ORIGINAL RESEARCH

Minimally Invasive Therapeutic Modalities for Pediatric Urolithiasis: A Single Center Experience from the Philippines

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Introduction: There is a limited data on the incidence of pediatric urolithiasis in the Philippines as well as studies on how it is managed. With the advent of endourology, there is already an evident shift from open stone surgery to minimally invasive surgery as first line in the treatment of pediatric urolithiasis. A tertiary referral center in the country caters to most pediatric urolithiasis cases in the country and offers the different minimally invasive modalities outlined in the latest guidelines. This study aimed to review the different minimally invasive therapeutic modalities for pediatric urolithiasis and its outcomes in the past ten years in a tertiary referral center in the Philippines.
Methods: This retrospective study was conducted through charts review of all pediatric patients (0-18 years) who underwent stone surgery from January 2012 to December 2022. Demographic and clinical data, stone characteristics, types of stone surgery, and outcomes were obtained.
Results: A total of 87 pediatric patients (54 boys, 33 girls) with 105 urolithiases were analyzed. The patients had a mean age of 13 years, with an interquartile range (IQR) spanning from 6 to 18 years. Among them, 62.07% were male, while 37.93% were female. The most prevalent symptom reported was flank pain, affecting 41.38% of the patients, followed by urinary tract infections (UTI) (11.49%) and gross hematuria (8.05%). For the management, 82.86% of the patients underwent minimally invasive stone procedures with extracorporeal shockwave lithotripsy (ESWL) as the most common procedure (44.76%) and ureterolithiases as the most common stone (43.81%). On the other hand, 17.14% of the subjects underwent open stone surgery done mostly on cystolithiases and large ureterolithiases (38.89% each). All patients recovered and were discharged post operatively.
Conclusion: The institution practices minimally invasive approaches in the majority of pediatric patients with urolithiasis. Open stone surgery is reserved for patient with large complex stones and those with anatomic abnormalities.

Key words: children, extracorporeal shockwave lithotripsy, percutaneous nephrolithotomy, ureteroscopy, endourology, open stone surgery

Introduction

The incidence of pediatric urolithiasis has been increasing globally over the last decades.[1-7] Children represent around 2-3% of all cases of urolithiasis with boys in the first decade of age are the most commonly affected and adolescent girls showed the greatest increase in incidence.[1-3] It occurs generally between age 5 and 15 years with marked increase in incidence between 10 and 19 years of age.[4] True incidence of pediatric urolithiasis, however, remains unclear due to shortage of epidemiological studies.[2,4]

Philippines is part of the Afro-Asian stone belt which ranges from Sudan, the Arab Republic of Egypt, Saudi Arabia, the United Arab Emirates, the

Islamic Republic of Iran, Pakistan, India, Myanmar, Thailand, and Indonesia to the Philippines.[1,5] In this area, urolithiasis affects all age groups with prevalence of stone disease ranging from 4-20%.[5] Pediatric urolithiasis remains endemic in low resource countries which may be attributed to hot climate, poor nutrition and diarrheal diseases.[6]

Aside from geographical and socioeconomic factors, most of the children with urolithiasis have an underlying metabolic or infectious etiology.[3,7] Recurrence is high if full metabolic work up is not done to give adequate treatment.[7] Hypercalciuria and hypocitrauria are the most common metabolic disorders noted.[1-2,6-8] Other metabolic abnormalities include hyperuricosuria, and hyperoxaluria as well as stones due to infectious etiology and genitourinary anatomical abnormalities (ureteropelvic junction obstruction and vesicoureteral reflux) provides additional risk factors.[9] Inheritance for autosomal recessive disorders such as primary hyperoxaluria and cystinuria as well as changes in dietary habits such including increase in protein consumption can also be attributed for stone formation.[1,4-5]

Along with the increase in incidence of urolithiasis in the pediatric population there is also a rise in the minimally invasive procedures available for treatment.[9-10] Current internationally-accepted guidelines including guidelines from American Urologic Association (AUA) and European Urologic Association (EAU) include minimally invasive procedures as first-line treatment of both nephrolithiasis and ureterolithiasis in children.[11-12] Minimally invasive procedures include extracorporeal shockwave lithotripsy (ESWL), endourologic procedures including ureteroscopy (URS), retrograde intrarenal surgery (RIRS) and percutaneous nephrolithotomy (PCNL).[11-12] Minimally invasive surgery is the treatment of choice for pediatric stones and it provides success with low complication rates.[10,13-17] Traditional open stone surgery has been reserved for selected complex cases in which minimally invasive modalities are not available or applicable.[14,16-17]

