Ultra-Mini-Percutaneous Nephrolithotomy for the Treatment of Upper Urinary Tract Stones Sized between 10-20 mm in Children Younger Than 8 Years Old

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Purpose: With the invention of miniature devices, it has been advised to apply less aggressive methods for the management of upper urinary tract stones, especially in children. In the recent years, ultra-mini percutaneous nephrolithotomy (UMP) has been used for the treatment of upper urinary tract stones in order to perform surgeries with less complications and more acceptable outcomes. Results reported from different medical centers have been promising.

Materials and Methods: Twenty-two children aged less than 8 years old with upper urinary stones sized between 10-20 mm underwent UMP. Inclusion criteria was solitary unilateral kidney stone, stone size between 10-20 mm, normal renal function tests, absence of any congenital malformations, and history of previous ESWL failure. Data including age, sex, side of kidney involvement, size of stone, location of stone, duration of surgery, duration of hospitalization, stone composition, need for blood transfusion, damage to adjacent organs, postoperative fever, septicemia after surgery, need for narcotics, further need for a complementary method, stone-free rate, pre and post-operative hemoglobin levels, and urinary leakage from the access tract were extracted from patients' medical files and were recorded.

Results: The mean age (± standard deviation) of children was 5.22 (±1.57) years. Fourteen (63.6%) patients were male. Fifteen (68.2%) renal stones were located in the right kidney, and 82% of patients had pelvis stones. 13 (59%) patients' stones were composed of calcium oxalate. Stone-free rate was 95.5%. In none of the cases urinary leakage, septicemia after surgery, injury to adjacent organs, and need for blood transfusions was reported.

Conclusion: Ultra-mini percutaneous nephrolithotomy is an efficient and safe method for treating urinary stones sized between 10-20 mm in children.

Keywords: children; Iran; nephrolithiasis; percutaneous nephrolithotomy; ultra-mini-percutaneous nephrolithotomy

INTRODUCTION

Kidney and urinary tract stones are one of the most common problems in pediatrics and due to factors such as sanitary lifestyle, malnutrition, anatomical abnormalities, genetics, poor fluid consumption, and inappropriate medication use, its prevalence is increasing [1,2]. Urinary tract stones are more common in males than females with men being three times more likely than women to acquire this disease[3]. Although the male predominance is maintained, this ratio is slightly different in children and the odds of having a urinary stone is 1.5-2 times more likely in boys[3]. In 2010, the incidence of kidney stones in children was estimated to be 50 cases per 100,000 people, showing a dramatic increase[4]. Due to the high prevalence and recurrence rate of urinary stones, a less invasive, cost-effective approach which can also be easily repeated is necessary for the management of urinary stones [5]. The majority of pediatric urinary stones can be effectively managed with less invasive procedures such as ESWL, PCNL, and RIRS [6]. In 2013, Desai and colleagues introduced the ultra-mini percutaneous nephrolithotomy (UMP) which has shown to be an effective method for treating medium-sized urinary stones[7,8]. Since there are limited studies investigating this approach in the pediatric population, the aim of this study was to evaluate ultra-mini percutaneous nephrolithotomy (UMP) for the treatment of upper urinary tract stones sized between 10-20 mm in children younger than 8 years in terms of safety and efficacy.

MATERIALS AND METHODS

Study design

This study was performed between 2017- 2019 on children younger than 8 years old with upper urinary tract stones sized between 10-20 mm admitted to Tohid and Kowsar hospitals in Sanandaj, Iran. During this period, 22 children who met the inclusion criteria were in-

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Received January 2020 & Accepted March 2020

Table 1. Patient demographic data and stone characteristics.

