

Endemic Bladder Stone Disease in Children, Pattern And Current Management: Experience From A Centre In Peri-Urban Setting In Pakistan

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Purpose: To share our recent experience of the pattern and demography of endemic bladder calculi in children and the outcomes of current management strategies for the removal of bladder calculi in a peri-urban setting.

Material and Methods: This retrospective longitudinal study was carried out at a dedicated urology centre. All patients with endemic bladder stones from January 2020 to December 2021 managed at our centre were included in this study. After discharge, each patient was followed up for 1 year. Data analysis was carried out with IBM SPSS v23. Mean and standard deviation were calculated for normally distributed continuous variables; for non-normally distributed continuous variables, median and IQR were calculated; frequency and percentage were calculated for categorical variables.

Results: This study included 254 patients, with a male-to-female ratio of 10.5:1. The mean age of the patients was 4.80 ± 2.86 years. Ninety-one percent of the patients belonged to rural areas. Open cystolithotomy (OC) was performed in 11 (4.3%) patients, transurethral cystolithotripsy (TUCL) in 165 (65.0%), and percutaneous cystolithotomy (PCCL) in 78 (30.7%). The mean operative time was 48.8 ± 4.34 minutes for TUCL, 36.18 ± 7.4 minutes for open cystolithotomy, and 38.6 ± 5.2 minutes for PCCL. The most common stone composition was ammonium urate + calcium phosphate (33.1%). The complication rate was 4.8% in TUCL, 12.8% in PCCL, and 27.3% in open cystolithotomy. Stone clearance was 98.1% for TUCL and 100% for both PCCL and OC.

Conclusion: Paediatric bladder calculus is still endemic in rural areas of Sindh with poor socioeconomic backgrounds. Timely diagnosis and early intervention with preventive measures can lead to better outcomes and fewer complications. Minimally invasive methods of cystolithotomy have a shorter hospital stay, are more cost-effective, and have fewer complications as compared to open cystolithotomy.

Keywords: endemic bladder calculi; endourology; percutaneous cystolithotomy; transurethral cystolithotripsy; urolithiasis.

INTRODUCTION

Endemic bladder stone disease in children is defined as stones formed in the bladder in the absence of obstruction, infection, and neurogenic diseases. It is highly prevalent in rural areas of poor countries due to malnourishment, diarrheal disease, and chronic dehydration.⁽¹⁾

Bladder stones in children have almost disappeared in developed western countries due to improvements in nutrition and a better health care system. Countries where this unfortunate disease still exists. India, Pakistan, the Middle East, Thailand, Indonesia, Afghanistan, Nepal, sub-Saharan Africa, Iran, Egypt, Turkey, Tunisia, Ethiopia, Cameroon, Morocco, Mauritania, and the so-called Afro-Asian stone belt.⁽²⁾

In Pakistan, the geographical distribution of paediatric urolithiasis is in a transitional phase. The incidence of endemic bladder stones is decreasing in urban areas, while the disease continues to be endemic in rural areas of Pakistan and poor localities in big cities. Recently reported experience from Mithi (a deserted district

of Sindh) in 2015 regarding paediatric bladder calculi shows that disease is still prevalent in one of the poorest districts of Sindh.⁽³⁾

Nutritional deficiency of protein, vitamins, and chronic dehydration, due to diarrheal disease and high environmental temperatures in the summer months, which can reach 49 to 50°C in Sindh (the southern province of Pakistan), where disease is highly prevalent.⁽⁴⁾

The clinical presentation of bladder stones in paediatric patients can vary, and they may include pain in the lower abdomen (suprapubic region), dysuria, frequent urination, haematuria, and urinary tract infections. In some cases, the child may be asymptomatic, and the bladder stones may only be detected during routine imaging studies.⁽⁴⁾

According to data published by SIUT, the situation in Pakistan is also changing, where the incidence of bladder stones has decreased from 70% in 1984 to 18% in 2007, among paediatric urolithiasis cases.^(5,6)