Pediatric urolithiasis has been one of the common problems in a tertiary referral center in the Philippines, however, no data has been published regarding its epidemiology as well as the management and outcomes of the different urologic interventions in the country. The study intends to summarize the demographic and clinical data of pediatric patients (0-18 years if age) with urolithiasis, their stone characteristics and the different available therapeutic modalities the institution has offered over the past ten years, highlighting the minimally invasive approaches for pediatric stone cases and their outcomes.

Methods

This is a single-center, retrospective study from the year 2012 to 2022. All patients age 0 - 18 years admitted in the wards, emergency room and outpatient department at a tertiary government medical center who underwent any of the following procedures below for urolithiasis from January 1, 2012 to December 31, 2022 were included in the study.

- Cystoscopic Procedures
- Ureteroscopy (URS)
- Extracorporeal Shockwave Lithotripsy (ESWL)
- Retrograde Intrarenal Surgery (RIRS)
- Percutaneous or Mini-Percutaneous Nephrolithotomy (PCNL)
- Laparoscopic Surgery
- Open Stone Surgery

All patients who underwent medical treatment and those who underwent any of these procedures for reasons not involving urolithiasis were excluded from the study.

Data were collected through retrospective chart review in the Medical Records Section for admitted/emergency room cases, Operating Room Records for outpatient cases and Endoscopy Unit for ESWL cases. The author reviewed charts of pediatric patients diagnosed with urolithiasis who underwent the different procedures listed above.

To summarize the general and clinical characteristics of the participants, descriptive statistics were employed. Nominal variables were evaluated using frequency and proportion, non-normally distributed interval/ratio variables were assessed using median and interquartile range, and normally distributed interval/ratio variables were evaluated using mean and standard deviation. Shapiro-Wilk test was used to determine normally

distributed interval/ratio variables. 95% confidence intervals were also computed for proportions. Missing variables were neither replaced nor estimated. Data analysis was conducted using R 4.2.2.

Results

A total of 87 pediatric patients with urolithiasis were analyzed (Table 1). The patients in this study had a mean age of 13 years, with an interquartile range (IQR) spanning from 6 to 18 years. Among them, 62.07% were male, while 37.93% were female. The most prevalent symptom reported was flank pain, affecting 41.38% of the patients, followed by urinary tract infections (UTI) (11.49%) and gross hematuria (8.05%). A significant majority of the patients (91.95%) did not have any associated comorbidities, while a minority presented with conditions like acute kidney injury (AKI) (4.6%) secondary from obstructing urolithiasis while others were diagnosed with distal renal tubular acidosis (RTA), global developmental delay, and seizure disorder, each accounting for 1.15% of the total.

Among the 71 patients, the median creatinine level was 0.70 with an interquartile range (IQR) of 0.40-0.95. For the urine culture results, majority of the patients have negative results after 48 to 72 hours (64.58%). Noteworthy bacterial findings from urine cultures included Acinetobacter baumanii, Klebsiella and Enterococcus spp. The remaining patients have insignificant bacterial culture results (20.83%). Almost a third of the total patients were able to obtain stone analysis test with results showing mostly mixed stone types (73.91%) with calcium oxalate as the predominant composition while 26.08% of the other patients each has either calcium oxalate or calcium phosphate stone composition.

The stone characteristics among pediatric patients with urolithiasis were analyzed (Table 2). A total of 105 different stone types based on location were obtained. Some patients had more than one stone type present or more than one stone type were treated in the 10-year period, making the total of 105 types of stone in 87 subjects. The average size of all the stones is 1.4 cm, 1.93 cm for the nephrolithiases, 1.22 cm for the ureterolithiases and 2.7 cm for the cystolithiases. No size was recorded for the urethral calculi.

