folia medica

Folia Medica 63(3):348-54
DOI: 10.3897/folmed.63.e55911

Original Article

Initial Experience in the Field of Pediatric Percutaneous Nephrolitholapaxia in Bulgaria

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Received: 27 June 2020 ♦ **Accepted:** 11 Aug 2020 ♦ **Published:** 30 June 2021

Citation: Dorosiev E, Minova G, Pelov T, Mladenov B. Initial experience in the field of pediatric percutaneous nephrolitholapaxia in Bulgaria. Folia Med (Plovdiv) 2021;63(3):348-54. doi: 10.3897/folmed.63.e55911.

Abstract

Introduction: Pediatric urolithiasis is a very specific and challenging problem in the field of modern urology. Currently, there are three major methods for kidney stone removal: the extracorporeal shock wave lithotripsy (ESWL), the retrograde intrarenal surgery (RIRS), and the percutaneous nephrolithotomy (PCNL), the latter one proving to be an efficient and safe monotherapy of stones even with larger burden. Different sizes of nephroscopes are used (standard, mini, micro), where smaller size is logically correlated with safer profile, especially in pediatric population.

Aim: To analyze the initial experience in using PCNL in children for the treatment of kidney concrements – rates of successful stone removal and registered complications.

Materials and methods: Twenty-six PCNL procedures of 25 children were performed – both standard and mini. The age of patients, size of the stones, operating time, changes in hemoglobin levels, duration of hospital stay, and the postoperative complications were recorded, analyzed and compared to data reported in current relevant literature.

Results: The mean age of patients was 9±5.2 years (15 boys and 10 girls). The average size of concrements subjected to nephrolitholapaxia was 16±0.7 mm, most of the cases being single stones. The average operative time was 150±33.4 min, and the average hospital stay was 4.1±1.5 days. The percentage of stone free children postoperatively was 94%. Complications included blood loss requiring transfusion in 1 patient (4%), postoperative urinary tract infection and fever (2 patients), and self-limiting hematuria in 16%.

Conclusions: PCNL is an effective and safe alternative in the management of nephrolithiasis in children. It is a method of choice for the treatment of concretions not suitable to treat with extracorporeal lithotripsy and after a qualitative selection of patients.

Keywords

pediatric, percutaneous nephrolithotomy, urolithiasis

INTRODUCTION

Kidney stone disease in children (also called pediatric nephrolithiasis or urolithiasis) has an increasing frequency globally, more specifically in the endemic areas of the developing world. The worldwide frequency of pediatric urolithiasis shows a big difference between the developing countries and the developed countries: 5-15% vs. 1-5%, respectively.[1-4]

In most of the cases this is due to infections of the urinary tract, anatomical features, and metabolic disorders.[5] Furthermore, there are climatic and dietary-related factors that are of importance in this matter.[6] In the last few years, we have been experiencing advancement in the technologies, which has led to the development of less invasive

techniques such as percutaneous nephrolitholapaxia and non-invasive extracorporeal lithotripsy that are used for the treatment of kidney stones in adults.[7] In children, the first procedure of percutaneous nephrolitholapaxia was reportedly conducted in 1985. The procedure has since been slowly recognized by others and with time and the experience gained in treating kidney stones using percutaneous nephrolitholapaxia in children, we are now able to say that we have enhanced confidence in the implementation of this technique.[7,8]

Recurrent kidney stones in childhood are more frequent, for which reason the minimally invasive interventions are the preferred treatment these days. The important point in treating children is that even when they are treated with such minimally invasive technique as nephrolitholapaxia, we should aim for the maximum percentage of kidney stone removal possible.[3] This procedure has become a standard in the treatment of kidney stone disease and has proven its safety and efficiency in the different age groups. It is also used either as a monotherapy or in combination with other methods and techniques.[7,9]

As monotherapy, nephrolitholapaxia has high efficiency and safety. The level of renal stones removal in percentages in literature is around 86.9% and 98.5% after a single session. This percentage can be higher when other techniques are performed such as repeating the nephrolitholapaxia a second time or performing an extracorporeal lithotripsy and ureterorenoscopy. With the introduction of instruments of smaller sizes into practice, it has become possible to apply the miniaturized extracorporeal lithotripsy ("miniperc") 13Ch or 14Ch[10-12] and also the ultra-mini nephrolitholapaxia[13], which helps reducing the percentage of blood transfusion needed[14]. Still, as an experimental method we are observing the entry of a "micro-perc", 4.85Ch, which gives the possibility to fragment the stone with a laser in situ and to leave it for a spontaneous elimination.

