

# Contemporary management of urinary tract stone disease in children within a high volume institution in Mexico

## *Manejo actual de la litiasis urinaria en pacientes pediátricos en una institución de alto volumen en México*

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### Abstract

**Background:** Pediatric urolithiasis is a rare condition around the world. Its presence and incidence are augmenting in developing countries, remarking the importance for urologists to keep updated to latest trends about its management. **Objective:** The aim of this study was to describe the clinical features and therapeutic surgical options and results for urinary tract stone disease in pediatric patients. **Materials and Methods:** This study included all pediatric patients who undergo surgical procedures to manage pediatric urolithiasis between 2017 and 2020 who had complete medical records and adequate follow-up in the General Hospital of México "Dr. Eduardo Liceaga." **Results:** Twenty-one pediatric patients undergo surgical treatment for urinary lithiasis between 2017 and 2020. Males were more affected than female with a relation of 3:1. The mean age at the procedure time was between 1 and 5 years old. The majority of the patients had an adequate body mass index (BMI) according to percentile by age. The upper urinary tract was mostly affected by lithiasis, only 9% of cases were located in the lower urinary tract. The majority of cases were treated with minimal invasive techniques with 14% of complications, and success rate of 90.47%. **Conclusions:** Urinary lithiasis is more common in male, usually locates at the upper urinary tract, frequently in the group of 1-5 years old, most cases had an adequate BMI, and the most frequently used techniques are minimal invasive, with a lower rate of complications and great success.

**Key words:** Urinary tract stone disease. Minimal invasive. Lithiasis.

### Resumen

La urolitiasis en pacientes pediátricos es una condición de baja frecuencia, con tendencia hacia el aumento, por lo que es importante actualizar a urólogos sobre las opciones terapéuticas actuales. **Objetivo:** Describir las características clínicas, las técnicas quirúrgicas y sus resultados usadas para el tratamiento de la urolitiasis en pacientes pediátricos. **Materiales y métodos:** El estudio incluyó todos los pacientes menores de 18 años quienes fueron tratados quirúrgicamente por litiasis urinaria desde el año 2017 al 2020, quienes poseían expedientes clínicos completos y seguimiento en el Hospital General de México. **Resultados:** Veinte y un pacientes menores de 18 años fueron sometidos a procedimientos quirúrgicos para resolver la litia-

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sis urinaria desde el 2017 al 2020. Los pacientes de sexo masculino fueron más afectados que pacientes del sexo femenino con una relación 3:1. El grupo de edad promedio de presentación fue mayor entre los 1-5 años de edad, la mayoría de pacientes poseían un adecuado índice de masa corporal ajustado por edad. El tracto urinario superior fue el más afectado, solo 9% se localizó en el tracto urinario inferior, la mayoría de casos se resolvieron con técnicas mínimamente invasivas con una tasa de complicaciones de 14%, llegando al estado libre de litiasis en 90.47% de los casos. **Conclusiones:** La litiasis urinaria es más común en el sexo masculino, generalmente en el grupo de edad pre-escolar. El índice de masa corporal en la mayoría de los casos se encontraba en rangos adecuados para la edad y el abordaje mínimamente invasivo fue utilizado con mayor frecuencia con 14% de complicaciones y un éxito de 90.47%.

**Palabras clave:** Urolitiasis. Mínima invasión. Pediátrico.

## Introduction

Urinary tract stone disease is common among adults but extremely rare in the pediatric population. Its presence demands extensive knowledge on the topic to identify which procedure is most beneficial to the patient and offers low risk of complications. Urinary tract stone disease justifies 1 out of 1000/7000 admissions into pediatric services<sup>1</sup>. The incidence of urinary tract stone disease in the pediatric population is around 2% and represents 5% of the total number of adults with urinary tract stones. The incidence is difficult to assess due to the complexity of the interrogatory and physical exploration. The incidence has increased 4% over the past 25 years<sup>2,3</sup>, 27 patients are admitted into pediatric services per year due to urinary tract stone disease in México<sup>4</sup>.