In terms of location, nephrolithiasis was categorized into four types. Calyceal calculus was the most common and was seen in 14.29% of cases,

Table 1. Demographic and clinical profile of pediatric patients with urolithiasis (n=87).

	Frequency (%); Mean ± SD; Median (IQR)
Age, years	13 (6-18)
Sex	
Male	54 (62.07)
Female	33 (37.93)
Symptoms	
Flank pain	36 (41.38)
UTI	10 (11.49)
Gross hematuria	7 (8.05)
Abdominal pain	6 (6.90)
Dysuria	3 (3.45)
Difficulty urinating	3 (3.45)
Fever	3 (3.45)
Hypogastric pain	2 (2.30)
Vomiting	1 (1.15)
Iliac pain	1 (1.15)
Bipedal edema	1 (1.15)
Lower quadrant pain	1 (1.15)
Comorbidities	
AKI	4 (4.60)
Distal RTA	1 (1.15)
Global developmental delay	1 (1.15)
Seizure disorder	1 (1.15)
Not found	80 (91.95)
Creatinine [n=71]	0.70 (0.40-0.95)
Low	21 (29.58)
Normal	44 (61.97)
High	6 (8.45)
Urine culture (n=48)	
Polymicrobial	4 (8.33)
Acinetobacter baumanii	1 (2.08)
Klebsiella spp	1 (2.08)
Enterococcus spp	1 (2.08)
Negative	31 (64.58)
Insignificant findings	10 (20.83)
Stone analysis (n=23)	
Calcium oxalate	3 (13.04)
Calcium phosphate	3 (13.04)
Mixed stone	17 (73.91)

staghorn calculus in 12.38%, infundibulopelvic calculus in 6.67% and pelvolithiasis in 8.57% respectively. Ureterolithiasis, which is the most common of all the stones, was divided into three regions, showed the proximal third to be the most prevalent location at 20.95%, followed by distal third ureterolithiasis at 11.43%. Cystolithiasis, which includes encrusted double J stents (DJS), was present in 12.38% and lastly, urethral calculus was the least common, observed in 1.90% of the cases. Radiodensity, measured in Hounsfield units (HU), was recorded for 41 samples with the mean radiodensity of 801.30 ± 382.61 for all stones. The mean HU for the nephrolithiasis was 830.56 and 786.40 for the ureterolithiases. For the cystolithiasis, only one HU had been recorded which is 450 and none for urethral calculi. (Table 2).

Among the pediatric patients diagnosed with urolithiasis, various therapeutic procedures were employed to address their condition. Table 3 presents the proportion of urolithiasis cases operated using various therapeutic modalities and the distribution of stone types treated by each modality.

Table 2. Stone characteristics of pediatric patients with urolithiasis.

	Frequency (%); Mean ± SD; Median (IQR)
Size, cm [n=92]	1.40 (0.80-2.10)
Nephrolithiasis [n=45]	1.93
Ureterolithiasis [n=41]	1.22
Cystolithiasis [n=6]	2.7
Location	[n=105]
Nephrolithiasis [n=44]	
Staghorn calculus	13 (12.38)
Calyceal calculus	15 (14.29)
Infundibulopelvic calculus	7 (6.67)
Pelvolithiasis	9 (8.57)
Uteropelvic junction calculus	0
Ureterolithiasis [n=46]	
Proximal third	22 (20.95)
Middle third	5 (4.76)
Distal third	12 (11.43)
Uterovesical junction calculus	7 (6.67)
Cystolithiasis (including encrusted DJS) [n=13]	13 (12.38)
Urethral calculus [n=2]	2 (1.90)
Radiodensity, HU [n=41]	801.30 ± 382.61
Nephrolithiasis [n=18]	830.56
Ureterolithiasis [n=22]	786.40
Cystolithiasis [n=1]	450

