The comparison of standard and tubeless percutaneous nephrolithotomy (PCNL) in children up to 18 years old

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Abstract

Background

The Percutaneous nephrolithotomy (PCNL) is an endourological method applied as the standard or tubeless method for kidney stones treatment.

Material and Methods

In a retrospective study, 88 surgery units involving 75 children up to 18 years old with kidney stones who underwent the surgery for 8 years with one of the two methods of standard or tubeless PCNL were evaluated and compared considering the success rate of operation, hemoglobin, and hematocrit drop, medications, transfusion, duration of surgery and the length of hospital stay.

Results

Among the 88 patients, 47 cases were operated with the standard PCNL and 41 cases by tubeless method. In children whom operated by standard and tubeless PCNL, the complete success rate of operation was 87.2% and 100% ($P = 0.006$), the need for blood transfusion was 2.1% and 0% ($P = 1.00$), the need for opioids was 27.7% and 14.6% ($P = 0.134$), the decrease in hemoglobin was -1.82 ± 0.94 and -1.30 ± 0.98 mg/dl ($P = 0.024$), the decrease in hematocrit was -5.40 ± 2.66 and -3.52 ± 3.11 mg/dL ($P = 0.003$), mean surgery duration was 109.30 ± 53.27 and 101.46 ± 31.92 minutes ($P = 0.414$), the duration of postoperative hospitalization was 3.38 ± 1.76 and 2.46 ± 1.27 days ($P = 0.007$) and the frequency of fever was 23.4% and 7.3% ($P = 0.04$), respectively.

Conclusion

The success rate of kidney stone surgery in children with the tubeless PCNL is higher than the standard method, and its complications are lower.

Introduction

Urinary stones are the third most common urinary tract disease, followed by urinary tract infections and various prostate disorders¹. Kidney stones are not common in children, but 20-40% of children can be associated to the metabolic disorders and anatomical abnormalities. Such events lead to the possibility of recurrence of the stone compared to adults^{2,3}. Because of some factors such as anatomical and metabolic abnormalities, small kidney size, and high recurrence rate in stone formation, treatment of kidney stones in children is significantly different from the adults⁴. The extracorporeal shockwave lithotripsy (ESWL) was introduced in 1982 which was the first choice for kidney stones⁵, even for complex

and very large stones in pediatric age group^{6,7}. PCNL was considered a standard surgical choice for complex stone diseases in children, since it was firstly reported by Woodside et al⁸. Traditional dermal procedures use 26Fr to 32Fr nephrostomy dilation pathway. Dilators and smaller sheaths were successfully used in the adults. Jackman et al. described 11-French mini PCNL technique and reported their early experiences in children. Endourologists were encouraged to use smaller instruments in children. Nephrostomy drainage using re-entry catheters after PCNL was shown to be useful for the drainage and homeostasis and facilitates repetitive, easy kidney access in cases of re-PCNL. Thus, tube-related morbidity such as significant postoperative pain, forced surgeons to change the technique to tubeless and totally tubeless⁹. Few centers reported their experiences of PCNL in infants and young children¹⁰⁻¹². The researchers' experience shows that PCNL can be done by the Tubeless method and that no special problem will be created for the patient¹³⁻¹⁶. This study aimed to compare standard and tubeless PCNL in children.

Materials And Methods

In a retrospective study, enrolled all patients with age up to 18 years old (youngest patient was 8 months and 22 days old) and kidney stone complaint and underwent PCNL referred to the urology clinic of Shahid Beheshti and Boali hospitals in Hamadan, Iran, between 2011 and 2018. All patients operated by one surgeon. Data extracted from the patients' medical records and were registered in the checklist. Inclusion criteria were:

Maximum age 18 years, stone size more than 1 cm in the lower calyx, more than 2 cm in upper calyx, middle calyx and pelvis and, more than 1 cm in the upper ureter and exclusion criteria were Incomplete data, age over 18 years old, definite indication for nephrostomy, including obstruction, severe bleeding and pyelonephritis

Statistical analysis

Data were analyzed using the SPSS software version 21. Descriptive data were shown in the form of tables and graphs, central indicators and dispersion. Independent t-test and Mann-Whitney test were used to compare the quantitative data and the Chi-square test and Fisher's exact test were used to compare nominal qualitative data. The level of statistical significance was considered less than 0.05.

Results

The total number of patients was 75, with 88 units of surgery in which 47 units underwent the standard PCNL (group S) and 41 units under tubeless (group T) method. In group S and T: mean age of patients were 7.17 ± 5.19 and 7.12 ± 5.75 ($P=0.967$) and mean weight were 23.87 ± 19.81 and 24.83 ± 15.69 kg ($P=0.810$) respectively.