Basiri et al. have recently released their findings on the lifetime prevalence of urolithiasis in the Iranian population, revealing a yearly increase of 0.06% in its prev-

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Table 1. Distribution of Demographic Characteristics, Dietary Information, Water Source, and Postoperative Complications Among Patients Receiving Surgical Intervention for Endemic Bladder Stones. (n=254)

		Frequency (N = 256)	Percentage (%)		
Occupation of father	Cook	1	0.4		
	Driver	9	3.5		
	Farmer	35	13.8		
	Guard	14	5.5		
	Labour	127	50		
	Painter	1	0.4		
	Peon	17	6.7		
	Plumber	1	0.4		
	Policeman	1	0.4		
	House keeping	1	0.4		
	Shopkeeper	21	8.3		
	Storekeeper	3	1.2		
	Teacher	22	8.7		
	Truck Driver	1	0.4		
	Dietary details	Cow Milk	123	48.4	
Cereals		106	41.7		
Rice		129	50.8		
Goat Milk		96	37.8		
Eggs		47	18.5		
Carrots		25	9.8		
Dry Fruits		0	0		
Source of water	Vegetables	216	85		
	Mineral Water	8	3.1		
	Tap Water (Hand Pump)	178	70.1		
	Water Supply (line water)	68	26.8		
Postoperative complication	TUCL (N = 165)	PCCL (N = 78)	OC (N = 11)		
	Fever	2 (1.2%)	5 (6.4%)	-	
	UTI	4 (2.4%)	1 (1.2%)	-	
	Bladder Perforation	1 (0.6%)	-	-	
	Urinary Retention	1 (0.6%)	-	-	
	Wound Infection	-	4 (5.1%)	3 (27.3%)	
Complication Grade according to MCCS	TUCL	PCCL	OC		
	Grade-I	-	-	-	
	Grade-II	6 (3.6%)	6 (7.6%)	-	
	Grade-IIIa	1 (0.6%)	3 (3.8%)	-	
	Grade-IIIb	1 (0.6%)	1 (1.2%)	3 (27.3%)	
	Grade-IV	-	-	-	
Grade-V	-	-	-		

Abbreviations: MCCS, Modified Clavien Classification System; TUCL, Transurethral Cystolithotripsy; PCCL, Percutaneous Cystolithotomy; OC, Open Cystolithotomy.

alence.⁽⁷⁾

A more recent study published by SIUT Karachi in 2012 has shown that the percentage of bladder stones is 30% among all urolithiasis cases in children.⁽⁸⁾

The management of bladder calculus in children has undergone a revolutionary change in the last two decades, from open surgery to endo urology. Previously, every bladder stone patient had to undergo open surgery, but the advent of lasers and the miniaturization of endoscopic instruments have made it possible to remove stones by keyhole incision or natural orifice, a totally scarless technique.⁽⁹⁾ The most commonly used endoscopic techniques are transurethral cystolithotripsy (TUCL) and percutaneous cystolithotomy (PCCL), depending on the size of the bladder calculi.⁽¹⁰⁾

In the past, the safety and efficacy of transurethral pneumatic lithotripsy for bladder calculi in children have been reported from SIUT⁽⁸⁾ and percutaneous cystolithotripsy from Faisalabad, Punjab⁽¹¹⁾, but very few have compared the three modalities for bladder stone removal from Pakistan.

This is the first study of its kind to provide us with an opportunity to report three modalities of management ranging from transurethral, percutaneous, and open cystolithotomy, along with the provision of demographic distribution, prevalence, and chemical composition of endemic bladder stones. With the above backdrop in mind, we report our pattern, demography, and current management outcomes in children with endemic bladder calculi.

der calculi.

MATERIALS AND METHODS

This retrospective longitudinal study was conducted at a specialized urology centre in Sindh. The study spanned a period of three years (January 2020 to December 2022), consisting of two years dedicated to surgical interventions, followed by one year of patient follow-up. Approval was obtained from the institutional Ethics Review Committee (SIUT-ERC-2023/A-430). Medical records of all children regardless of gender, aged between 9 months and 12 years, who underwent surgical intervention for bladder stones from January 2020 to December 2021 were reviewed. Patients with chronic kidney disease, bladder outlet obstruction, stones in an augmented bladder, and a positive urine culture were excluded from the study.