For percutaneous nephrolithotomy (PCNL) which was done to 19 cases (includes 5 mini-PCNL), the predominant stone type addressed was staghorn calculus, constituting 52.63% of all PCNL cases. This was followed by pelvolithiasis at 26.32% and infundibulopelvic calculus at 21.05%. Extracorporeal shockwave lithotripsy (ESWL), conducted in 47 cases, was most used for treating calyceal calculus and the proximal third ureterolithiasis, each comprising 29.79% and 25.53%. Ureterovesical junction calculus and distal third ureterolithiasis made up 12.77% each of the ESWL cases. Middle third ureterolithiasis and infundibulopelvic calculus were the least common for ESWL, at 6.38% and 4.26%. Ureteroscopy, performed in 13 cases, was primarily employed for the proximal third ureterolithiasis, accounting for almost half of the ureteroscopy cases (46.15%). The distal and middle third ureterolithiases each made up 30.77% and 23.08%, respectively. For cystoscopy (including cystolithotripsy), conducted in 8 cases, the primary indication was cystolithiasis (including 4 encrusted DJS), accounting for 75% of the cases while urethral calculus was accounted for 25% of the cystoscopy cases. Lastly, open stone surgery, performed in 18 cases (17.14%), was most frequently used for cystolithiasis (including 1 encrusted DJS) with 38.89%. Proximal third ureterolithiasis and staghorn calculus each made up 22.22% and 16.67% of the open surgery cases. Calyceal calculus and ureterovesical junction calculus were the least common, both at 5.56%.

All 87 patients achieved recovery, denoting a recovery rate of 100% with a confidence interval (CI) of 95.77% to 100%. Similarly, the discharge rate for these patients was also 100% (CI: 95.77%-100%), indicating that all patients were successfully discharged post-treatment. (Table 4)

On the aspect of post-operative complications or conditions seen on Table 4, post operative fever/ febrile episodes were the most frequently observed symptom, presenting in 17.24% of patients (CI: 10.74%-26.52%). Fever may be attributed to different causes since most of these patients have negative blood and urine cultures post operatively

Table 3. Proportion of cases operated using the different modalities.

	Percutaneous nephrolithotomy (n=19)	**Extracorporeal shockwave lithotripsy (n=47)**	**Ureteroscopy (n=13)**	**Cystoscopy (n=8)**	**Open stone surgery (n=18)**
	Frequency (%, 95% CI)				
Nephrolithiasis					
Staghorn calculus	10 (52.63, 31.71-72.67)	0	0	0	3 (16.67, 5.84-39.22)
Calyceal calculus	0	14 (29.79, 18.65-43.98)	0	0	1 (5.56, 0.99-25.76)
Infundibulopelvic calculus	4 (21.05, 8.51-43.33)	3 (6.38, 2.19-17.16)	0	0	0
Pelvolithiasis	5 (26.32, 11.81-48.79)	4 (8.51, 3.36-19.93)	0	0	0
Uteropelvic junction calculus	0	0	0	0	0
Ureterolithiasis					
Proximal third	0	12 (25.53, 15.25-39.51)	6 (46.15, 23.21-70.86)	0	4 (22.22, 9-45.21)
Middle third	0	2 (4.26, 1.17-14.25)	3 (23.08, 8.18-50.26)	0	0
Distal third	0	6 (12.77, 5.98-25.17)	4 (30.77, 12.68-57.63)	0	2 (11.11, 3.10-32.80)
Uterovesical junction calculus	0	6 (12.77, 5.98-25.17)	0	0	1 (5.56, 0.99-25.76)
Cystolithiasis (including encrusted DJS)	0	0	0	6 (75, 40.93-92.85)	7 (38.89, 20.31-61.38)
Urethral calculus	0	0	0	2 (25, 7.15-59.07)	0

Table 4. Clinical outcomes of pediatric patients with urolithiasis.

	Frequency (%, 95% CI)
Recovered	87 (100, 95.77-100)
Discharged	87 (100, 95.77-100)
Fever/ febrile episodes	15 (17.24, 10.74-26.52)
Fluid collection	1 (1.15, 0.20-6.23)

upon investigation. Fluid collection, which could be an indicator of potential complications such as urinoma, was observed in one patient (1.15%) (CI: 0.20%-6.23%). This patient underwent ultrasound guided aspiration of the fluid collection likely urinoma and was discharged unremarkably.

