Neumann T, et al. Effectiveness of pneumatic versus laser lithotripsy for upper tract urolithiasis: a systematic review and meta-analysis. *Urol Int*. 2025;15(22):100-106.
4. Fauzan R, Herman H, Rachman W, Sitompul AP, Astram A. Endourological versus open cystolithotomy for bladder stone management among children: a systematic review and meta-analysis. *F1000Res*. 2023;12(7):124-129.
5. Gou L, Wang Z, Zhou Y, Zheng X. Comparison of nephroscopy and cystoscopy used in the treatment of bladder stones: a systematic review and meta-analysis of randomized controlled trials. *BMC Surg*. 2021;21(1):448-455.
6. Shamsher A, Naeem M, Khan ZU, Khan RA, Wazir BG, Malik A. Transurethral nephroscopic fragmentation of large urinary bladder calculi using pneumatic Swiss lithoclast. *Khyber J Med Sci*. 2018;11(1):81-83.
7. Akhtar Z, Allahyani H, Rahman S. Common complications of transurethral pneumatic lithotripsy in children with bladder stone disease at a tertiary care hospital HMC Peshawar: original article. *Pak J Urol*. 2024;1(2):41-47.
8. Cauni VM, Tanase F, Mihai B, Gorecki GP, Ples L, Sima RM, et al. Single-center experience with Swiss LithoClast Trilogy for kidney stones. *Diagnostics*. 2023;13(8):1372-1377.
9. Mustafa M, Al Zabadi H, Mansour S, Nabulsi A. Endoscopic management of upper and lower ureteric stones using pneumatic lithotripter: a retrospective medical records review. *Res Rep Urol*. 2023;9(7):77-83.
10. Türk C, Petřík A, Sarica K, Seitz C, Skolarikos A, Straub M, et al. EAU guidelines on interventional treatment for urolithiasis. *Eur Urol*. 2016;69(3):475-482.
11. Assimos D, Krambeck A, Miller NL, Monga M, Murad MH, Nelson CP, et al. Surgical management of stones: American Urological Association/Endourological Society guideline. *J Urol*. 2016;196(4):1153-1160.
12. Preminger GM, Tiselius HG, Assimos DG, Alken P, Buck C, Gallucci M, et al. 2007 guideline for the management of ureteral calculi. *J Urol*. 2007;178(6):2418-2434.
13. Tiselius HG, Ackermann D, Alken P, Buck C, Conort P, Gallucci M. Guidelines on urolithiasis. *Eur Urol*. 2001;40(4):362-371.
14. Skolarikos A, Straub M, Knoll T, Sarica K, Seitz C, Petřík A, et al. Metabolic evaluation and recurrence prevention for urinary stone patients: EAU guidelines. *Eur Urol*. 2015.
15. Miller NL, Lingeman JE. Management of kidney stones. *BMJ*. 2007;334(7591):468-472.
16. Schwartz BF, Stoller ML. The vesical calculus. *Urol Clin North Am*. 2000;27(2):333-346.
17. Douenias R, Rich M, Badlani G, Mazor D, Smith A. Predisposing factors for bladder calculi in men. *J Urol*. 1991;146(4):1106-1109.
18. Stav K, Dwyer PL. Urinary bladder stones in women. *Obstet Gynecol Surv*. 2012;67(11):715-725.
19. Bultitude MF, Rees J, Glass J, Gowda V, Smith P, Tiptaft R, et al. Management of bladder stones. *BJU Int*. 2003;91.
20. Philippou P, Moraitis K, Masood J, Junaid I, O'Flynn K. The management of bladder stones in adults and children. *Nat Rev Urol*. 2012;9(12):652-659.
21. El-Hakim A, Elhilali MM. Holmium laser lithotripsy of bladder calculi. *J Endourol*. 2000.
22. Teichman JMH. Techniques of urinary stone removal. *J Endourol*. 2000.
23. Sofer M, Kaver I, Greenstein A, et al. Holmium laser lithotripsy of bladder calculi. *J Endourol*. 2002.

24. Atan A, Basar MM, Sut N, et al. Comparison of pneumatic lithotripsy and holmium:YAG laser lithotripsy for urinary stones. *Urol Res*. 2006.
25. Grabe M, Bartoletti R, Bjerklund Johansen TE, et al. Guidelines on urological infections. *Eur Assoc Urol*. 2015.
26. Oelke M, Bachmann A, Descazeaud A, et al. EAU guidelines on the treatment and follow-up of non-neurogenic male lower urinary tract symptoms including benign prostatic obstruction. *Eur Urol*. 2013;64(1):118-140.
27. Delvecchio FC, Preminger GM. Management of staghorn calculi: current practice and future developments. *J Endourol*. 2003.
28. Segura JW, Preminger GM, Assimos DG, Dretler SP, Kahn RI, Lingeman JE, et al. Ureteral stones clinical guidelines panel summary report on the management of ureteral calculi. *J Urol*. 1997.
29. European Association of Urology. EAU Guidelines on Urolithiasis. Arnhem: EAU Guidelines Office; 2024.
30. National Institute for Health and Care Excellence. Renal and ureteric stones: assessment and management. NICE guideline. London: NICE; 2019.