Original Article

Effectiveness of Percutaneous Cystolithotripsy in Pediatric Age Group

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Abstract

Background: Urolithiasis is a prevalent condition in tropical and subtropical regions, with the urinary bladder being the primary site for stone formation in the lower urinary tract, accounting for 5% of urinary calculi.
Objective: The objective of this study was to determine the safety and effectiveness of percutaneous cystolithotripsy (PCCL) in the pediatric age group.
Methods: This was a descriptive study carried out at Lady Reading Hospital, Peshawar, for six months. There were 104 children aged between 5 and 18 years with bladder stones of size less than 3 cm. PCCL was done by a skilled urologist. Complete clearance of the stone and postoperative complications were the outcomes measured. Data was analyzed using SPSS v22 with significance at $P \leq 0.05$.
Results: Among the 104 patients, with a mean age of 9.2 ± 3.4 years, 92.3% achieved complete stone clearance. Complications were observed in 14.4% of patients, including hematuria (3.8%), infection (4.8%), urine extravasation (1.9%), and sepsis (1.0%). There were no significant differences in stone clearance rates based on gender, socioeconomic status, or place of residence. Although not statistically significant, stones smaller than 1.5 cm showed a higher clearance rate of 100%, compared to a clearance rate of 89.2% for stones larger than 1.5 cm.
Conclusion: PCCL is a safe and effective treatment for pediatric bladder stones, with high rates of stone clearance and low complication rates. It is suggested that further studies with larger series and longer follow-up should be done to validate these findings and observe recurrence.
Keywords: Pediatric urolithiasis, percutaneous cystolithotripsy, bladder stones, surgical outcomes
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Introduction

Urolithiasis is a prevalent condition in tropical and subtropical regions, with the urinary bladder being the primary site for stone formation in the lower urinary tract, accounting for 5% of urinary calculi.[1,2] The incidence of vesicolithiasis has decreased significantly in developed nations but remains prevalent in many developing regions, notably in Africa, the Middle East, and South and East Asia, collectively termed as the afro-Asian stone belt.[2] Boys have a higher incidence compared to girls, with the peak occurrence typically observed at 5 years of age.[3] Bladder calculi in children, in the absence of infection or underlying anatomical or neurological conditions, are considered endemic.[4]

Epidemiological studies link stone formation with dietary habits, suggesting that a diet high in carbohydrate foods, low in animal proteins, and rich in oxalate can lead to the formation of urinary salts and subsequent stone developments.[5] Girls, due to their shorter urethral length, often pass calculus debris without retention in the bladder, whereas males frequently experience stone nucleus formation and retention. The growth of stones is influenced by deposition and resorption mechanisms, which progress over several years until patients develop symptomatic presentations necessitating surgical intervenetion.[3] Symptoms typically include lower abdominal pain, urinary stream interruption, penile discomfort, dysuria, urinary frequency, poor stream, hematuria, or urine retention.[6]

Traditionally, vesicolithiasis is managed through open vesicolithotomy; however, advancements in technology have enabled the transition to less invasive techniques. These include transurethral stone fragmentation via intra-corporeal cystolithotripsy or holmium laser, vesicolitholapaxy, and percutaneous cystolithotripsy.[7] These innovative

approaches are associated with reduced hospitalization duration and faster post-operative recovery times. In one study conducted by Ahmad T et al[8] had reported that the effectiveness of percutaneous cystolithotripsy was 95.55% in terms of stone clearance. Percutaneous cystolithotripsy has been proven to completely clear stone or fragment into smaller insignificant pieces.[9] When compared to individuals who had open vesicolithotomies (18%), patients undergoing cystoscopic procedures experience fewer postoperative problems (10%).[10] In one study suprapubic urine leakage was found in 1 (5.26%) case. One (5.26%) patient developed pre-vesical extravasation which was managed conservatively. Two (10.52%) patients developed minor hematuria which was insignificant. Infection was seen in two (10.52%) patients which was managed by antibiotics.[8]

Despite widespread use, notably, significant data on the percutaneous cystolitholapaxy for bladder stones in pediatric age group in our set-up is lacking, and no studies have evaluated the effectiveness of percutaneous cystolithotripsy in pediatric age group. The objective of this study was to evaluate the safety and efficacy of percutaneous cystolithotripsy in pediatric age group.