Patients with kidney stones were matched considering the gender, surgical history, location, size of stones and tract number in standard PCNL and tubeless groups (Table 1). The single tract was used for 91.5% and 92.7% in standard and tubeless PCNL groups, respectively ($P = 1.00$). General, spinal and epidural anesthesia was reported in 91.5%, 6.4%, 2.1% and 90.2%, 9.8%, 0% ($P = 1.00$), frequency of need for intraoperative lithotripsy was also in 83% and 80.5% ($P = 0.762$), respectively. There was no statistical significant difference among the children with kidney stones under standard PCNL and tubeless methods considering blood transfusion frequency and drug utilization. The complete success rate in tubeless nephrolithotomy group was significantly higher than in the PCNL group (Table 2). The decrease rate in hemoglobin and hematocrit in the standard group was significantly higher than tubeless group. There was no statistical significant difference among the children underwent PCNL standard and tubeless surgery considering the mean surgical duration. Hence, average hospital stay in the standard nephrolithotomy group was significantly higher than tubeless group (Table 3). None of the patients in two groups had a kidney, pelvic, ureter, liver, spleen, intestine, pleural, and large vessel damage. Due to the complications, postoperative fever was reported in 11 cases (23.4%) in the standard group and 3 cases (7.3%) in the tubeless group ($P = 0.040$). Other complications found in the standard group included hemorrhage (require 200 cc blood transfusion) during surgery, urinary leakage from nephrostomy site, and postoperative hypertension that were observed in each patient. In all patients of both standard nephrolithotomy (except for 1 telescopic procedure) and tubeless groups, dilatation was performed by one shot method.

Discussion

In the present study, the complete success rate in the tubeless nephrolithotomy group was significantly higher than standard nephrolithotomy, while the need for re-PCNL, the length of hospital stay, and hematocrit and hemoglobin dropping were less in the former group. In all patients in both standard and tubeless nephrolithotomy groups, a one-shot method was performed (except for one case in the standard group, which was dilated by the telescopic method). The fluid consumed in all patients was distilled water. None of the patients in two groups had damage to renal parenchyma, pelvis, ureter, liver, spleen, intestine, pleura, and large arteries. Due to the complications, eleven cases of postoperative fever were observed in the standard group and three cases in the tubeless group, one case of intraoperative bleeding, one case of urinary leakage from the nephrostomy site, and one case of postoperative hypertension in the standard group.

In the present study, the success rate or complete stone removal in tubeless PCNL was significantly higher than standard PCNL which was consistent to the results of researches conducted by Aghamir et al¹⁷ and the retrospective study by Bilen et al¹⁸. In the study by Iqbal et al¹⁹ and the meta-analysis by Xun et al²⁰ and Nouralizadeh et al²¹ no significant difference was observed between standard PCNL and tubeless considering the success rate.

In the present study, the need for postoperative blood transfusion in tubeless PCNL was lower than standard PCNL, no statistical significant difference was observed between two methods. Consistent to

the results of present study, in the studies conducted by Xun et al. in 2017, Aghamir et al. and Karakoyunl et al²², the difference was not significant.

In the present study, the need for postoperative opioids in tubeless PCNL method was lower than standard PCNL; there was no statistical significant difference between two methods in terms of the frequency of need for drug injection. In a study by Xun et al and other study by Karakoyunl et al. in comparing the rate of pain and drug use in kidney stone surgery by standard PCNL and tubeless method, the frequency of opioids and analgesic drug use in tubeless PCNL was lower than standard PCNL. The reason for the different results may be due to the lack of uniform treatment of nurses, the phenomenon of pain in patients, and different pain thresholds in patients. Moreover, prescribing the analgesics in different places does not have the same standard function. It may be easy to prescribe in some hospitals. Other hospitals may have stricter regulations due to financial issues or strict insurance.

Due to the results of researchers performed, kidney stone surgery in children and adults by tubeless PCNL method reduces the length of hospital stay after surgery^{20, 23}. In a study conducted by Mousavi Bahar et al. in 2006, the average hospital stay was 48 hours²⁴. In a study by Salem et al. on 20 children undergoing tubeless PCNL, the mean length of hospital stay was 1.7 days, while it was 2.8 days in the standard PCNL group²⁵ which is consistent to our study. In the present study, the mean operation time in the tubeless PCNL method was less than standard PCNL (8.22 minutes); there was no statistically significant difference between two methods due to surgery time. Based on the results of a meta-analysis on 1148 patients, Xun et al. reported that tubeless PCNL was significantly associated to a reduction in surgical time (minus 3.79 minutes). In the study of Bilen et al, the duration of surgery and fluoroscopy was shorter in the tubeless group. However, in the studies conducted by Iqbal et al., by Nouralizadeh et al and by Aghamir et al., there was no significant difference between tubeless and standard PCNL in terms of surgery duration. The reason for surgical time reduction in tubeless PCNL compared to the standard was due to the removal of nephrostomy in tubeless method.