After we have gained enough experience with adult patients, we started applying the new methods in pediatric population including the nephrolitholapaxia without drainage. This technique is used in uncomplicated cases and for stones under 2 cm, and when patients are left with a permanent catheter and with a double J stent in the ureter[15,16] or completely without drainage[17]. The non-drainage methods allow a faster recovery of patients after the procedure, an earlier discharge and in addition, it is less painful.[18]

On the other hand, the main priority in using nephrostomy catheters and ureteral stents in nephrolitholapaxia is the drainage of urine from the kidneys.[19]

Furthermore, by doing this we can insure a secondary access to the cavity system of the kidney when remainders of renal stones can be found after the first procedure.

The reported complications of nephrolitholapaxia in children are most frequently hemorrhages, postoperative fever, infections, and urine leaking from the puncture site. The hemorrhages demanding blood transfusion are under 10% [14,15,20-22] and are highly related to the size and quantity of the concernment, the operating time, the size of the instruments used[21,23,24]. Less than 15% are reported to be postoperative complications related to infections of the urinary tract.[14,20-22,25]

The average postoperative hospital stay is similar to the one observed in adults. It is about three to four days on average according to the data published in literature and is shorter than the stay after conventional surgery. The less invasive nature of this technique makes it a promising alternative to the conventional surgery for the treatment of renal stones in children.[25-27]

AIM

The aim of the present study was to present our initial experience in the use of nephrolitholapaxia in children for the treatment of kidney concernments – percentages of successful stone removal and registered complications.

MATERIALS AND METHODS

We have performed a retrospective analysis of surgical interventions of kidney concernments using the nephrolitholapaxia in children for the period from May 2012 to January 2020. During this period, in the Department of Pediatric Urology, which is part of the Clinic of Urology of NI Pirogov University Hospital for Active Treatment and Emergency Medicine in Sofia, we performed 26 nephrolitholapaxia procedures in 25 children. The size of concrements was measured in millimetres.

The children were diagnosed after taking their full medical history and performing a complete physical examination. The imaging studies that were performed were X-rays, echography of the urinary tract, and CT urography. A day before operation, we performed a complete blood count test, biochemical profile, blood type test, and coagulation test for every child. Blood was requested upon request for a blood transfusion. A preoperative antibiotic prophylaxis was performed for each child. Also, they had consultations with paediatricians and anaesthesiologists. Before performing the procedure, informed consent was obtained from the parents.

In our clinic, all nephrolitholapaxia procedures are carried out as standard procedures and also in compliance with the rules of asepsis and antiseptics and under general anesthesia. The operative technique of nephrolitholapaxia applied by us is in prone position and involves an initial retrograde catheterization of the ureter with a urinary catheterization 5-7Ch depending on the age, followed by a retrograde urethral pyelography. A puncture under ultrasonographic and radioscopic control then follows, after which a dilation of the nephrostomy tract is performed under image guidance (X-ray). The dilation of nephrostomy tract is performed using Alken or Amplaz metal telescopic dilators. We use a nephroscope with outer shaft 26Ch with perma-

nent irrigation or a sheath 16Ch when performing a mini nephrolitholapaxia. After examination of the pyelocalyceal system using a nephroscopy, we perform an ultrasound or laser lithotripsy of concretions in the cavity system of the kidney. Upon completion of the procedure, we drain the collecting system using a nephrostomy catheter, most often 12Ch, or we leave the procedure tubeless. We remove the urinary catheterization at 24 hours and the nephrostomy catheter on the second to fifth day postoperatively if there is absence of considerable bleeding and fever.

We observed every patient after the discharge from the hospital with a few control examinations distributed over time. Two weeks after the discharge, we did a control ultrasound examination and a review X-ray of the urinary tract with the purpose of finding remaining concretions after the manipulation. We examined urine for a microbiological growth of all patients, regardless of their sterile culture two weeks after discharge. All our "little" patients remain under our active observation for a long period regardless of the results from the control examinations.