Methods

This descriptive study was conducted at the Department of Urology, Lady Reading Hospital, Peshawar, from September 2024 to February 2025 following the approval of the research synopsis. A total of 104 patients were included in the study, with the sample size calculated using the WHO sample size calculator. The calculation was based on an anticipated effectiveness of percutaneous cystolithotripsy for stone clearance (95.5%), a 95% confidence level, and a 1% margin of error. A non-probability consecutive sampling technique was employed to recruit participants. Eligible patients included both male and female children aged between 5 and 18 years, presenting with bladder stones less than 3 cm in size. Patients were excluded if they had active urinary tract infections, sepsis, bladder stones larger than 3 cm, or any anatomical or physiological abnormalities of the urinary bladder. This study was conducted after obtaining prior permission from the hospital ethical committee vide Ref No. 95/LRH/MTI. All children who fulfilled the inclusion criteria were included in the study. The aim of study was explained to all selected patients, and informed written consent was obtained. A detailed history and radiological examination were performed for all included patients. All patients underwent surgery, where percutaneous cystolithotripsy was performed by an expert urologist (FCPS). A 7-day follow-up was conducted to diagnose complete stone clearance and identify any complications. The data was entered into statistical software SPSS version 22. Quantitative variables such as age, duration of disease, size of stone, and number of stones were expressed as mean and standard deviation or median (IQR) after checking the normality of data using the Shapiro-Wilk test. Qualitative variables like gender, residence, socioeconomic status, effectiveness, and safety were expressed in terms of frequency and percentages. Effectiveness and safety were stratified by age, gender, duration of disease, size of stone, number of stones, residence, and socioeconomic status to assess effect modification. Post-stratification, the Chi-square test or Fisher's exact test was applied, and a P-value ≤ 0.05 was considered statistically significant.

Results

This study included 104 pediatric patients with a mean age of 9.2 ± 3.4 years (range: 5 to 14 years), comprising 61.5% males (n = 64) and 38.5% females (n = 40). Most children lived in urban areas (51.9%, n = 54), while 48.1% (n = 50) resided in rural settings. In terms of socioeconomic background, 61.5% (n = 64) were from low-income families, 28.8% (n = 30) from medium, and 9.6% (n = 10) from high. The average stone size was 1.77 ± 0.41 cm, with 82.7% (n = 86) having a single stone. Before treatment, 38.5% (n = 40) of patients had urinary tract infections, and 8.7% (n = 9) presented with sepsis. The average duration of symptoms before intervention was 45 ± 12 days. Postoperative stone clearance was achieved in 92.3% of patients (n = 96; 95% CI: 90% to 94%), while the overall complication rate was 14.4% (n = 15), including hematuria in 3.8% (n = 4), urine extravasation in 1.9% (n = 2), infection in 4.8% (n = 5), and sepsis in 1.0% (n = 1). Chi-square analysis showed no statistically significant differences in stone clearance based on gender (P = 0.41), residence (P = 0.67), or socioeconomic status (P = 0.56). When comparing stone size, clearance was 100% among patients with stones <1.5 cm (n = 30) and 89.2% among those with stones ≥1.5 cm (n = 74), a difference that was not statistically significant (P = 0.18) but indicated a trend

favoring smaller stones. An independent samples t-test found no significant difference in mean stone size between males (1.77 ± 0.30 cm) and females (1.78 ± 0.56 cm) (P = 0.90). Logistic regression adjusted for age and gender showed that stone size (OR = 1.2, 95% CI: 0.8–1.7), socioeconomic status (OR = 1.1, 95% CI: 0.9–1.3), and residence (OR = 1.2, 95% CI: 0.9–1.5) were not significant predictors of stone clearance.

Table 1: *Stone Clearance Status among Pediatric Patients*

Clearance Status	Frequency (n)	Percentage (%)
Incomplete Clearance	8	7.7
Complete Clearance	96	92.3
Total	104	100

Table 1 presents the postoperative stone clearance status among pediatric patients. "Complete Clearance" refers to the absence of visible stone fragments on postoperative imaging, while "Incomplete Clearance" indicates the presence of residual calculi.

Table 2: *Clearance Rate by Stone Size Category*

Stone Size Category	Number of Patients (n)	Clearance Rate (%)	P Value
<1.5 cm	30	100	0.18
≥1.5 cm	74	89.2	

Table-1 presents the clearance rates by stone size category; difference not statistically significant (P = 0.18). Figure-1 shows the percentage of pediatric patients who experienced specific postoperative complications, including hematuria, urine extravasation, sepsis, and infection.

