Microperc Versus Miniperc for Treatment of Renal Stones Smaller Than 2 cm in Pediatric Patients

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Purpose: Pediatric stone disease is an important clinical problem in pediatric urology practice. We aimed to compare mini-percutaneous nephrolithotomy (miniperc) and micro-percutaneous nephrolithotomy (microperc) in pediatric patients who underwent unsuccesful SWL procedure.

Materials and methods: A number of 43 pediatric patients, aged 17 years or younger, were treated with miniperc or microperc procedures due to renal calculi by a single surgeon. In group 1, there were 27 patients who underwent miniperc procedure. In group 2, 16 patients were treated by microperc.

Results: Mean age of the patients were 9.5 (3-17) years in group 1 and 7.9 (2-16) years in group 2 ($P = .25$). Stone burden was similar between the two groups. Mean operation duration was 74.1 (40-110) minutes in miniperc group and 37.2 (20-55) minutes in microperc group ($P < .01$). Patients who underwent microperc were discharged from clinic earlier. Hyperthermia without bacteraemia was observed in 2 children in the miniperc group and was treated by using a single dose of paracetamol and also 2 children in the same group needed blood transfusion. There was a tendency for low haemoglobin decrease in microperc group compared to miniperc ($P > .05$).

Conclusion: The management of pediatric stone disease has evolved with improvements in techniques and minimalisation of surgical instruments and thus, it can be effectively and safely used in children by experienced surgeons.

Keywords: microperc; miniperc; nephrolithiasis; pediatric; percutaneous nephrolithotomy

INTRODUCTION

Pediatric stone disease is an important clinical disorder in pediatric urology practice. The incidence and characteristics of stones show a wide geographical variation in children. Although urinary stone disease is generally considered to be a relatively rare disease, it is quite common in some regions of the world. Pediatric stone disease is endemic in Turkey, Pakistan and some South Asian, African and South American countries[(1)]. According to a study, the annual incidence of primary urinary system stone disease is 1% in Turkish school-aged children[(2)]. Stone evaluation, indications and treatment options are similar to adults however; small sized and specific instruments are needed for children[(3)]. Micro-percutaneous nephrolithotomy (PNL) is a recently introduced PNL technique that is performed using a 4.8 F micro-sheath all-seeing needle with no need for tract dilation or an additional access sheath.[(4,5)] It has a three-way 0.9 mm micro-optic connector, an irrigation system, and laser fragmentation capabilities. In this technique after lithotripsy procedure was performed for small stones, fragments passes spontaneously. It currently is the endpoint PNL technology used to treat kidney stones[(6)]. Shockwave lithotripsy (SWL) provides convincing results especially in experienced centers. However, in large and complex stones, the presence of anatomic abnormalities, SWL failure, hard stones like cystine and accompanying congenital anomalies there is a need for treatment by other minimal invasive techniques such as endourologic procedures[(7)]. In this study; we aimed to compare mini-PNL (miniperc) and micro-PNL (microperc) treatments in pediatric patients who underwent unsuccesful SWL procedure before.

MATERIALS AND METHODS

In this retrospective study, patients who were treated with one of two endourological procedures (miniperc or microperc) in our department were included. We treated patients with miniperc between January 2010 and September 2013 and with microperc between October 2013 and March 2016. Other inclusion criteria were age of 17 years or younger and SWL failure. Patients with anomalous kidneys, bleeding disorders or musculoskeletal deformities were not included. 43 pediatric patients were treated by a single surgeon due to renal calculi. In group one, there were 27 patients who underwent miniperc procedure and in group two, 16 patients were treated by microperc. Demographic characteristics of the patients is illustrated in **Table 1**. When we asked stone intervention history we learned that one child who underwent microperc had miniperc before. Non of the children had co-morbidity. Approval of the institutional ethics committee was taken for conducting the study and specific informed consent was obtained from patients' parents. While kidney urinary tract and bladder x-ray radiography (KUB) and/or urinary ultrasonography (USG) were

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Received April 2016 & Accepted September 2016

Table 1: Characteristics of the patients

	Miniperc	Microperc	*P*-value
Patients: Male-Female N(%)			
Total	13(48.1) – 14(51.9) 27	8 (50) – 8(50) 16	0.20
Mean age ± SD (range); years	9.5 ±5.4 (3-17)	7.9 ± 3.6 (2-16)	0.25
Operation side Right-Left N(%)	13(48.1) – 14(51.9)	8 (50) – 8 (50)	0.43
Mean stone size ± SD (range); mm	13.4 ± 4.8 (7.8-18.7)	12.1 ± 4.3 (7.1-18.6)	0.22
	Renal pelvis 18 (66.7)	Renal pelvis 7 (43.8)	
Stone localisation N (%)	Lower calyx + Renal pelvis 6 (22.2)	Lower calyx 7 (43.8)	
	Other 3 (11.1)	Other 2 (12.4)	-

