

Surgical Management of Pediatric Urolithiasis: Descriptive Study from a Tertiary Care Center in Nepal

Bipin Guragain, Anjit Phuyal, Milan Gyawali, Durga Pandit, Purushottam Parajuli, Manish M Pradhan, Sujeet Poudyal, Suman Chapagain, Bhojraj Luitel, Pawan R Chalise, Uttam K Sharma, Prem R Gyawali

Author(s) affiliation

Department of Urology and Kidney Transplant Surgery, Maharajgunj Medical Campus, Tribhuvan University Teaching Hospital, Institute of Medicine, Maharajgunj, Kathmandu, Nepal

Corresponding author

Bipin Guragain, MBBS, MS
bipin9841706621@gmail.com

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ABSTRACT

Introduction

Urolithiasis is common in the pediatric population in low-resource countries but appropriate management is not available in all parts of the country. This study aimed to identify demographic parameters, clinical characteristics, and surgical management of pediatric urolithiasis in a tertiary care center in Nepal.

Methods

This was a retrospective and descriptive study of pediatric patients (≤ 18 years) who underwent surgical management of urolithiasis in the Department of Urology and Kidney Transplant Surgery, Tribhuvan University Teaching Hospital from January 2021 to December 2022.

Results

Total 64 patients with Male: Female ratio 1.78:1 and mean age of 8.63 ± 5.56 years presented mostly with pain abdomen (93.8%) followed by lower urinary tract symptoms (26.6%), hematuria (20.3%), and fever (14.1%). The mean number of calculi was 2.2 ± 1.47 and the mean size was 13.97 ± 8.30 mm. Most of the calculi (39.1%) were in the right system and 90.62% were in the upper tract. Only 15.62% of patients had calculi in the lower tract. Open surgeries were performed in only 10.93% and the rest were managed by minimally invasive procedures. Percutaneous nephrostomy tube insertion was done in 6 (9.37%) of patients and 1 (1.56%) underwent nephrectomy for nonfunctioning kidney.

Conclusion

Pediatric urolithiasis patients presented with pain abdomen, lower urinary tract symptoms, or hematuria. Surgical management has shifted from open surgeries in the past to minimally invasive surgeries at present.

Keywords

Minimally invasive surgery; pediatric; urolithiasis

INTRODUCTION

Urolithiasis is “the formation or presence of calculi within the kidneys, ureter, bladder or urethra.” It is common in adults but relatively rare in the pediatric population.¹ Pediatric urolithiasis is endemic in low-resource countries with a prevalence of up to 15%. It is less common in developed countries with a prevalence of 1-5%.² It is associated with increased morbidity and high recurrence rate of 6.5-44%.³ Factors responsible for pediatric urolithiasis may be different from that of adults with urinary tract malformations, infections, and nutritional changes being common in the pediatric population.⁴ Urolithiasis can lead to renal insufficiency in the pediatric population.⁵

Management of pediatric urolithiasis requires complete stone clearance, eradication of urinary tract infection (UTI), and correction of underlying metabolic or anatomical abnormalities.⁶ Management options for urolithiasis are similar to that of adults. With the miniaturization of instruments and low morbidity, minimally invasive techniques like ureteroscopic lithotripsy (URSL), retrograde intrarenal surgery (RIRS), percutaneous nephrolithotomy (PCNL), percutaneous cystolithotripsy (PCCL), transurethral cystolithotripsy are the treatment of choice. However, some select cases may still require an open approach.⁷

The study aimed to identify demographic parameters, clinical characteristics, and surgical management of pediatric urolithiasis in a tertiary care center in Nepal.

METHODS

This is a descriptive study of pediatric patients (≤ 18 years) who underwent surgical management of urolithiasis in the Department of Urology and Kidney Transplant Surgery, TUTH, Kathmandu, Nepal from January 2021 to December 2022. The patients were listed from registers of operation theater (OT) and ward and their record files were obtained from the medical record section. The following information was obtained: demographics, clinical presentation, laboratory tests, imaging, number, size, location and Hounsfield Unit of the calculi, surgery, number of surgeries required to clear calculi, complications, and hospital stay. Depending on the stone burden, location, and presentation, surgical management was different. Patients with more than one hospitalization for stone management were counted only once. Approval for the study was taken from the Institutional Review Committee of Institute of Medicine.