We examined and recorded the data regarding the age of our patients, the size of the concretions, the operating time, the changes in hemoglobin levels, the duration of the hospital stay, and the postoperative complications. Some of the quantitative indicators are presented with average values and the corresponding standard deviations. The categorical variables are presented in percentages.

RESULTS

An analysis of the demography of the patients shows that their mean age is 9±5.2 years. Fifteen of them were boys and 10 were girls. No significant comorbidities were registered. Age and sex of the patients and clinical data are presented in **Table 1**.

Standard PCNL size was performed in 3 cases (within the first 10 cases), where ultrasound was used for stone disintegration. All other 23 PCNL procedures were performed with a nephroscope 12Ch (mini) with Holmium laser as a source of energy.

Table 1. Demographic and clinical data of the patients

Indicators	Data
Mean age (years)	9±5.2
Boys / Girls (number)	15/10
Average size of concretions (mm)	16±0.7
Average operative time (min)	150±33.4
Average decrease in hemoglobin (g/dL)	1.40±0.30
Average hospital stay (days)	4.1±1.5
Clearing of concretions (%)	94
Nephrostomy drainage (number/%)	22 (88%)
Without nephrostomy drainage, n (%)	3 (12%)

The average size of the concrements subjected to nephrolitholapaxia in our practice was 16±0.7. In 21 patients, we detected a single stone, while in 4 we observed multiple stones. In one patient with multiple stones in the kidney, in order to achieve a stone-free result, we performed a second PCNL. PCNL on the left side was performed in 58% of the cases, while on the right side – in 42% of all cases. **Fig. 1** presents radiographic images from different stages of PCNL in a patient with multiple kidney stones on the left side.

The average operative time was 150±33.4 min, which improved with the learning curve – 161±32.1 min for the first 10 cases and 131±30.7 min for the rest. The average hospital stay was 4.1±1.5 days. The percentage of stone free children postoperatively is 94%.

In 22 of our operative interventions, we used nephrostomy drainage catheters which were removed on days 2 or 5 after the surgery. The other 3 children were operated without a nephrostomy drainage (tubeless). In the tubeless cases – all of them with minimal to none intraoperative bleeding, we did not register postoperative complications.

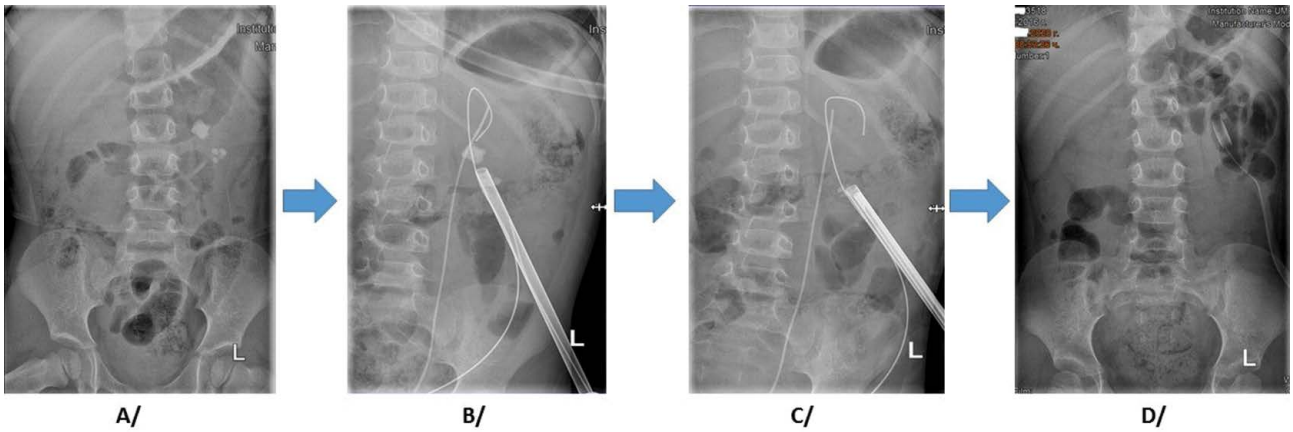

Figure 1. Radiographic images during the different stages of PCNL in a pediatric patient (4 years old) with multiple kidney stones on the left side: **A**. preoperative imaging; **B**, **C**. during PCNL; **D**. "stone free" after the procedure (with nephrostomy catheter).