Each patient visiting our clinic underwent ultrasound and X-ray imaging of the kidney, ureter, and bladder (KUB) to assess the number, size, and location of stones present. Upon confirmation of a bladder stone diagnosis, a standardized set of preoperative investigations, including a complete blood count (CBC), blood urea, serum creatinine, serum electrolytes, and urine analysis and culture, were conducted for all patients. Patients with bladder stones measuring ≤ 1.5 cm underwent Transurethral Cysto-Lithotripsy (TUCL). Percutaneous Cystolithotomy (PCCL) was chosen for patients with stone sizes between 1.6 and 2.9 cm or for younger

Table 2. Descriptive Statistics for Duration of Surgery, Total Hospital Stay, and Duration of Catheterization among Patients Undergoing Surgical Management of Endemic Bladder Stones.

		N	Min:	Max:	Mean	S. D	Median	IQR
Duration of surgery (minutes)	Transurethral cystolithotripsy	165	35.0	60.0	48.8	4.34	49.0	6.0
	Percutaneous Cystolithotomy	78	30.0	49.0	38.6	5.2	39.0	9.0
	Open Cystolithotomy	11	25.0	49.0	36.18	7.4	35	14
Total hospital stay (days)	Transurethral cystolithotripsy	165	1.0	3.0	1.40	0.52	1.0	1.0
	Percutaneous Cystolithotomy	78	1.0	7.0	1.44	1.32	1.0	0.0
	Open Cystolithotomy	11	2.0	4.0	2.72	0.78	3.0	1.0
Duration of catheterisation (days)	Transurethral cystolithotripsy	165	1.0	7.0	1.40	0.96	1.0	0.0
	Percutaneous Cystolithotomy	78	1.0	14.0	2.35	2.55	1.0	2.0
	Open Cystolithotomy	11	4.0	7.0	6.63	0.92	7.0	0.0

patients where a 13-Fr cystoscope sheath could not be passed through the urethra due to its narrow calibre. For stones measuring ≥ 3.0 cm, an open cystolithotomy was performed. During TUCL procedures, cystourethroscopy was conducted using a paediatric scope, followed by fragmentation of stones using a 6/7.5 Fr uretero-roscope (URS) and pneumatic Lithoclast. Stone fragments were then extracted with the assistance of a 13-Fr cystoscope sheath and an Ellik evacuator. For a percutaneous approach, a 6Fr Nelaton tube was inserted into the bladder per urethra for retrograde filling of the bladder; an ultrasound-guided puncture was made with an 18-gauge needle and guidewire inserted; the tract was dilated over the guidewire initially with fascial dilators up to 8Fr; an olive-tip central rod was then inserted and subsequently the tract dilated up to 27-Fr with metallic Alken’s dilators; a 28–30Fr Amplatz sheath was inserted over the dilators; and a semirigid nephroscope was introduced through the Amplatz sheath to visualize and fragment stone with pneumatic lithoclast. All stone fragments were then removed with crocodile-grasping forceps. For an open cystolithotomy, a Pfannenstiel incision was made over the skin, subsequent subcutaneous tissue, a rectus sheath was opened along the line

of the incision, muscles split, and the peritoneum was pushed upwards to expose the bladder. Stay sutures were taken, and the bladder opened vertically between the stay sutures. Stone (s) removed, bladder washed, suprapubic catheter placed, bladder closed in two layers with Polyglactin 3/0 sutures, drain placed, and wound closed in layers. Stones retrieved from all three treatment modalities were sent for analysis to see their chemical composition. Per urethral Foley was inserted in all three modalities, while a suprapubic catheter was inserted in selected cases of PCCL and open cystolithotomy patients. A peri-vesicle drain was only placed in patients who underwent an open cystolithotomy. Each patient was kept on regular follow-up for one month to note and deal with early post-operative complications. Once all tubes, i.e., drain, foley, suprapubic catheter, and stitches, were removed, the patient was discharged. After discharge, each patient was regularly followed on an outpatient basis for 1 year (last follow-up in December 2022) with ultrasound KUB and post-void residue, renal function tests, urine analysis and culture, and uroflowmetry (if indicated) to identify long-term complications like stone recurrence, UTI, and urethral stricture formation. Data regarding age, gender, residence,