performed for the evaluation of urolithiasis, abdominal computed tomography (CT) was performed for patients who were scheduled for surgery. Prior to the surgery, the anesthesiology clinic was consulted about all study patients, and the patients' routine blood and urine tests were performed preoperatively. Erythrocyte suspension was prepared for all pediatric patients before operation. Stone size was calculated by measuring the largest diameter on radiological graphs or summing the measurements of multiple stones. Operations were performed under general anaesthesia and prophylactic antibiotics were administered to the patients just before the operation. Complete blood count and blood serum creatinine of patients were analysed at the end of surgeries. Operation time was defined as the time between the first renal puncture to the completion of stone removal. We also suggested families to refer to our clinic again three weeks after discharge with stone analysis and 24 hour urine samples for metabolic analysis and thus possible medical treatments. The stone clearance was assessed using KUB and urinary USG 24 or 48 hours after operation. Stone clearance was defined as either stone free or with asymptomatic and clinically insignificant residual stone of ≤ 4 mm. It is well known that KUB and USG are not as sensitive as computed tomography in the detection of residual stone fragments. In our study the stone-free status was assessed with KUB and USG because of concerns about radiation exposure.

Miniperc Technique

All procedures were performed under general anaesthesia in prone position, after performing retrograde catheterisation with a 4 Fr ureteral catheter in lithotomy position. The anatomy of the calyx was visualised by infusing contrast solution through the ureteral catheter. Percutaneous access was achieved by a single surgeon under fluoroscopic guidance by using an 18-gauge needle. Amplatz dilators of up to 12-20 Fr were used for tract dilation through the hydrophylic guide. Fragmentation and stone removal were accomplished in all patients using pneumatic or ultrasound energy. Stone fragments were removed by retrieval graspers through a 12 F pediatric nephroscope. Operation was completed when residual fragments were not detected on fluoroscopic imaging control. At the end of this procedure, a nephrostomy tube was placed after removing the ureteral catheter.

Microperc technique

A 4 Fr ureteral catheter was inserted in patients under general anaesthesia in lithotomy position. After catheterisation, the patient was turned to prone position. The anatomy of the calyx was visualised by infusing contrast media through the ureteral catheter. After detecting the suitable calyx, access was made under the guidance of fluoroscopy by the surgeon using an all-seeing needle. After removing the needle, a three-way connector was applied to the proximal part of the sheath to connect to the laser probe and irrigation system. The stone was fragmented by using holmium energy under direct vision. Stone fragmentation was achieved with a 200 μm holmium laser fiber until stone fragments were deemed small enough to be passed spontaneously. The surgeon controlled a water pump which aided in vision and the clearance of stone fragments. Drainage of the kidney was supplied through the open-ended ureteral catheter. Stone fragmentation was confirmed by direct vision and fluoroscopy. The procedures were terminated with no need of any nephrostomy tube. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Statistical analysis

Statistical analysis was performed with IBM SPSS Statistics for Windows (Version 22.0). Data was given as mean±standard deviation (SD), minimum and maximum values for continuous variables. Categorical variables were compared using chi-square test, while continuous variables were compared using independent sample t-test. Statistical significance was considered at $P \leq .05$ level.

RESULTS

Mean age of the patients were 9.5 (range:3-17) years in the miniperc group and 7.9 (range: 2-16) years in the microperc group; the difference was not statistically significant ($P = .25$). There was no statistically significant difference in terms of stone burden and laterality. Mean operation time was 74.1 (range: 40-110) minutes in the miniperc group and 33.6 (range: 25-45) minutes in the microperc group ($P < .01$). Patients who underwent miniperc and microperc were discharged from clinic after an average 4.0 ± 1.7 (range: 2-11) days and 1.5±1.0 (range: 1-4) days from surgery, respectively ($P < .01$). Residual fragments were detected in 2, and 1 patients respectively for miniperc and microperc groups and the stone clearance rates were found as 92.6% and 93.8% respectively ($P = .48$). Postoper-

Table 2: Postoperative findings of the patients

	Miniperc	Microperc	P-value
Mean operation time ±SD (range); minutes	74.1±19.7 (40-110)	37.2 ± 9.8 (20-55)	< 0.01
Mean hospitalization time ±SD (range); days	4.0 ± 1.7 (2-11)	1.5 ±1.0 (1-4)	< 0.01
Mean haemoglobin change (range); g/DL	–1.14 ± 1.32 (–3.9,1.1)	–0.79 ± 0.49 (–1.4,0.1)	0.28
Mean creatinine change ±SD (range); mg/dL	0.04 ± 0.13 (–0.13,0.3)	0.08 ± 0.06 (–0.01,0.17)	0.33
Stone clearence %	92.6	93.8	0.48