Regarding the observed complications **(Table 2)**, we had to perform a blood transfusion to one child (4%). Two children developed a postoperative fever, and we found a urinary tract infection in both of them. Four of the children had hematuria which was taken under control within 24 hours. Four other children had leak of urine from the puncture site which ceased after the first day.

The urine culture controls at 14 days showed "no growth" in 22 and asymptomatic bacteriuria in 4 cases.

Table 2. Registered complications

Indicators	Data n (%)
Patients with blood transfusion	1 (4%)
Postoperative fever	2 (8%)
Postoperative urinary tract infection (UTI)	2 (8%)
Hematuria	4 (16%)
Postoperative leaking at the puncture site	4 (16%)

DISCUSSION

Extracorporeal lithotripsy is a method of choice in the treatment of children with urolithiasis and more specifically for larger concretions.[28-30] Nephrolitholapaxia is a suitable alternative for the treatment of concretions unable to be treated by extracorporeal lithotripsy. The method turns out to be especially applicable for children who are expected to require multiple procedures with extracorporeal lithotripsy. Since 1985, when nephrolitholapaxia was introduced in clinical practice with children, there have been few publications in literature.[31,32]

Children who form kidney stones in early childhood require increased attention in order to achieve the highest possible percentage of clearance of concretions by using minimally invasive surgical interventions.[33-35] According to data collected during a number of studies with the nephrolitholapaxia method, there is a high percentage of clearance of concretions up to 90% even in the cases of staghorn calculi.[18,37] Other authors report a minimum of 63% and a maximum of 83-90% cases of clearance of concretions using nephrolitholapaxia in children.[9,36,37] In our clinic, we achieved a higher percentage of clearance of concretions – 94%, which probably is due to fact that the cases treated with nephrolitholapaxia were not so many and because of the appropriate selection of children.

The average time for performing the operation varies widely. According to Samad et al.[38], it is 80 min for children under the age of 5 and 90 min for children over the age of 5. Other authors report a longer average operative time: 150.1±38.7 min for children under the age of 7 and 166.3±39.6 min for children over 7 years of age. (p=0.1).[38] Another study compared the average time to perform nephrolitholapaxia depending on the presence or absence of nephrostomy drainage. For those authors, the mean operative time was 156±38.7 min for nephrolitholapaxia with a nephrostomy drainage and 160±41.1 min for the group without the nephrostomy.[40] Our mean operative time for nephrolitholapaxia is comparable to that of some of the referred authors – 150±33.4 min. Our longer operative time is most likely due to our initial experience in performing the minimally invasive technique.

With regard to the choice of instruments, there are different approaches.

According to some authors, the use of a nephroscope for adults leads to acceptable results in children with a relatively low risk of complications and a lack or minimal degree of scaring.[41] On the other hand, Gunes et al.[42] reported an increased number of complication cases in children under the age of 7 for whom instruments for nephrolitholapaxia for adults were used. The use of nephrolitholapaxia in children requires in-depth knowledge of renal anatomy and an extremely precise technique to minimize complications and a possible severe blood loss requiring blood transfusion.[38] The first nephrolitholapaxia procedures in children in our clinic were performed using instruments for adults. Later on, we adopted the use of instruments suitable for children, which we consider to be more appropriate.

A modern approach that is gaining popularity is the non-drainage nephrolitholapaxia. The importance of the reduction of hospital stay and the reduction of pain after the procedure of nephrolitholapaxia encourage the development of non-drainage methods. Agrawal et al.[43] compare the non-drainage nephrolitholapaxia and the standard nephrolitholapaxia procedures. They report a significant decrease of urine leakage, of postoperative pain, the need of analgesia, the duration of the hospital stay, and the faster recovery of the patients from the group of non-drainage nephrolitholapaxia. In our practice, in most of the cases (22) we used a nephrostomy catheter for urine drainage after nephrolitholapaxia. In three of the children, we performed nephrolitholapaxia without using a nephrostomy. In these cases, we didn't observe complications related to the method chosen.