Sixty-four patients were included. The patients had presented to either pediatric emergency or Urology out-patient department (OPD) with symptoms and on evaluation with urine routine and microscopic

examination, renal function tests, ultrasound (USG) of abdomen and pelvis, and X-Ray KUB (kidney-ureter-bladder), were found to have urolithiasis. Some patients had further imaging with non-contrast computed tomography (NCCT) KUB or CT urography. Before surgical management, all patients underwent urine culture and sensitivity, preoperative investigations, and pre-anesthetic checkups. Surgical management was based on European Association of Urology (EAU) guidelines for stone management and availability of the procedure in the center. Some patients underwent multiple procedures based on surgical technique and calculus burden. Any complication of the procedure was recorded. Hospital stay was recorded.

RESULTS

Sixty-four patients who underwent 155 surgical procedures (including 22 pre-stenting, 51 Double-J (DJ) stent removal, 6 percutaneous nephrostomy (PCN) placement, 7 open surgeries and 69 minimally invasive surgery) were evaluated. Some patients had more than one calculus and some underwent more than one procedure for stone clearance. Male patients were 64.06% (M:F=1.78:1). Mean age was 8.63 ± 5.56 years. The most common presentation was pain abdomen (93.8%) and symptoms duration ranged from 8 hours to 36 months with most of them (25%) presenting in one month as shown in Table no. 1.

Genitourinary abnormalities like horseshoe kidney, bladder exstrophy, medullary sponge kidney, small right kidney with loss of corticomedullary differentiation and bilateral VUR were seen in 7.81% of cases.

Average serum creatinine was $55 \mu\text{mol/l}$ (13-138). Among 38 patients whose urine routine and microscopic examination were available, 50% had microscopic hematuria. USG abdomen and pelvis was performed in 100% of cases, and NCCT KUB/CT urography in 92.2% cases. The mean number of calculi was 2.2 ± 1.47 (1-6) with total of 141 calculi. The mean size of calculi was 13.97 ± 8.30 mm (2-47mm). Out of 30 patients whose calculus Hounsfield unit was available, the average HU was

Table 1. Clinical presentation

Clinical presentation	Number (%)
Pain abdomen	60 (93.8)
Lower urinary tract symptoms	17 (26.6)
Hematuria	13 (20.3)
Fever	9 (14.1)
Acute retention of urine	3 (4.7)
Poor urinary stream	2 (3.1)
Lithuria	1 (1.6)

+784.77±412.55 (+300-+1907). The number of patients with bilateral, right, left, urinary bladder (UB) and urethral calculus were 18(28.12%), 25(39.06%), 15(23.44%), 8(12.50%), and 2(3.12%) respectively. Out of 12.50% of patients with UB calculus, 9.38% had only UB calculus, and rest 3.12% also had ureterolithiasis and nephrolithiasis. Similarly, patients with urethral calculus also had ureterolithiasis and bilateral nephrolithiasis (Table 2).

Mean number of procedures was 2.42±0.90 (1-4). Out of 64 patients, 10.94% underwent open surgical procedure and 90.62% underwent minimally invasive surgery as shown in Table no. 3 and 4. Some patients underwent more than one procedure for stone clearance like mini-PCNL followed by re-look RIRS; transurethral cystolithotripsy for UB calculus and URSL for ureteric calculus; bilateral RIRS or multiple RIRS sessions. One patient with horseshoe kidney underwent mini-PCNL and open pyelolithotomy. The most common procedure was RIRS (42.19% of patients). Storz Flex-X2S scope was used with access sheath 9.5 F internal diameter and Holmium:YAG or Thulium fiber laser. Out of 27 cases of RIRS, only two cases (7.41%) did not require pre-stenting and the rest 25 (92.59%) required pre-stenting. Out of 19 URSL (performed with either 7F or 4.5/6.5F Wolf ureteroscope), two (10.5%) cases required pre-stenting. Out of 13 cases of PCNL, three (23.08%) with residual calculi required re-look RIRS. Three patients with ureteral calculus had no calculus on ureteroscopy. One case of left distal ureteric calculus of 6.8x5mm (HU +928) had stone expulsion with medical management with alpha blocker. The other two cases with VUJ calculus 4x3 mm and 3.5x3.1 mm had spontaneous stone expulsion.

PCN insertion was done in 9.37% cases to decompress the obstructed system followed by definitive surgery. Urinary bladder calculus was seen in 12.50% of patients (9.36% male and 3.12% female), with mean size of 19.65mm (10.2-32mm). All patients underwent cystoscopy prior to definitive therapy. 7.81% of patients with less than 20mm calculus underwent cystolithotripsy whereas those with calculi greater than 20 mm underwent PCCL (1.56%) or open cystolithotomy (3.12%).