In the present study, the mean drop in the hemoglobin and hematocrit of children operated by tubeless PCNL was significantly lower than standard PCNL. Consistent to the results of our study in the research conducted by Iqbal et al, the mean drop in hemoglobin and hematocrit in standard PCNL was greater than in tubeless method. Contrary to our findings, in a study by Nouralizadeh et al, by Xun et al. and Aghamir et al., no significant difference was reported between tubeless PCNL surgery and standard PCNL in terms of hemoglobin and hematocrit loss.

In the present study, in both PCNL methods, the total number of children who used two tracts was 7. The mean time of surgery, the duration of hospitalization and the success rate were 118.57 minutes, 3.00 days and 85.7%, respectively. In a study by Abduvokhidov and Mousavi Bahar et al on 25 patients aged from 21 to 72 years in Tajikistan, stone removal rate was 88%, the average surgical time was 95 minutes, and the average hospital stay was 3.3 days²⁶. Since in both researches, the surgery was done by a single person, the results of two studies are nearly similar considering the rate of kidney-free stone and the average stay of patients. However, due to the duration of surgery, the results of two researches are

somewhat different which may be due to the age difference among studying the populations (children versus adults) in two studies. Because performing PCNL in children due to their small kidneys and kidney access problems, performing PCNL requires more precision, sensitivity and time than adults.

Conclusion

In children with the kidney stones, renal stone surgery by tubeless PCNL is more successful than the standard method, and the rate of hemoglobin drop, hematocrit drop, frequency of postoperative fever, and length of hospital stay were less than standard PCNL method. However, because all tubeless PCNLs were performed by one surgeon, the surgeon's experience may affect the results observed in this procedure.

Declarations

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Conflict of interest: The authors declare that they have no conflict of interests

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References

- [1] Marshall ,stoller MD .Urinary stone disease in;smith General urology. Email A Tanagho , Jack W.Me Aninch, sanfrancisco, Mc Growhill 2008.pp 246-277.
- [2] Bennett AH, Colodny AH. Urinary tract calculi in children. *J Urol*. 1973;109(2):318-320.
- [3] Stapleton FB. Clinical approach to children with urolithiasis. 1996:389-397.
- [4] Kroovand RL. Pediatric urolithiasis. *Urologic Clinics of North America*. 1997;24(1):173-184.
- [5] Chaussy C, Schmiedt E, Jocham B, Brendel W, Forssmann B, Walther V. First clinical experience with extracorporeally induced destruction of kidney stones by shock waves. *J Urol*. 1982;127(3):417-420.
- [6] Lottmann H, Traxer O, Archambaud F, Mercier-Pageyral B. Monotherapy extracorporeal shock wave lithotripsy for the treatment of staghorn calculi in children. *J Urol*. 2001;165(6 Part 2):2324-2327.

- [7] Orsola A, Diaz I, Caffaratti J, Izquierdo F, Alberola J, Garat J. Staghorn calculi in children: treatment with monotherapy extracorporeal shock wave lithotripsy. *J Urol*. 1999;162(3):1229-1233.
- [8] Woodside JR, Stevens GF, Stark GL, Borden TA, Ball WS. Percutaneous stone removal in children. *The Journal of urology*. 1985;134(6):1166-1167.
- [9] White RH. The epidemiology of venous thromboembolism. *Circulation*. 2003;107(23_suppl_1):I-4-I-8.
- [10] BADAWEY H, SALAMA A, EISSA M, KOTB E, MORO H, SHOUKRI I. Percutaneous management of renal calculi: experience with percutaneous nephrolithotomy in 60 children. *J Urol*. 1999;162(5):1710-1713.
- [11] Jackman SV, Hedican SP, Peters CA, Docimo SG. Percutaneous nephrolithotomy in infants and preschool age children: experience with a new technique. *Urology*. 1998;52(4):697-701.
- [12] Mahmud M, Zaidi Z. Percutaneous nephrolithotomy in children before school age: experience of a Pakistani centre. *BJU international*. 2004;94(9):1352-1354.
- [13] Mousavi-Bahar SH, Mehrabi S, Moslemi MK. The safety and efficacy of PCNL with supracostal approach in the treatment of renal stones. *International urology and nephrology*. 2011;43(4):983-987.
- [14] Mousavi-Bahar SH, Mehrabi S, Moslemi MK. Percutaneous Nephrolithotomy Complications in 671 Consecutive Patients: A Single-Center Experience. *Urology journal*. 2011;8(4):271-276.
- [15] Mousavi-bahar SH, Amirhasani S, Mohseni M, Daneshdoost R. Safety and efficacy of percutaneous nephrolithotomy in patients with severe skeletal deformities. *Urology journal*. 2017;14(3):3054-6058.
- [16] Mousavi Bahar SH, Zargar A, Babolhavaeji H, Mani Kashani KH. The Study of Success Rate of PCNL in Treatment of Renal Calculi in Patients with Congenital Renal Anomaly. *Razi Journal of Medical Sciences*. 2007;14(55):173-179.
- [17] Aghamir SMK, Salavati A, Aloosh M, Farahmand H, Meysamie A, Pourmand G. Feasibility of totally tubeless percutaneous nephrolithotomy under the age of 14 years: a randomized clinical trial. *Journal of endourology*. 2012;26(6):621-624.
- [18] Bilen CY, Gunay M, Ozden E, Inci K, Sarikaya S, Tekgul S. Tubeless mini percutaneous nephrolithotomy in infants and preschool children: a preliminary report. *The Journal of urology*. 2010;184(6):2498-2503.
- [19] Iqbal N, Salman Assad IH, Hassan Y, Khan H, Farooq MA, Akhter S. Comparison of outcomes of tubed versus tubeless percutaneous nephrolithotomy in children: A single center study. *Turkish journal of urology*. 2018;44(1):56.