Discussion

A total of 87 patients with 105 stone types (based on location) who underwent different stone procedures in a 10-year period were done and supervised mainly by three pediatric urology consultants in the institution. About two thirds of the subjects were males and one third were females with a mean age of 13 years. This is supported in other studies in which showed higher urolithiasis occurrence in males than in females with studies citing a M/F ratio of 1.3/1 to as high as 3.1/1.[1-2,7,18-19] Most common presentations were flank pain (41.38%) and recurrent urinary tract infection (11.49%). Symptomatology varies per age group, usually infants present with crying, irritability and vomiting in 40% of the cases while the classic renal colic and hematuria were more common in older age groups since ureterolithiases were more common in adolescents.[2,10,20] Majority of the patients have negative stone cultures which is a requirement for some of the minimally invasive procedure such as PCNL. Full metabolic workup, though it is recommended for stone disease in this age group, is not available in the institution. In the available data, only few subjects have co-morbidities and only 26.44% of the patients submitted for stone analysis. For the patients who submitted for stone analysis, 73.91% were mixed stones with calcium oxalate as the primary component. This is comparable to other retrospective studies done in other countries in which calcium oxalate is the most common stone component in the pediatric population.[6,16,19] Children with anatomic abnormalities, urinary tract infections and metabolic disturbances are known to have higher risk for stone recurrence.[21-22] A study on the metabolic abnormalities in pediatric Filipino patients is suggested.

Majority of the stones were managed via minimally invasive approach (82.86%) with ESWL as the most common procedure (44.76%). The average size of ureterolithiasis was 1.22 cm in largest diameter while nephrolithiasis has an average size of 1.93 cm. Both have an average HU of <1000. All of these features render both stone types amenable for minimally invasive approaches. With a high success rates in adults, minimally invasive procedures rapidly became the standard treatment for children with urolithiasis and since children have higher stone recurrence rates, minimally invasive procedures were favored in this population type instead of repeated open stone procedures.[9,17,21] With refinement in the technique, it offers short operative time, less exposure to anesthesia, excellent stone-free rates with minimal morbidity.[17,23]

No laparoscopic stone surgery was done in the institution in the 10-year period and its role has yet to be maximized by the institution for the years to come. Laparoscopic procedures will probably be used in patients with large stone burden in which it can reproduce what an open stone surgery can do using minimal access.[24-25] It has been proven to be safe and feasible in the pediatric population with high success and minimal complications.[24-25] No robot-assisted surgeries were also done in the institution as the institution has yet to acquire one, though, the indications are almost the same as for the laparoscopic surgery. Retrograde Intrarenal Surgery, on the other hand, was only introduced in the institution later in the year 2022. RIRS has been proven safe and effective in the pediatric population and is an emerging option for stones <2 cm.[26-27]

Only 17.14% underwent open stone surgery with the majority done on cystolithiasis and ureterolithiasis (38.89% each). Cystolithiases have a large average diameter of 2.7 cm which was deemed appropriate for an open stone surgery. On the other hand, open stone surgeries done on ureterolithiasis were mostly on those larger than 2 cm. Cystolithiases are endemic to some developing countries attributed to low protein diet, use of goat milk and dehydration.[28] For the management of lower tract calculi, minimally invasive approach such as laser cystolithotripsy is advisable for small stones (<1 cm) to avoid iatrogenic urethral stricture especially in the pediatric male population.[29] Percutaneous lithotripsy or open cystolithotomy is preferred for large bladder calculi.[23,29] For urethral calculi, cystoscopic procedures such as

laser lithotripsy or pushback of the calculus for posterior urethral calculus (to be followed by laser cystolithotripsy or cystolithotomy to extract or fragment the urethral stone) or manual extraction for anterior urethral calculus can be done.[30] For open stone surgeries involving nephrolithiasis, mostly were done on large staghorn calculi more than 4 cm and all of these were mostly done during the first four years of the study where minimally invasive approach such as PCNL is only starting to be practiced in the institution.