Complications of Clavien_Dindo class I/II, were seen in only 7.8% cases. One case of prone mPCNL had failed puncture, bleeding requiring blood transfusion, and post-operative sepsis. Similarly, three cases of prone mPCNL had post-operative sepsis which settled after treatment with intravenous antibiotics. One female with prone mPCNL had self-expulsion of DJ stent in the 5th postoperative day. There was one case of cystolithotripsy and right URSL which required clot evacuation for clot retention.

The average hospital stay was 5.22 ± 3.40 days (2-

Table 2. Location of the calculus

Location	Number (%)
Kidney	46 (71.9)
Pelvis	27 (42.2)
Pelviureteric junction (PUJ)	9 (14.1)
Proximal ureter	3 (4.7)
Mid ureter	2 (3.1)
Distal ureter	18 (28.2)
Vesicoureteric junction (VUJ)	4 (6.3)
Urinary bladder	8 (12.5)
Urethra	2 (3.1)

Table 3. Minimally invasive procedures

Minimally invasive procedure	Number (%)
Ureteroscopy (URS)	3 (4.69)
Ureteroscopic lithotripsy (URSL)	19 (29.69)
Retrograde intrarenal surgery (RIRS)	27 (42.19)
Mini percutaneous nephrolithotomy (mPCNL)	13 (20.31)
Transurethral cystolithotripsy	6 (9.37)
Percutaneous cystolithotripsy (PCCL)	1 (1.56)

Table 4. Open surgical procedures

Open surgical procedure	Number (%)
Open pyelolithotomy	1 (1.56)
Open ureterolithotomy	2 (3.12)
Open cystolithotomy	2 (3.12)
Open urethrolithotomy	1 (1.56)
Nephrectomy	1 (1.56)

17 days), lower for URSL and higher for PCNL and open surgeries. Metabolic evaluation and stone analysis reports were not available.

DISCUSSION

Pediatric urolithiasis varies widely in incidence, natural history, etiology, and clinical presentation based on geographic location and economic condition. Although less frequent than adult urolithiasis, pediatric urolithiasis has been increasing over the past few decades because of rapid variations in habits and increasing affluence.⁸ Mean age at presentation in our center was 8.63 years which is similar to that reported in literature from developing countries like Armenia, Pakistan, Brazil, Sri Lanka, and Turkey (mean 7.3 years) but different from those in North American literature (mean 11.3 years).^{2,3,10-13} The male-to-female ratio in our center was 1.78:1 which was similar to other studies¹¹ with a range of 1.2-4:1 in developing countries but different from the North American

series (no significant difference).^{10,12}

The most common presentation was pain abdomen (93.8%), similar to other studies.^{2,10,11,14} Lower urinary tract symptoms were found in 26.6% which was similar to other study.¹¹ About 20.3% of patients presented with gross hematuria. Microscopic hematuria is seen in up to 80-90% of different studies^{12,15} but in our study 50% had microscopic hematuria.

The most common diagnostic modality was USG abdomen and pelvis (100%). Most cases (92.18%) had undergone CT. Patients with solitary urinary bladder calculus without hydronephrosis were diagnosed with USG and X-Ray KUB. USG avoids radiation and contrast exposure but is operator dependent. NCCT is second line choice with high sensitivity (97-100%) and specificity (96-100%).¹⁶ NCCT is the gold standard for diagnosing urolithiasis in adults but in children, its availability, need for sedation (for contrast studies) long term effects of radiation are major drawbacks.¹⁴

Anatomic abnormalities were seen in 7.81% of patients. However, in other studies, it was found in 14.2-16.1% with ureteropelvic junction obstruction being common.^{2, 10} Average number of calculi was 2.2 (1-6) with a mean size of 13.9±8.3 mm (2-47) similar to another study¹⁰ and mean HU of +784.

Most of the patients had calculi in right system (39.1%) similar to another study.¹⁰ Twenty-eight % had bilateral calculi. In literature, bilateral stone disease is common in setting of underlying metabolic abnormality¹² which could not be evaluated in our study. Most of the patients (90.62%) had calculus in upper urinary tract whereas 15.6% had calculus in lower urinary tract similar to a recent study in Somalia.¹⁷ About 12.50% of cases had urinary bladder calculus and 3.12% had urethral calculus which was similar to previous studies done in Nepal, with 8% UB calculus and 1% urethral calculus,¹⁸ 10% UB calculus.¹⁹ UB calculus is rarely reported in developed countries.^{20, 21} UB calculus is common in developing countries as only breast milk and rice are given to the infants and very young children that leads to high urinary ammonia excretion due to low dietary phosphorus. Other factors responsible are high green vegetable intake (high dietary oxalate load) with low dietary citrate.²¹