Gender distribution of urolithiasis varies by age, males from 0 to 10 years old are more likely to be diagnosed than females, with a correlation of 1.3:1. Females are affected more often between the ages of 11 and 17 years old, with a relation of 1:0.3. Women are most likely to be hospitalized in the emergency room with a relative risk of 1.5, due to complicated urinary tract infections. Geography influences the incidence of this disease, being higher in dry and warm weather. Some communities in Yucatán, México, are a clear example of increased rates of pediatric lithiasis due to higher rates of uricosuria, calciuria, and acid urine pH<sup>5</sup>.

The etiology of urinary tract stones is multifactorial, 76-85% of cases have an atribuible lithogenic cause and only 15% is idiopathic<sup>6</sup>. Urinary tract infections are important lithogenic factor because it promotes urea splitting onto ammonia ions, alkalize the urine and supersaturate ammonium phosphate and magnesium<sup>7,8</sup>.

The location of the stone has been usually reported in the upper urinary tract, mostly in the kidney or the

ureter, some series reported in Tunisia reported an augmented rate of bladder stones caused by endemic schistosomiasis<sup>9</sup>. The startup of the treatment is adequate hydration and it should be adjusted to the weight and should be 70-100 ml/kg. None a study has demonstrated that spontaneous stone passage is more common in children than adult.

Contemporary invasive (ureteroscopy [URS] or percutaneous nephrolithotomy [PNL]) and non-invasive (external shock wave lithotripsy) surgical treatment have replaced the open or laparoscopic procedures. URS with the use of flexible URS is a potentially less invasive technique than percutaneous renal surgery but it is contraindicated in stones bigger than 2 cm. PNL has a significant higher stone free rate but also a higher risk for complications. Stone location, size, number, and preferences of the surgeons are important aspects to consider when selecting the best technique for our patient; every treatment should be individualized<sup>10</sup>.

Stone location, composition, size, anatomy of the collecting system, presence of obstruction or infection status, and the preferences of the surgeon are important aspects to consider when selecting the be.

## Patients and methods

This study included infants from 12 months to 17 years of age who were treated for urinary tract stones disease in the urology service of the General Hospital of México "Dr. Eduardo Liceaga" in México City between 2017 and 2020. Medical records of the patients were reviewed retrospectively by gender, age of presentation, localization, size, number, lithiasis volume, surgical procedure applied, stone free rate, and complications after the procedure.

Children with incomplete medical records and those who did not continued the follow-up in our service were excluded from this study. Descriptive statistical formulas were used to summarize the results using

**Table 1. Demography of pediatric patients with urolithiasis treated in the Urology Unit at Hospital General de México, 2017-2020**

Characteristics	Valor	n (Range)	%
GENDER	Male	13 (1.2-17)	61.90
	Female	8 (1.7-18)	38.09
Age groups	1-5	9	42.86
	6-10	4	19.05
	11-15	5	23.81
	16 or more	3	14.29
Percentile by weight and age	Adequate	12 (5-85)	57.14
	Over weight	7 (over p85)	33.33
	Under weight	2 (under p 5)	9.52
Type of intervention	Minimal invasive	11	52.38
	Non-minimal invasive	10	47.61

SPSS Windows V 22. Most cases were diagnosed by computed tomography and treated in the operating room by URS, PNL or extracorporeal shock wave therapy (ESWL).

## Results

A total of 21 pediatric patients were treated surgically for urolithiasis. The main surgical procedures were: Invasive procedures such as PNL and URS and non-invasive procedures as ESWL.

The presentation age ranged from 1.2 to 18 years old, 42.9% of the cases were on patients between 1 and 5 years old. Regarding patient gender, the majority of cases occurred in male patients, with a ratio of 3:1. Male patients were affected in 66.7% of the cases.

Body mass index (BMI) was adjusted by age and percentiles, 57.2% of patients presented adequate BMI located between percentile 5 and 85, with a media located in the percentile 67, followed by 38.1% who were over percentile 85 and 4.7% were located under percentile 5. The surgical technique used for each patient was indicated based on the lithiasic load and the anatomical location of the stone. Invasive surgical techniques were used in 52.38% of the cases, and noninvasive in 47.6% of the cases (Table 1). The most frequent location of the lithiasis was the renal pelvis in 57.2% of the cases, followed by a ureteral location with 14.2%, while urethral and bladder location were reported to be 4.8% each (Table 2).