Variable		Number	%
Age (year) mean ± SD		5.22 ±1.57	
Sex	Male	14	63.6
	Female	8	36.4
Kidney	Left	7	31.8
	Right	15	68.2
Stone location	Pelvis	18	82
	Upper Ureter	1	4.5
	Pelvis and Upper Ureter	3	13.5
Stone composition	Calcium oxalate	13	59.1
	Cystine	5	27.7
	Calcium oxalate and Cystine	1	4.5
	Uric acid and Calcium oxalate	2	9
	Uric acid , Calcium oxalate, Calcium Phosphate	1	4.5
Number of stones	1	19	86.5
	2 (pelvis and upper ureter)	3	13.5
Blood transfusion	No	22	100
	Yes	0	0
Damage to adjacent	No	22	100
organs	Yes	0	0
Fever after surgery	No	18	81.8
	Yes	4	18.2
Septicemia after	No	22	100
surgery	Yes	0	0
Need for narcotics	No	22	100
	Yes	0	0
Need for further	No	19	86.5
complementary	Yes	3	13.5
method (JJ stent, ureteroscopy, etc)			
Stone -free status	No	1	4.5
	Yes	21	95.5
Perirenal urinary	No	22	100
collection	Yes	0	0
Urinary leakage	No	20	91
from access tract	Yes	2	9
Duration of surgery (Min) Mean ± SD		58.6 ± 5.68	
Size of kidney stone (mm) mean ± SD		15.5 ± 2.81	
Duration of Hospitalization (Hour) mean ± SD		44.7 ± 15.3	
Hemoglobin level mean ± SD	Before	13.32 ± 0.52	P-value
	After	12.18 ± 0.67	< .001

cluded in the study and subsequently underwent UMP. Inclusion criteria were single unilateral kidney stone measuring between 10-20 mm, normal renal function tests, absence of any congenital malformations, history of previous ESWL failure, and finally guardian permission for participation in this study. Patients' clinical data including age, sex, kidney involvement, location of stone, duration of surgery, size of stone, duration of hospitalization, type and number of stones and surgical data such as need for blood transfusion, damage to adjacent organs, postoperative fever, septicemia after surgery, need for narcotics, further need for a complementary method (double-J stent, ureteroscopy, re-PCNL, etc), stone-free rate, pre and post-operative hemoglobin levels, and urinary leakage from the access tract were extracted from their medical files and recorded in a separate check list. Prior to study recruitment, written informed consent was obtained from patients' parents after a verbal interview between the doctor, the patient and the legal guardian.

The surgical tool used in this study was the UMP device (LUT, Germany) which consists of a 1 mm (3F) telescope, 7.5 F nephroscope, inner sheath with three ports (one each for the telescope, saline irrigation inlet, and laser fiber), and a 11-13F metallic outer cannula which served as the Amplatz sheath.

After general anesthesia, while the patient was placed in lithotomy position, a 4F ureteric catheter was inserted into the kidney in a retrograde manner. Then the patient was switched to prone position and with the help of C-arm (fluoroscopy) image intensifier, the desired calyx was determined. Under fluoroscopic guidance, an 18-gauge Chiba needle, which was most suitable according to the size and position of the stone, was used for entering the kidney calyx. The needle insertion site was dilated 1 mm. Then a 0.035-inch J-tip guide wire was passed through the needle. Dilatation was performed using a 7.5F nephroscope and an 11-13F sized Amplatz cannula. Under direct visualization of the nephroscope provided by Holmium:YAG laser, the stone was broken and then washed-out. The presence of residual stones was evaluated by kidney urinary bladder (KUB) radiography and ultrasonography, and a stone-free result was defined as residual stone fragments of less than 4 mm.

Nephrostomy was not routinely performed in any patient. Since no significant residual stone was seen in fluoroscopic control, the pyelocaliceal system was unaffected and no contrast extravasation was observed. In two patients, the leakage of the access tract last-

ed for 2–5 days. The presence of an inferior ureteral stone in control KUB and ultrasound implied the need for performing TUL and JJ insertion. On day 6 after UMP, JJ was inserted and leakage was discontinued the following day. After 4 weeks, ultrasound examination was performed and due to the absence of stone in the system and ureteral tract, double- J was removed. This study was approved by the Ethics Committee of Kurdistan University of Medical Sciences (IR.MUK. REC.1397.369).