Previously urolithiasis was managed with open surgery but with advances in technology and creation of newer small pediatric-size endoscopic instruments, minimally invasive surgery (MIS) is being performed now-a-days.²² The most common procedure was RIRS (42.2%). As the instrument is similar for both pediatric population and adults, most of the pediatric patients (92.59%) required pre-stenting similar to the study by Ferretti et al,²³ but in the study by Thomas et al, it was only 57%.¹⁴

PCNL was performed in 20.4% (prone:18.8%, supine:1.6%) with large stone burden i.e., >1.5 cm calculus in kidneys/pelvis with favorable anatomy, previous surgery. MiniPCNL with 12F nephroscope and 15/16F working sheath was performed. Both prone and supine PCNL are being practiced in our center. Tubeless PCNLs with the use of only DJ stent and no nephrostomy tube have been performed in cases without significant bleeding, pelvicalyceal breach, or residual fragments. PCNL is an accepted minimally invasive procedure in children and adults.²⁴ The success rate of PCNL for pediatric urolithiasis varies from 80% to 95%.²⁵

In our study, 10.94% of patients underwent open procedures because of anatomical abnormalities (open pyelolithotomy in horseshoe kidney) and high stone burden in ureter and urinary bladder. In other studies, reasons for open surgery were anatomical abnormalities, neglected stones causing renal failure, complex and large stones with cortical atrophy, and/or sepsis.²⁶

After surgeries in the ureter, pelvis, and kidney either by open or endoscopic procedure, DJ stents of proper size were placed and in pediatric patients' removal of DJ stent required GA/IVA. One patient with 6.8mm distal ureteric calculus had passed calculus with medical management with an alpha-blocker. There are only a few studies regarding the use of medical expulsive therapy as an off-label treatment in pediatric urolithiasis with controversial results.²⁷ Mean size of spontaneously passed calculus was four mm (seen in two cases of VUJ calculus) and reduced spontaneous elimination of calculus larger than four mm similar to other studies.^{12,28}

Urinary bladder calculi (12.5%) were managed with transurethral cystolithotripsy (7.81%) or open cystolithotomy (3.12%) or percutaneous cystolithotripsy (1.56%). In developed countries, robotic cystolithotomy is also being done.²⁹ The method for stone clearance should be based on anatomy and stone burden along with the availability of equipment and the surgeon's experience.²⁹ Out of two urethral calculi, one was pushed back to UB, and cystolithotripsy was done whereas urethrolithotomy was done in a case with traumatic scrotal hematoma and LUTS.

PCN insertion was required in 9.37% of patients with moderate to gross hydronephrosis, and pyonephrosis and they were further managed based on stone location and kidney status. Nephrectomy was required in one case (1.56%) of pyonephrosis with a nonfunctioning kidney. A similar study in Somalia showed 2.2% nephrectomy due to stone disease.¹⁷

Most of the complications were Clavien-Dindo grade I and II, (postoperative fever, urosepsis, bleeding) which were seen after PCNL and were medically

managed. However, reported complications after pediatric PCNL are 24% hemorrhage requiring transfusion.³⁰

The average hospital stay was 5.22 ± 3.40 days (2-17 days), similar to other studies.² Hospital stay depends on the procedure and availability of operation theater because of the excess operative list. Patients stay longer because they come from different rural parts of the country and are reluctant to get discharged when advised by doctor.

This is a retrospective study so it relies on the information available in the medical records which may not be sufficient. Other patients with urolithiasis who visited OPD and were managed medically were not included. Although we routinely perform stone analysis, metabolic evaluation, and follow-up of patients, these data were not available in medical records. A further prospective study including metabolic evaluation, stone analysis, and stone recurrence is required although this study has helped to know the demographics, clinical presentation, and surgical management of pediatric urolithiasis in a tertiary care center in Nepal.

CONCLUSION

Pediatric urolithiasis patients presented with pain abdomen, lower urinary tract symptoms, or hematuria. The majority had upper urinary tract calculus and a few have lower urinary tract calculus. Spontaneous passage was seen in calculus ≤ 4 mm whereas most of the calculi required medical or surgical management. Surgical management consisted of open surgeries to minimally invasive surgery. Open surgeries are limited to large stone burden and complex cases in about 10.93%. Further studies are required to detect metabolic disorders and stone recurrence in the pediatric population.

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CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

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