ative findings of the patients is illustrated in **Table 2**. Residual fragments were between 5 and 7 mm in diameter. We did not perform any auxiliary procedures for those asymtomatic fragments. We decided non-interventional follow-up with 3 month intervals for those patients. We observed that resiual fragment of one patient in miniperc group was spontaneously cleared in follow-up. For other asymtomatic residual fragments of patients (one in miniperc and one in microperc group) we are continuing non-interventional follow-up. So final stone free rate SFR can be considered as 96.3% for the miniperc group and 93.8% for the microperc group. The mean decreases in haemoglobin values for miniperc and microperc groups were 1.14 ± 1.32 g/dL and 0.79 ± 0.49 g/dL ($P > .05$). Erythrocyte transfusion was given for two patients in the miniperc group because of observing macroscopic hematuria and hemoglobin drop postoperatively (Clavien Grade II). No transfusion was needed in the microperc group. There was a tendency for low haemoglobin decrease in microperc group compared to miniperc. The mean increase in creatinine values was 0.04 ± 0.13 mg/dL and 0.08±0.06 mg/dL for miniperc and microperc groups, respectively ($P > .05$). Subfebrile hyperthermia was observed in 2 children in the miniperc group and was treated by using a single dose of paracetamol (Clavien Grade I). In the miniperc group, nephrostomy catheter was inserted for all patients. The average time of nephrostomy removal was on postoperative 3.3 (range: 2-4) days. Urethral foley catheters of all patients were removed on the following day. In the microperc group, ureteral catheters were placed intraoperatively. In 7 patients, ureteral catheters were changed with double j catheters at the end of the operation due to intraoperative hematuria. Urethral foley catheters of those patients were removed on the following day. In another 9 patients in group two, ureteral catheters were removed with the urethral foley drains on average postoperative 1.3 (range: 1-2) day.

DISCUSSION

There is a wide range in the incidence of pediatric urolithiasis; its incidence rates are 5 to 15% and 1 to 5% in developing countries and developed countries, respectively.[8] Children with urinary stone disease represent a high risk group for stone recurrence.[9] Since the recurrence rate is higher in children compared to adults, urologists are required to aim at leaving no residual stone fragments behind after any treatment made for urinary stones. A previous study showed that 69% of children with residual stone fragments of ≤ 5 mm following SWL had an increase in stone size.[10] Currently, most pediatric stones can be easily managed by SWL. Guidelines state that SWL is the first choice for treating most renal pediatric stones and PNL can be preferred for larger and complex stones. The guidelines also mention that PNL can be used as monotherapy in most cases but is also used as an adjunctive procedure to other therapies.[1] In children, SWL requires general anaesthesia with short hospital stay and stone free rates of almost 60-70% especially for lower calyx stones after repeated treatments, as well.[11] With the miniaturized access technique which is described in 1998, Jackman et al. reported total success rate of 85% and listed the benefits of this new technique as increased maneuverability, decreased blood loss and shorter hospital stay, along with limitations including prolonged operative times and potential impairment of visualisation during the procedure, especially for larger stones[12] Potential limitations for the use of PNL procedure in children include possible parenchymal damage and associated impairment in renal function, radiation exposure and the risk of major complications, including urinary sepsis and bleeding.[3] PNL has its invasiveness and related morbidity, mainly hemorhagic risk, as major limitation, especially in pediatric patients.[13] In our study, hyperthermia without bacteraemia was observed in 2 children in the miniperc group and was treated by using a single dose of paracetamol and also 2 children in the same group needed blood transfusion. The further miniaturisation of the urological instrumentation has very recently offered new possibilities for minimally invasive stone treatment. The "microperc" has been described as a new very minimally invasive PNL technique, which is performed by using a 4.85 F metallic needle.[14,15] Microperc has been recently proposed in adult patients. Caione et al. reported that the success rate of microperc was 100% in 5 children with a mean age of 5.8 years. In this study, except for one patient who needed conversion to retrograde intrarenal surgery due to stone migration and poor visibility, the mean hospital stay was 2.4 ± 0.6 days for four patients after the removal of ureteral catheter.[14] Microperc is a new innovation whose potential and scope of indications have not yet been completely defined. A few authors demonstrated that microperc access in a limited number of pediatric patients can be considered as safe and effective and also in preschool children.[16-18] Pediatric patients are more sensitive to hemoglobin decrease when compared with adults and the main advantage of microperc in pediatric patient is the low risk of bleeding. In the studies by Desai and colleagues, the mean hemoglobin decrease was calculated as 1.4 g/dL.[16] In another study, the mean hemoglobin decrease was 0.1 ± 0.3 mg/dL (range: 0–1.1 mg/dL) for moderate-size renal stones[19]. In one study by Dağgülli and colleagues, blood transfusion was not required for any of the pediatric patients, and the mean hemoglobin decrease was 0.7 g/dL.[20] In our study, the hospital stay was shorter in the microperc group. One of the most important reasons behind this advantage might be the absence of nephrostomy tube. Limitations of our study could be considered to be retrospective nature, the lack of long-term follow-up, and unavailability of data on stone composition.

CONCLUSIONS

All of the endourological interventions are invasive treatments; therefore, they may sound offensive for pediatric patients and especially for their relatives. The management of pediatric stone disease has evolved with improvements in techniques and minimalisation of surgical instruments and thus, they can be effectively and safely used in children by experienced surgeons. Both microperc and miniperc are minimal invasive treatment options for renal stones in children. According to our study, microperc procedure is more minimally invasive and has shorter hospitalisation duration, therefore, it may be preferred for pediatric patients in experienced centers.

ACKNOWLEDGMENT

We appreciate Ahmet Altun and Selim Çam for their great helps in analysis of the statistics.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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