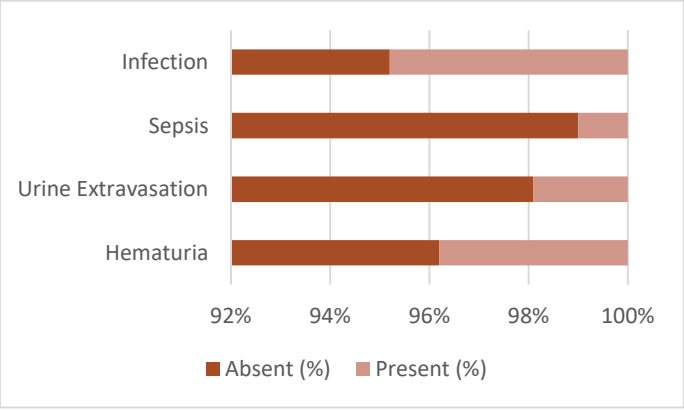

Figure 1: *Postoperative complication rates in pediatric patients.*

Discussion:

The burden of pediatric urolithiasis continues to rise globally, prompting the need for optimized treatment strategies that are effective, minimally invasive, and safe. In this context, our study assessed the outcomes of percutaneous cystolithotripsy (PCCL) in children, reporting a 92.3% stone clearance rate and a 14.4% overall complication rate. These results affirm the growing body of literature favoring minimally invasive approaches for pediatric stone management. Our findings resonate with studies such as Mahmood et al[11], who reported a 93.25% stone-free rate using mini-percutaneous nephrolithotomy (MPCNL) in children, along with minor complication rates and short hospital stays, reinforcing the clinical utility of percutaneous techniques in pediatric populations. Similarly another study in UK by Jones et al[18], reported a stone free rate of 99%, highest ever recorded in the literature. The predictive role of stone characteristics has been highlighted in previous work by Okhunov et al[12], who proposed the Stone nephrolithometry system, showing that larger and more complex stones are associated with reduced clearance and higher complications. This complements our finding that stones <1.5 cm had a 100% clearance rate, while stones ≥1.5 cm showed slightly lower success at 89.2%, though the difference was not statistically significant.

We also observed that most complications in our study were mild—such as hematuria, urine extravasation, and low-grade infections—echoing outcomes from Tejwani et al., who documented a 13% complication rate following ureteroscopy, primarily consisting of minor events.[17] This supports the favorable safety profile of PCCL, especially when performed by experienced surgeons. Moreover, our complication types and rates are similar to those reported by Sultan et al., who evaluated various minimally invasive modalities in children and concluded that MPCNL and PCCL are well-tolerated with limited morbidity.[14] The surgical innovation driving improved outcomes in pediatrics has included adjunctive tools like the ureteral access sheath (UAS), which has been shown to reduce ureteral trauma and facilitate flexible ureteroscopy. Ripa et al. systematically reviewed its role and found high success rates with minimal ureteral injury, highlighting how technical refinements contribute to pediatric safety.[16]

Despite our strong results, we noted no significant difference in stone clearance or complications based on gender or socioeconomic status (SES). This is in contrast to findings by Scotland et al., who observed that children from higher SES groups had better outcomes due to early intervention and access to resources.[20] Our study's lack of association may be due to a limited sample size or relatively uniform care delivery at our institution. A critical concern in pediatric stone management is long-term recurrence, which we could not assess due to limited follow-up. However, studies such as those by Michele G et al. report recurrence rates as high as 16% after 8 months of the initial surgery, underlining the importance of monitoring stone-forming risk factors even after successful clearance.[19] Hong Y et al., using ultrasound-guided PCNL, further emphasize that while immediate outcomes are excellent, sustained surveillance remains key to identifying early signs of recurrence.[15] Similarly, Chang et al. reported that after augmentation cystoplasty, urinary tract stone formation was the most frequent long-term complication (36.4%), reinforcing the need for extended follow-up in pediatric urology.[22] Beyond surgical outcomes, the use of clinical scoring systems has gained attention for predicting operative complexity and prognosis. While our study did not apply such systems, tools like Guy's Stone Score (GSS) and the CROES nomogram, compared by Caglayan et al., have shown utility in pediatric populations—particularly for assessing complications and clearance likelihood.[21] Their work supports the need for broader adoption of such scoring in pediatric endourology.

In addition, Jeong et al. proposed the S-ReSC score, another method for evaluating stone burden preoperatively. Its application in pediatric cohorts remains limited, but it may serve as a useful adjunct in the future.[13] Labadie et al. also compared multiple scoring systems, affirming that while no single system is perfect, standardized tools enhance procedural planning.[23]

While surgical techniques continue to evolve, variability in how outcomes are reported poses challenges to evidence synthesis. This was observed by Hyams et al., who highlighted considerable heterogeneity in the reporting of stone-free rates, complications, and patient characteristics across studies—urging the need for uniform metrics in pediatric research.[24]

Finally, complexity scoring was further advanced by Thomas et al., who introduced Guy's Stone Score, which stratifies cases by anatomical and stone-related factors. Although primarily designed for adults, its adaptation in pediatric settings may prove beneficial for benchmarking and training.[25] As such, future studies should consider integrating validated scoring systems to guide surgical decision-making and improve inter-study comparability.