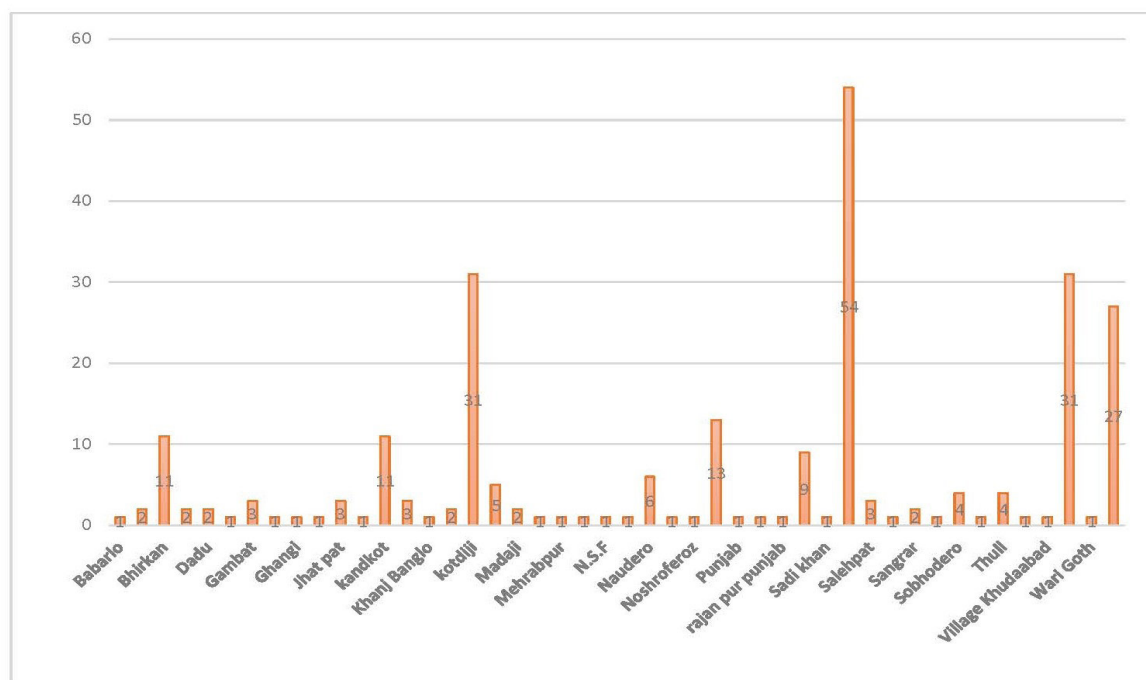


Figure 1. Village-wise distribution of children suffering from endemic bladder calculi based on their geographic locations (n=254)