**Table 2. Urinary stone location in pediatric patients treated in the Urology Unit at Hospital General de México, 2017-2020**

Location	N	%
Pyelic stone	12	57.2
Single calyceal stone	2	9.5
Staghorn stone	2	9.5
Ureteral stone	3	14.2
Urethral stone	1	4.8
Bladder stone	1	4.8
Total	21	100

**Table 3. Surgical treatment according to the lithiasic load in cases of pediatric urinary lithiasis in the Urology Unit at Hospital General de Mexico, 2017-2020**

Lithiasic load (mm <sup>3</sup> )	ESWL	PCNL	URS	Total
1-5	1	0	0	1
6-10	4	0	0	4
11-15	3	0	0	3
16-20	2	0	0	2
100-200	0	0	1	1
201-300	0	0	4	4
301-400	0	1	2	3
400 or more	0	2	1	3
Total	10	3	8	21

ESWL: extracorporeal shock wave therapy, URS: ureteroscopy.

The higher the lithiasic load, the more invasive the surgical procedure needed. It is remarkable that the lithiasic load presented variations according to the technique that was used (Table 3). Lithiasic load was overall  $189 \pm 239$  mm<sup>3</sup>, ranging from 5 mm<sup>3</sup> to 778 mm<sup>3</sup>. For the ESWL group, the average stone size was  $11.6 \pm 4.2$  mm<sup>3</sup>, ranging from 5 to 180 mm<sup>3</sup>. For the PNL group, the average stone size was  $422 \pm 137$  mm<sup>3</sup>, ranging from 310 to 576 mm<sup>3</sup>. The URS group presented an average lithiasic load of  $325 \pm 262$  mm<sup>3</sup>, ranging from 100 to 768 mm<sup>3</sup>.

Upper urinary tract stones (renal-ureteral) were treated mostly by ESWL, PNL, and URS. However, lower urinary tract stones were mainly indicated to be managed with URS (Table 4).

**Table 4. Surgical management according to anatomic stone location in cases of pediatric urinary lithiasis in the Urology Unit at Hospital General de Mexico, 2017-2020**

Stone location	ESWL		NLP		URS	
	n	%	n	%	n	%
Calyceal stone	1	10	0	0	1	12.5
Ureteral stone	0	0	0	0	3	37.5
Penile urethra stone	0	0	0	0	1	12.5
Bladder stone	0	0	0	0	1	12.5
Staghorn stone	0	0	2	66.7	0	0.0
Pyelic stone	9	90	1	33.3	2	25.0
Total	10	100	3	100	8	100.0

ESWL: extracorporeal shock wave therapy, URS: ureteroscopy.

**Table 5. Stone-free rate obtained after surgical management of pediatric urinarolithiasis in the Urology Unit at Hospital General de Mexico, 2017-2020**

Stone free rate	ESWL		PCNL		URS		Total	
	n	%	n	%	n	%	n	%
Yes	9	90	3	100	7	87.5	19	90.5
No	1	10	0	0	1	12.5	2	9.5
Total	10	100	3	100	8	100	21	100

ESWL: extracorporeal shock wave therapy, URS: ureteroscopy.

ESWL was done on 47.62% of cases of urinary lithiasis. The average number of hits of ESWL was  $2350 \pm 747$  hits, ranging from 2000 to 4000. In 19.05% of the cases, double J-stent placement was required. URS was applied in 38% of cases; the most frequently used technique was flexible left URS in 44% of the cases, followed by left semi-rigid URS in 44% and right semi-rigid URS in 12% of the cases. PNL intervention was indicated on 14.29%, making it the least used technique.

Surgical technique impacted the outcome of the pathology (Table 5) out of the ten patients who received ESWL nine of them obtained a Stone Free status or stone size smaller than 4 mm<sup>3</sup>. Before the surgical intervention, 60% of patients presented stones sized between 10 and 15 mm<sup>3</sup>. Patients managed with URS were in 87.5% of cases free of lithiasic load or with a reduction of the stone size smaller than 4 mm<sup>3</sup> after the surgical procedure. Regarding the patients managed with PNL 100% of them were stone

**Table 6. Complications according to surgical management in cases of pediatric urinary lithiasis in the Urology Unit at Hospital General de Mexico, 2017-2020**

Surgical procedure	Complications				Clavien dindo clasification
	SI	%	NO	%	
ESWL	0	0	10	100	-
URS	2	25	6	75	I/II
NLP	1	33.33	2	66.33	IIIa
Total	3	14.28	18	85.72	-

ESWL: extracorporeal shock wave therapy, URS: ureteroscopy.

free or found out a stone size smaller than 4 mm<sup>3</sup> after the procedure.