Due to the small number of cases, we cannot commit to an opinion on the effectiveness and safety of this approach. According to a recent study, the non-drainage nephrolitholapaxia is a safe method in child population without negative consequences if the patient selection has been performed correctly.

Although it is a minimally invasive technique, nephrolitholapaxia carries the risk of a significant blood loss that requires blood transfusion. In one of the publications we studied, blood transfusion was reported to be required in 6.2% of the cases.[41] According to another survey, blood transfusion was needed in 7% of the cases of children in preschool age.[39] In our clinic, blood transfusion was required for only one child which represents 4% of all our cases.

During the postoperative period, we observed fever in two of the children (8%). After performing a microbiological analysis, UTI was found. The patients underwent anti-

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biotic therapy according to an antibiogram. In clinical trials with a similar scenario to ours, there was a higher percentage of UTI – 14% of cases[44] or a smaller – 3.7% [39].

Regarding the postoperative hematuria and the urine leakage in the puncture site, our data is comparable to those in literature.[39]

Our survey was conducted on a small number of patients and has retrospective features. Regardless, the data established by us are comparable to those of other authors working in this field.

CONCLUSIONS

We believe that nephrolitholapaxia is an effective and safe alternative to the treatment of renal concretions in children, with minimal complications. It is a method of choice for the treatment of concretions non-suitable for an extracorporeal lithotripsy and after a qualitative selection of patients.

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Первоначальный опыт в области детской перкутанной нефролитолапаксии в Болгарии

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Дата получения: 27 июня 2020 ♦ **Дата приемки:** 11 августа 2020 ♦ **Дата публикации:** 30 июня 2021

Образец цитирования: Dorosiev E, Minova G, Pelov T, Mladenov B. Initial experience in the field of pediatric percutaneous nephrolitholapaxia in Bulgaria. Folia Med (Plovdiv) 2021;63(3):348-54. doi: 10.3897/folmed.63.e55911.

Резюме

Введение: Детская мочекаменная болезнь – очень специфическая и актуальная проблема современной урологии. В настоящее время существует три основных метода удаления камней из почек: экстракорпоральная ударно-волновая литотрипсия (ЭУВЛ), ретроградная внутрипочечная хирургия (РВПХ) и перкутанная нефролитолапаксия (ПНЛ), причём последняя оказывается эффективной и безопасной монотерапией даже при больших камнях. Используются нефроскопы разных размеров (стандартные, мини, микро), в которых меньший размер логически коррелирует с более безопасным профилем, особенно среди педиатрической популяции.

Цель: Проанализировать первоначальный опыт применения ПНЛ среди детей для лечения камней в почках – частоту успешного удаления камней и осложнений.

Материалы и методы: У 25 детей проведено 26 процедур ПНЛ – как стандартных, так и миниатюрных. Возраст пациентов, размер камня, время операции, изменения уровня гемоглобина, продолжительность пребывания в больнице и послеоперационные осложнения были задокументированы, проанализированы и сопоставлены с данными, представленными в актуальной литературе.

Результаты: Средний возраст пациентов составил 9 ± 5.2 года (15 мальчиков и 10 девочек). Средний размер камней, подвергнутых нефролитолапаксии, составил 16 ± 0.7 мм, в большинстве случаев это был одиночный камень. Среднее время операции составило 150 ± 33.4 минуты, а среднее время пребывания в больнице – 4.1 ± 1.5 дня. Процент детей без камней в почках после операции составил 94%. Осложнения включали потерю крови, потребовавшую переливания, у 1 пациента (4%), послеоперационную инфекцию мочевыводящих путей и лихорадку (2 пациента) и самоограничивающуюся гематурию у 16%.

Заключение: ПЦНЛ – эффективная и безопасная альтернатива лечению нефролитиаза у детей. Это предпочтительный выбор при лечении камней, непригодных для лечения с помощью экстракорпоральной литотрипсии, и после качественного отбора пациентов.

Ключевые слова

педиатрический, перкутанная нефролитотомия, мочекаменная болезнь