Despite the promising findings, there are several limitations to this study that should be addressed in future research. The sample size of 104 patients is relatively small, and larger studies with more diverse patient populations are needed to validate the findings and enhance the generalizability of the results. Additionally, the absence of long-term follow-up limits our ability to assess stone recurrence and its impact on renal function over time. It is crucial to incorporate long-term follow-up. To improve the current research on percutaneous cystolithotripsy (PCCL), future studies should involve multiple centers with larger and more varied patient groups. This will make the findings stronger and provide more complete data across different groups of people. Additionally, long-term follow-up is important to track stone recurrence and kidney function over time. Research should also focus on creating better scoring systems for children to predict outcomes more accurately.

Conclusion:

In conclusion, this study offers useful information on how effective and safe percutaneous cystolithotripsy (PCCL) is for treating pediatric urolithiasis. The 92.3% stone-clearance rate and low complication rate match what other studies have found, supporting the use of less invasive methods for treating kidney stones in children. However, more research with long-term follow-up, larger sample sizes, and child-specific prediction models are needed to improve patient selection, outcomes, and reduce recurrence rates.

Ethical Permission: The Institutional Review Board of Lady Reading Hospital-MTI approved this study vide reference No. 95/LRH/MTI.

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Authors' contribution:

SFQ: Concept & design of study, drafting of manuscript

AAG: Critical revisions for important intellectual content, final approval of version to be published Concept & design of study

WU, ZR: Acquisition of data, analysis & interpretation, drafting of article

RM: Analysis & interpretation

RM: Drafting of article

FM: Acquisition of data

References

1. Soliman NA, Rizvi SAH. Endemic bladder calculi in children. Pediatr Nephrol. 2017;32(9):1489-1499. Doi: 10.1007/s00467-016-3492-4.
2. Delbalre B, Baowaidan F, Culty T, Khellht L, Brassier M, Ferragu M, et al. Prospective comparison of thulium and holmium laser lithotripsy for the treatment of upper urinary tract lithiasis. Eur Urol Open Sci. 2023;51:7-12. Doi: 10.1016/j.euros.2023 .02.012
3. Halstead SB. Epidemiology of bladder stone in children: precipitating events. Urolithiasis. 2016;44(2):101-8. Doi: 10.1007/s00240-015-0835-8. Epub 2015 Nov 11.
4. Mishra DK, Bhatt S, Mukhilesh R, Somani BK, Agrawal MS. Mini-percutaneous cystolithotripsy (mPCCt) versus transurethral cystolithotripsy (TUC) in preschool children: Prospective comparative non-randomized outcomes over 8 years. J Pediatr Urol. 2020;16(6):782.e1-782.e6.
   Doi: 10.1016/j.jpurol.2020.09.021.
5. Lal B, Paryani JP, Memon SU. Childhood Bladder Stones-An Endemic Disease of Developing Countries. J Ayub Med Coll Abbottabad. 2015;27(1):17-21. PMID: 26182729.
6. Hussain I, Qurashi MF, Kanjoo SR, Rashid A. Comparison of percutaneous cystolithotripsy with vesicolithotomy in pediatric age group for safety and effectiveness. Professional Med J. 2020;27(08):1742-6. DOI: 10.29309/TPMJ/2020.27.08.4130.
7. Akmal M, Munir MI, Jatari AA, Subhani GM, Javed SH. Percutaneous cystolithotripsy; is it safe and successful in all age groups? Ann Punjab Med Coll. 2017;11(1):25-27.
   Doi: https://doi.org/10.29054/apmc/2017.240
8. Ahmad T, Khan FU, Ali S, Ammar MA. Effectiveness and safety of percutaneous cystolithotripsy under 5 years of age. Pak J Med Health Sci. 2022;16(1):110-8. Doi: https://doi.org/10.53350/pjmhs20221611770
9. Rizk yah HF, Ambeng YY. Pediatric bladder stone in secondary hospital care: a case report. J Res Soc Sci Eco Manag. 2021;11(5):486-91.
   Doi: https://doi.org/10.59141/jrssem.v1i5.56
10. Ahmad T, Khan SW, Tayyib M, Khalily MY. Comparative analysis of cystolithalopexy and percutaneous cystolithotripsy in senior pediatric population aged 6 to 15 years. Pak J Med Health Sci. 2022;16(11):848-50.
    Doi: https://doi.org/10.53350/pjmhs20221611848
11. Mahmood SN, Said SHA, Mohammed RO, Jaafar MS. Safety and efficacy of mini-percutaneous nephrolithotomy in management of renal stones in pediatric age group. BMC Nephrol. 2025;26(1):111.
    Doi: 10.1186/s12882-025-04031-4.
12. Okhunov Z, Friedlander JI, George AK, Duty BD, Moreira DM, Srinivasan AK et al. STONE nephrolithometry: novel surgical classification system for kidney calculi. Urology. 2013;81(6):1154-9.
    Doi: 10.1016/j.urology.2012.10.083.
13. Jeong CW, Jung JW, Cha WH, Lee BK, Lee S, Jeong SJ et al. Seoul National University Renal Stone Complexity Score for Predicting Stone-Free Rate after Percutaneous Nephrolithotomy. PLoS One. 2013;8(6):e65888. Doi: 10.1371/journal.pone.0065888.
14. Sultan S, Aba Umer S, Ahmed B, Naqvi SAA, Rizvi SAH. Update on surgical management of pediatric urolithiasis. Front Pediatr. 2019;7:252. Doi: 10.3389/fped.2019.00252.
15. Hong Y, Yu L, Huang X, An L, Xiong L, Xu T et al. Outcome of Ultrasonography-Guided Percutaneous Nephrolithotomy for the Management of Pediatric Urolithiasis. J Endourol. 2025;39(2):146-150. Doi: 10.1089/end.2023.0771.
16. Ripa F, Tokas T, Griffin S, Ferretti S, Bujons Tur A, Somani BK. Role of pediatric ureteral access sheath and outcomes related to flexible ureteroscopy and laser stone fragmentation: a systematic review of literature. Eur Urol Open Sci. 2022 12;45:90-98. Doi: 10.1016/j.euros.2022.09.012.
17. Tejwani R, Wang HH, Wolf S, Wiener JS, Routh JC. Outcomes of shock wave lithotripsy and ureteroscopy for treatment of pediatric urolithiasis. J Urol. 2016;196(1):196-201. Doi: 10.1016/j.juro.2016.02.2975. Epub 2016 Mar 17.
18. Jones P, Rob S, Griffin S, Somani BK. Outcomes of ureteroscopy (URS) for stone disease in the paediatric population: results of over 100 URS procedures from a UK tertiary centre. World J Urol. 2020;38(1):213-218. Doi: 10.1007/s00345-019-02745-3.
19. Gnech M, Rotondi G, Minoli DG, De Marco EA, Mitzman F, Silvani C et al. Semi-closed-circuit vacuum-assisted mini percutaneous cystolithotomy (vamPCL) in the pediatric population: Initial exper-