All patients were discharged stable after the procedures whether be an open or a minimally invasive procedure. Fifteen patients had fever post operatively (10 underwent minimally invasive approach while 5 underwent open stone surgery) which resolved with ambulation, hydration and for some, IV antibiotics , while 1 patient had fluid collection seen on ultrasound after an open stone procedure (extended open pyelolithotomy) which was managed via percutaneous aspiration and delayed removal of double J stent. Studies suggest indications for an open stone surgery include anatomic abnormalities (diverticular stones, presence of ureteropelvic junction obstruction), complex large stone burden which is not expected to have good results with minimally invasive approaches and repeated endourologic failure.[14,16-17]

Conclusion

The tertiary referral center in the Philippines caters to a number pediatric urology cases and referrals yearly including urolithiasis. Due to the advancement in technology and availability of specialized instruments, there is a rise of minimally invasive therapeutic modalities as standard approach to pediatric urolithiasis which are proven to be safe and effective in the pediatric population. The institution already practices minimally invasive approaches in the majority of the pediatric stone cases and open stone surgery is only reserved for selected cases such as large complex stones and those with concurrent anatomic abnormalities. There is still room for other minimally invasive advancements such as laparoscopic and robot assisted surgeries in the future.

Conflict of Interest

The authors declare no conflicts of interest in writing the study.

Ethical Considerations

The study was conducted after approval by the Institutional Review Board.

References

1. Sharma AP, Filler G. Epidemiology of pediatric urolithiasis. Indian J Urol 2010 Oct; 26(4): 516-22. doi: 10.4103/0970-1591.74450.
2. Grivas N, Thomas K, Drake T, Donaldson J, Neisius A, Petrík A, Skolarikos A. Imaging modalities and treatment of pediatric upper tract urolithiasis: a systematic review and update on behalf of the EAU Urolithiasis Guidelines Panel. J Pediat Urol 2020. doi:10.1016/j.jpurol.2020.07.003
3. Sas DJ. An Update on the changing epidemiology and metabolic risk factors in pediatric kidney stone disease. Clin J Am Soc Nephrol 2021; 6(8): 2062-8, August 2011. | DOI: 10.2215/CJN.11191210
4. Clayton DB, Pope JC. The increasing pediatric stone disease problem. Ther Adv Urol 2011 Feb;3(1): 3-12. doi: 10.1177/1756287211400491.
5. López M, Hoppe B. History, epidemiology and regional diversities of urolithiasis. Pediatr Nephrol 2010 Jan;25(1):49-59. doi: 10.1007/s00467-008-0960-5.
6. Rizvi SAH, Sultan S, Zafar MN, Ahmed B, Aba Umer S & Naqvi SAA. Paediatric urolithiasis in emerging economies. Int J Surg 2016; 36: 705-12. doi:10.1016/j.ijsu.2016.11.085
7. Issler N, Dufek S, Kleta R, et al. Epidemiology of paediatric renal stone disease: a 22-year single centre experience in the UK. BMC Nephrol 2017; 18: 136. https://doi.org/10.1186/s12882-017-0505-x
8. Milliner DS & Murphy ME. Urolithiasis in Pediatric patients. Mayo Clinic Proceedings 1993; 68(3): 241–8. doi:10.1016/s0025-6196(12)60043-3
9. Destro F, Selvaggio GGO, Lima M, et al. Minimally invasive approaches in pediatric urolithiasis. The experience of two Italian centers of Pediatric Surgery. Front Pediatr 2020; 8: 377. doi: 10.3389/fped.2020.00377
10. Önal B, Kırlı EA. Pediatric stone disease: Current management and future concepts. Turk Arch Pediatr 2021 Feb 3;56(2):99-107. doi: 10.5152/TurkArchPediatr.2021.20273.
11. Assimos D, Krambeck A, Miller NL et al: Surgical management of stones: American Urological Association/Endourological Society Guideline, part II. J Urol 2016; 196: 1161.
12. EAU Pocket Guidelines. Edn. presented at the EAU Annual Congress Amsterdam 2022. ISBN 978-94-92671-16-5.