Complications were assessed depending on the surgical technique used taking into consideration according to the Clavien-Dindo Classification. Three patients had complications representing 14% of cases. One patient showed postoperative complication with sepsis due to a left kidney abscess (Clavien Dindo IIIA); this patient had a history of diabetes mellitus and it was solved by percutaneous drainage. This surgical technique was infrequently reported during the research period, approximately once per year. Regarding URS two patients presented post-operative complications: one patient required blood transfusion due to hemorrhage and was treated conservatory (Clavien Dindo II), and the other presented fever and was treated by extended spectrum antibiotic (Clavien Dindo I) (Table 6).

## Discussion

This article describes the demographic characteristics and surgical techniques applied nowadays to treat urinary tract stone disease on the pediatric population in the urology service of a referral hospital in México City. The percentage of pediatric patients who undergo surgical treatment of urolithiasis is extremely small even in referral units.

Male patients had major frequency of presentation, mostly in the group from 1 to 5 years of age; incidence is probably augmenting in pre-scholar aged infants due to external factors such as diet and exercise. Over and under weighted patients did not have a higher presentation rate of urolithiasis compared to normal BMI adjusted by percentile.

The aim of the treatment is to obtain a stone free state while preserving kidney function avoiding

recurrence and complications<sup>11</sup>. For this reason, adequate selection of the surgical technique is key for effective management of urolithiasis in pediatric patients. In our hospital, the decision was made analyzing the lithiasic load and localization of the stone.

Major lithiasic volume was associated with invasive procedures and expose to greater risk of complications. The most frequently used techniques to treat urolithiasis in our institution were minimally-invasive, such as URS and PNL representing 52% of the cases, similar to international series where it has been clear that open surgery or laparoscopic surgery is used only in 2.6% of cases<sup>12</sup>. Surgical invasive techniques have increased its application in the past 14 years<sup>13</sup>.

ESWL mostly uses 800-2000 shocks to reach a stone free state in 60-90% of the cases in a 3-month period<sup>14</sup>. In our series, we used ESWL in 47.3% of the cases, with success in 90% of the cases. However, the number of given shocks was higher than international series and none of the cases had complications. In our study, we did not follow-up with computed tomography to all patients, which could have affected our results by giving a higher rate of stone free state. However, the previous studies have shown that 62% of cases resulted in a stone free status in our institution<sup>15</sup>. Predictors factors have been identified internationally: density lower than 600 UH, stone size smaller than 12 mm predicts success, and caliceal-pelvic angle major than 45 grades predicts failure of the treatment<sup>16</sup>.

Even though complications after ESWL are present in 9% of the cases<sup>17</sup>, we did not have any complications after the application of this technique in our study. NLPC was found to be the most efficient technique with a stone free ratio of 100% after one procedure, similar to international series where they found success on 47-100% of the procedures<sup>18</sup>, but is associated with a higher rate of complications, with 33%, slightly higher than international reports. About 30% develop fever and 24% required blood transfusion<sup>19,20</sup>.

URS achieved a stone free rate of 87% in our study, similar to international studies where success was found on 58%-93% of the cases<sup>21</sup>. URS was the selected procedure to treat 100% of the cases of lower tract stones<sup>22</sup>. The complications in international series are between 0% and 15%, mostly infections, bleeding, and urethral perforation rate of 10% and stenosis of 2%. Specifically in this procedure our complication rate was higher than reported internationally due to the small number of patients who went through this surgical technique in this study.

## Conclusion

We can state that urolithiasis in pediatric patients is uncommon. It affects mostly pre-scholar males. The treatment could be done by invasive and non-invasive techniques with adequate rates of stone free and a low complication rate.

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## Conflicts of interest

The authors declare that does not exist a conflict of interest.

## Ethical disclosures

**Protection of human and animal subjects.** The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

**Confidentiality of data.** The authors declare that they have followed the protocols of their work center on the publication of patient data.

**Right to privacy and informed consent.** The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

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