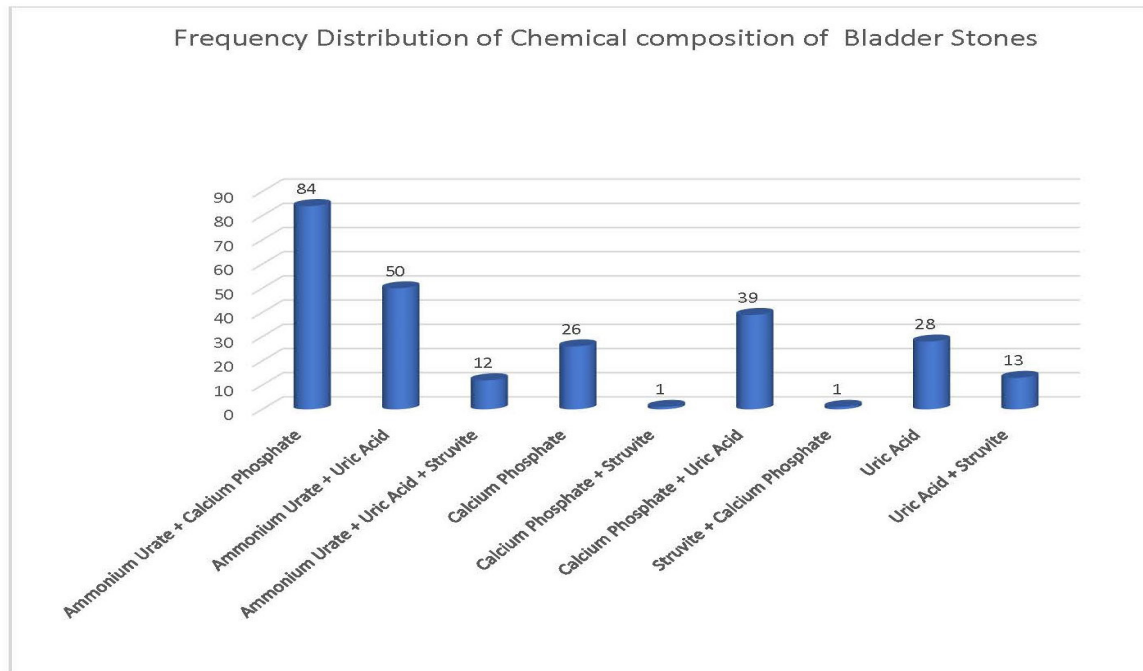


Figure 2. Frequency distribution of Chemical composition of stone.

symptomatology, socioeconomic status, family history of stone disease, and detailed dietary history about water consumption, source of water, milk consumption, protein consumption, and duration of breastfeed, findings of a haematological, biochemical, urinary, and radiological investigation, duration of procedure, duration of catheterization and suprapubic catheter, postoperative short- and long-term complications, hospital stay, and auxiliary procedures, if any, were retrieved from the pre-tested questionnaire, and data analysis was carried out using IBM SPSS v23.

The mean and standard deviation were calculated for continuous variables, and frequency and percentage were calculated for categorical variables.

RESULTS

Out of 892 paediatric patients admitted to the urology ward with stone disease, 254 (28.4%) were diagnosed with vesical stones. The majority of patients were male, constituting 232 (91.3%), compared to 22 (8.7%) females, resulting in a male-to-female ratio of 10.5:1. The mean age of the patients was 4.80 ± 2.86 years. Among the 254 patients, 91 (35.8%) had a positive family history of stone disease. Clinical presentation varied, with a combination of symptoms; dysuria was the most common presentation, observed in 120 (47.2%) patients, followed by crying during voiding in 97 (38.2%) patients, abdominal pain in 84 (33.1%) patients, and urinary retention in 61 (24.0%) patients.

All patients belonged to a poor socioeconomic class, with parents earning less than one US dollar per day. Fifty percent of fathers were laborers earning daily wages. The majority of patients, 232 (91.3%), belonged to rural areas. The mean 24-hour water consumption was 3.93 ± 1.73 cups per day, primarily from tap water (70.1%), with only 8 (3.1%) patients having access to mineral water. The mean duration of breastfeeding was

17.3 ± 6.98 months. Meat consumption was low, with a mean of 95.63 ± 46.83 grams per week. The majority of children received their nourishment from rice and vegetables.

Surgical interventions included open cystolithotomy in 11 (4.3%) patients, transurethral cystolithotripsy in 165 (65.0%) patients, and PCCL in 78 (30.7%) patients. The mean stone size for TUCL was 1.26 ± 0.39 cm, for PCCL it was 2.05 ± 0.46 cm, and for open cystolithotomy it was 3.21 ± 0.68 cm. Pre-operative haemoglobin levels averaged 10.51 ± 1.2 g/dL. The mean operative time was 48.8 ± 4.34 minutes for TUCL, 36.18 ± 7.4 minutes for open cystolithotomy, and 38.6 ± 5.2 minutes for PCCL.