ience of a novel technique in native and augmented bladders. J Pediatr Urol. 2025;21(4):855-861. Doi: 10.1016/j.jpurol.2024.12.023.
20. Scotland KB, Armas-Phan M, Dominique G, Bayne D. Social determinants of kidney stone disease: The impact of race, income, and access on urolithiasis treatment and outcomes. Urology. 2022;163:190-195. Doi: 10.1016/j.urology.2021.08.037.
21. Caglayan V, Onen E, Avci S, Sambel M, Kilic M, Oner S. Comparison of Guy's Stone Score and Clinical Research of the Endourological Society nomogram for predicting surgical outcomes after pediatric percutaneous nephrolithotomy: a single center study. Minerva Urol Nefrol. 2019;71(6):619-626. Doi: 10.23736/S0393-2249.19.03405-2.
22. Chang JW, Kuo FC, Lin TC, Chin TW, Yang LY, Chen HH et al. Long-term complications and outcomes of augmentation cystoplasty in children with neurogenic bladder. Sci Rep. 2024;14(1):4214. Doi: 10.1038/s41598-024-54431-z.
23. Labadie K, Okhunov Z, Akhavein A, Moreira DM, Moreno-Palacios J, Del Junco M, et al. Evaluation and comparison of urolithiasis scoring systems used in percutaneous kidney stone surgery. J Urol. 2015;193(1):154-9. Doi: 10.1016/j.juro.2014.07.104.
24. Hyams ES, Bruhn A, Lipkin M, Shah O. Heterogeneity in the reporting of disease characteristics and treatment outcomes in studies evaluating treatments for nephrolithiasis. J Endourol. 2010;24(9):1411-14. Doi: 10.1089/end.2009.0645.
25. Thomas K, Smith NC, Hegarty N, Glass JM. The Guy's stone score—grading the complexity of percutaneous nephrolithotomy procedures. Urology. 2011;78(3):277-81. Doi: 10.1016/j.urology.2010.04.038.