Statistical analysis

Descriptive statistics are reported as frequencies and percentages. In addition, continuous variables with normal distribution are expressed as mean ± standard deviation (SD). Data was analyzed using Stata 14 software.

RESULTS

The mean age (± SD) of patients was 5.22 (±1.57(years old. Out of 22 patients, 14 (63.6%) were male. In 15 patients (68.2%), the stone was located in the right kidney and 82% of patients had a pelvis stone. 59% of the stones had a calcium oxalate composition. The average size of stones was 15.5 mm. Mean surgical time was 58.6 minutes and mean hospital stay was 44.7 hours. In 4 cases (18.2%), postoperative fever was reported and 3 (13.5%) cases required further complementary operations (e.g. ureteroscopy or double-J stent insertion). Stone-free rate was 95.5%. Urinary leakage, septicemia after surgery, injury to nearby organs, and need for blood transfusion were not reported in any cases. However, the results of our study showed a significant drop in the level of serum hemoglobin after surgery ($P < .001$). Results are summarized in **Table 1**.

DISCUSSION

The location of the stone in the urinary system and the anatomy of the pyelocaliceal system are important factors in choosing the appropriate treatment approach [(12)]. Ultra-mini-percutaneous nephrolithotomy (UMP) has been shown to be a safe and effective method for treating small-size urinary stones. The advantages of this method are rapid performance, high stone clearance, and minimal complications[(9,10)]. In this study, the average stone size was 15.5 mm. In a study by Desai et al. the average stone size was (14.9 ± 4.1 mm) in adults[(11–13)]. In another study, the average stone size was 8 - 20 mm[(14)]. A systematic review of 7 studies with 262 patients who underwent UMP reported a mean stone size of 18.6 mm and an average stone-free rate of 88.2% from. Also, in 5 of the studies, JJ stent was used in 44.5% of cases[(15)].

According to the findings of the present study, 68.2% of the stones were located in the right kidney. Also, the mean surgical time was 58.6 minutes and mean hospital stay was 44.7 hours. In a study by Tepeler et al., the ratio of right kidney to left kidney stone was 2.125 and the mean time of surgery and hospital stay were 65.4 minutes and 1.4 days, respectively [(16)]. Desai and colleagues reported a mean time of surgery of 59.8 (± 15.9) minutes and a mean hospital stay of (± 0.9 days) in their study[(12)]. The results of another study showed that the mean duration of surgery was 39.7 minutes and mean hospital stay was 22.3 hours[(14)]. In a systematic review study conducted in 2017, the mean surgery time and hospital stay was estimated as 89 minutes and 1.8 days, respectively[(15)]. The reason for the variations in results could be due to differences in age groups, type of stone, and location of the stone.

Although PCNL is still the standard choice for treating stones larger than 20 mm, but due to the size of the device, its access site, and complications, it is not considered a safe method for kidney stones of less than 20 mm, especially in the pediatric population. Despite the efficacy of PCNL in stone removal, it has serious side effects, the most important of which is bleeding [(17,18)]. In this study, all stones were opaque. In five patients with cysteine stones, the stones were seen with KUB and fluoroscopy. In several studies, it has been suggested that the presence of non-opaque stones is associated with longer operative times and increased complications[(19,20)]. It is assumed that UMP reduces the risk of trauma and serious complications, especially bleeding, in children. In the present study, significant bleeding requiring blood transfusion was not reported in any study, which is consistent with the study of Jones and colleagues[(15)].

The limitations associated with our study were a small sample size, and the lack of a control group for comparison of UMP with other treatment modalities.

CONCLUSIONS

According to the findings of this study, it can be concluded that UMP is an appropriate and safe method for treating medium-sized urinary stones (between 10-20 mm) in children younger than 8 years old.

ACKNOWLEDGMENTS

The study was sponsored by the deputy of research and technology of Kurdistan University of Medical Sciences, Sanandaj, Iran. The authors wish to thank the Clinical Research Development Center at Kowsar Hospital, Sanandaj, Iran for their collaboration.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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