The mean hospital stay was 1.40 ± 0.52 days for transurethral cystolithotripsy, 1.44 ± 1.32 days for percutaneous cystolithotomy, and 2.72 ± 0.78 days for open cystolithotomy. The mean duration of per-urethral catheterization was relatively higher for open cystolithotomy (6.67 ± 0.92 days) compared to 1.40 ± 0.96 days for transurethral cystolithotripsy and 2.35 ± 2.55 days for percutaneous cystolithotomy.

Immediate postoperative complication rates were 4.8% for TUCL, 12.8% for PCCL, and 27.3% for open cystolithotomy. Common complications included postoperative high-grade fever, managed conservatively with antibiotics, and surgical site infections requiring re-admission, daily dressing, systemic antibiotics, and secondary suturing under anaesthesia. During transurethral cystolithotripsy, urine leakage from a bladder perforation was seen in one patient. The patient was treated by placing an ultrasound-guided percutaneous intraperitoneal drain, which was followed by open exploration and bladder repair. Stone clearance was 100% among patients who underwent percutaneous and open cystolithotomy, while 98.1% (162 patients) for transurethral cystolithotripsy. Three (1.9%) patients with residual stones after transurethral cystolithotripsy required an-

other session of TUCL to achieve complete stone clearance.

We conducted stone analysis for all patients, revealing that the majority (78.8%) of stones had a mixed composition, with the combination of ammonium urate and calcium phosphate being the most prevalent (33.1%) (Figure 2).

At the one-year follow-up, stone recurrence was noted in two patients who underwent PCCL and one patient each after TUCL and open cystolithotomy (OC). Additionally, twenty-six patients (18 after TUCL, 6 after PCCL, and 2 after OC) presented with lower urinary tract symptoms. We further assessed these symptoms using uroflowmetry and pre- and postvoid ultrasound to rule out urethral stricture. However, none of the patients were identified as having urethral stricture.

DISCUSSION

The persistent prevalence of bladder stone disease presents a notable health concern, particularly in low-income nations, where restricted resources and inadequate healthcare infrastructure exacerbate its impact. This discourse delves into the outcomes of a study carried out at a tertiary care public sector hospital in Sukkur, delving into the demographic aspects, patterns, and contemporary management approaches concerning bladder stone disease in paediatric patients.

This study uncovered a persistent prevalence of bladder stone disease among children residing in peri-urban and rural areas of the Sindh province, constituting 28.4% of paediatric urolithiasis cases treated at this centre. This figure contrasts with the 70% prevalence of vesical calculi reported by Naqvi et al. in 1984.⁽⁵⁾ In rural areas, particularly in deserted regions of the Sukkur area such as Saleh Pat, Kotdiji, and Khudabad villages, the prevalence of bladder stone disease was notably high. This finding aligns with existing literature, which underscores the heightened burden of bladder stones in low-income countries.^(3,5) Malnutrition, particularly a diet low in protein, emerged as the primary associated cause of endemic bladder stone disease.⁽¹²⁾ The patient population in this study also exhibited protein-deficient diets, with a mean meat consumption of 95.63 ± 46.83 grams per week.

Ultrasonography with a full bladder and plain X-ray KUB imaging are effective diagnostic modalities for identifying and characterizing bladder stones in children.⁽¹³⁾ This series primarily utilized ultrasonography, a more accessible and cost-effective diagnostic tool. It enables the reliable detection of bladder stones and the evaluation of stone burden, facilitating treatment planning and decision-making.

Various surgical approaches have been employed and proposed worldwide in the past, ranging from traditional open surgery to more advanced endoscopic and minimally invasive techniques.⁽¹⁴⁾ While literature comparing different surgical approaches is available, few studies have comprehensively compared all three approaches.⁽¹⁴⁻¹⁷⁾ This study analyses the outcomes of three surgical techniques for bladder stone removal—transurethral cystolithotripsy, percutaneous cystolithotomy, and open cystolithotomy—for short- and long-term outcomes, as well as operative time, duration of the indwelling urethral catheter, hospital stay, and complications.