13. Shepherd P, Thomas R & Harmon EP. Urolithiasis in children: Innovations in management. J Urol 1988; 140(4): 790–2. doi:10.1016/s0022-5347(17)41814-3
14. Onal B, Citgez S, Tansu N, Emin G, Demirkesen O, Talat Z, Erozenci A. What changed in the management of pediatric stones after the introduction of minimally invasive procedures? A single-center experience over 24 years. J Pediatr Urol 2013; 9(6): 910–4. doi:10.1016/j.jpurol.2012.12.015
15. Smaldone MC, Docimo SG, Ost MC. Contemporary surgical management of pediatric urolithiasis. Urol Clin North Am 2010 May;37(2):253-67. doi: 10.1016/j.ucl.2010.03.006.
16. Jallouli M, Jouini R, Sayed S, Chaouachi B, Houissa T, Ayed M, Nouri A. Pediatric urolithiasis in Tunisia: A multi-centric study of 525 patients. J Pediatr Urol 2006; 2(6): 551–4. doi:10.1016/j.jpurol.2005.12.002
17. Fragoso AC, Valla JS, Steyaert H, Arnaud P, Esposito C, & Estevão-Costa J. Minimal access surgery in the management of pediatric urolithiasis. J Pediatr Urol 2009; 5(1): 42–6. doi:10.1016/j.jpurol.2008.07.0
18. Robinson C, Shenoy M & Hennayake S. No stone unturned: The epidemiology and outcomes of paediatric urolithiasis in Manchester, United Kingdom. J Pediatr Urol 2020. doi:10.1016/j.jpurol.2020.03.009
19. Rellum DM, Feitz WF, van Herwaarden AE & Schreuder MF. Pediatric urolithiasis in a non-endemic country: A single center experience from The Netherlands. J Pediatr Urol 2014; 10(1): 155–61. doi:10.1016/j.jpurol.2013.07.019
20. Durkee CT, Balcom A. Surgical management of urolithiasis. Pediatr Clin North Am. 2006 Jun;53(3):465-77, vii. doi: 10.1016/j.pcl.2006.02.009.
21. Abhishek Kuma J, Mandhani A, Srivastava A, Kapoor R & Ansari MS. Pediatric urolithiasis: Experience from a tertiary referral center. J Pediatr Urol 2013; 9(6): 825–30. doi:10.1016/j.jpurol.2012.11.0
22. Copelovitch L. Urolithiasis in children: medical approach. Pediatr Clin North Am 2012 Aug;59(4): 881-96. doi: 10.1016/j.pcl.2012.05.009. Epub 2012 Jun 15.
23. Sarica K & Sahin C. Contemporary minimally invasive surgical management of urinary stones in children. Eur Urol Suppl 2017; 16(1): 2–7. doi:10.1016/j.eursup.2016.09.0
24. Agrawal V, Bajaj J, Acharya H, Chanchalani R, Raina VK, Sharma D. Laparoscopic management of pediatric renal and ureteric stones. J Pediatr Urol 2013 Apr; 9(2): 230-3. doi: 10.1016/j.jpurol.2012.03.001. Epub 2012 Apr 10.
25. Peng T, Zhong H, Hu B, Zhao S. Minimally invasive surgery for pediatric renal and ureteric stones: A therapeutic update. Front Pediatr 2022 Aug 18;10:902573. doi: 10.3389/fped.2022.902573.
26. Garzi A, Prestipino M, Calabrò E, Di Crescenzo RM, Rubino MS. Minimally invasive treatment of urolithiasis in children: Evaluation of the use of flexible ureterorenoscopy and laser lithotripsy. Transl Med UniSa 2020 May 31;22: 46-9.
27. Resorlu B, Sancak EB, Resorlu M, Gulpinar MT, Adam G, Akbas A, Ozdemir H. Retrograde intrarenal surgery in pediatric patients. World J Nephrol 2014 Nov 6;3(4):193-7. doi: 10.5527/wjn.v3.i4.193.
28. Lal B, Paryani JP, Memon SU. Childhood bladder stones-An endemic disease of developing countries. J Ayub Med Coll Abbottabad 2015 Jan-Mar;27(1):17-21.
29. Mishra SK, Ganpule A, Manohar T, Desai MR. Surgical management of pediatric urolithiasis. Indian J Urol 2007 Oct;23(4):428-34. doi: 10.4103/0970-1591.36718.
30. Amend G, Gandhi J, Smith NL, Weissbart SJ, Schulsinger DA, Joshi G, Khan SA. Transrectal ultrasound-guided extraction of impacted prostatic urethral calculi: a simple alternative to endoscopy. Transl Androl Urol 2017 Jun; 6(3): 585-9. doi: 10.21037/tau.2017.05.27.