- [20] Xun Y, Wang Q, Hu H, et al. Tubeless versus standard percutaneous nephrolithotomy: an update meta-analysis. *BMC urology*. 2017;17(1):102.
- [21] Nouralizadeh A, Simforoosh N, Shemshaki H, et al. Tubeless versus standard percutaneous nephrolithotomy in pediatric patients: a systematic review and meta-analysis. *Urologia Journal*. 2018;85(1):3-9.
- [22] Karakoyunlu N, Ekici M, Yesil S, Zengin K, Goktug G, Ozok U. Comparison of complications associated with standard and totally tubeless percutaneous nephrolithotomy according to modified Clavien grading: A multicenter retrospective study. *The Kaohsiung journal of medical sciences*. 2014;30(12):613-618.
- [23] Iqbal N, Assad S, Hussain I, et al. Comparison of outcomes of tubed versus tubeless percutaneous nephrolithotomy in children: A single center study. *Turkish journal of urology*. 2018;44(1):56.
- [24] Mousavi Bahar SHA, Amir Hassani S. PCNL Monotherapy for Staghorn Renal Stone. *Avicenna Journal of Clinical Medicine*. 2006;13(3):39-42.
- [25] Salem HK, Morsi HA, Omran A, Daw MA. Tubeless percutaneous nephrolithotomy in children. *Journal of pediatric urology*. 2007;3(3):235-238.
- [26] Abduvokhidov AA, Mousavi-Bahar SH, Aminov MM, Amirhasani S, Mehrobi S, Sadulloev FS. Multiple tracts tubeless percutaneous nephrolithotomy. *European Urology Supplements*. 2019;18(12):e3639.

Tables

Table 1: Basic information of patients

Parameter	Standard PCNL n (%)	Tubeless PCNL n (%)	P value
History of surgery	7(14.9)	7(17.1)	0.962
Yes	40(85.1)	34(82.9)	
No			
Hydronephrosis Severity	4(8.5)	2(4.9)	0.482
Without	30(63.8)	27(65.8)	
Mild to moderate	13(27.7)	12(29.3)	
Severe			
Location of stone	22(46.8)	16(39.0)	0.736
Right	22(46.8)	23(56.1)	
Left	3(6.4)	2(4.9)	
Bilateral			
Size of stone	14(29.8)	17(41.5)	0.475
<2Cm	26(55.3)	20(48.8)	
≥2Cm	7(14.9)	4(9.7)	
Staghorn			
Tract Number	43(91.5)	38(7.92)	1.00
1	4(8.5)	3(7.3)	
2			

Table 2: Frequency of surgery outcomes in patients under cutaneous nephrolithotomy operation

Parameter	Standard PCNL n (%)	Tubeless PCNL n (%)	P value
Complete Success rate	41(87.2)	41(100)	0.006
Partial Success rate	6(12.8)	0(0)	
blood transfusions	1(2.1)	0(0)	1.000
Re PCNL	6(12.8)	0(0)	0.028
Analgesics Use	13(27.7)	6(14.6)	0.134

Table 3: Hemoglobin and hematocrit decrease, Duration of hospitalization and Operation time in patients operated by nephrolithotomy

Parameter	Standard PCNL Mean±SD	Tubeless PCNL Mean±SD	P value
Hemoglobin decrease, mg/dL	-1.82 ±0.94	-1.30 ±0.98	0.024
Hematocrit decrease, mg/dL	-5.40 ±2.66	-3.52 ±3.11	0.003
Duration of hospitalization, day	3.38 ±1.76	2.46 ±1.27	0.007
Operation time, min	109.30 ±53.27	101.46 ±31.92	0.414