In a study focusing on the management of vesical

stones in the paediatric population, Esposito et al. compared the outcomes of robotic-assisted cystolithotomy (RACL), TUCL, and PCCL.⁽¹⁴⁾ They reported 100% stone clearance across all treatment modalities, with complications of MCCS grade II observed in 33% of patients. They also noted a significantly longer duration of indwelling catheters and hospital stay for patients undergoing PCCL ($P = 0.001$).⁽¹⁴⁾ In our study, the rate of early complications was 4.8% in TUCL, 12.8% in PCCL, and 27.3% in open cystolithotomy, with the majority of complications classified as MCCS grade-II. In a separate study conducted in Tehran, Iran, a 15-year analysis compared open cystolithotomy, TUCL, and PCCL. The study revealed that the operative time was notably longer for TUCL ($P = 0.001$), while the mean hospital stay was higher for patients undergoing open cystolithotomy ($P = 0.001$).⁽¹⁵⁾ These findings parallel our study, where the hospital stay was significantly prolonged for patients undergoing open cystolithotomy compared to those undergoing PCCL or TUCL.

Malladad et al. reported a male-to-female ratio of 6:1, with 81% of patients hailing from rural areas characterized by low socioeconomic status. Chemical analysis in their patient cohort revealed a mixed composition in 92% of cases, with calcium phosphate, calcium oxalate, and uric acid being the most common combination (21%).⁽¹⁶⁾ In contrast, our study cohort exhibited a higher male predominance with a male-to-female ratio of 10.5:1. Similarly, the majority of patients in our population also originated from rural areas (91.3%) and belonged to a poor socioeconomic class. Ammonium urate emerged as the most frequently observed chemical composition in our study, often in conjunction with calcium phosphate or uric acid. These findings are consistent with the findings of Sallah et al., who identified ammonium urate (93%) as the most prevalent component of stone composition.⁽¹⁷⁾

In a meta-analysis encompassing over 1000 patients, Davis et al.⁽¹⁸⁾ examined 8 studies concerning the outcomes of bladder stone management in developing countries. They found that the hospital stay for an open cystolithotomy was significantly longer compared to PCCL and TUCL ($P = 0.05$), mirroring our study findings. Additionally, they reported stone-free rates of 100%, 86.6%, and 100% for open cystolithotomy, TUCL, and PCCL, respectively. Similarly, in our study, stone-free rates were 100% for both open surgery and PCCL, while TUCL achieved a stone-free rate of 98.1%.

During a long-term follow-up spanning one year, Mohammed S. Al-Marhoon et al.⁽¹⁹⁾ reported urethral stricture in 3.7% of patients who underwent transurethral disintegration of bladder stones. Conversely, none of our patients developed urethral stricture during the one-year follow-up period.

As approaches and technology have advanced, surgical methods have also transitioned from open procedures to minimally invasive surgery (MIS). Although MIS often yields exceptional results and outcomes, there are occasions when open surgery becomes necessary, particularly in cases where anatomy is unsuitable for instrumentation or in the event of technological failures. Our study indicates that the minimally invasive endoscopic approach for stone removal is safe and generally results in superior outcomes compared to contemporary open surgical methods.

The retrospective nature of this study and the unequal groups for comparison represent the primary limitations. Therefore, we warrant future prospective studies to further investigate these findings.

CONCLUSIONS

Bladder calculi remain prevalent in the rural regions of Sindh province, Pakistan, characterized by poor socio-economic conditions, nutritional deficiencies, and a hot climate. Early diagnosis and prompt intervention, along with preventive measures, can result in improved outcomes and reduced complications. Minimally invasive techniques for bladder stone removal offer shorter hospital stays, cost-effectiveness, and fewer complications compared to open cystolithotomy. Our future strategy involves implementing robotic-assisted vesicolithotomy as a replacement for open cystolithotomy.

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CONFLICT OF INTEREST

None of the authors have any conflict of interest to disclose.

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