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Percutaneous nephrostomy experience in pediatric patients: comparison of fine and thick needle techniques

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ABSTRACT

Objectives: The aim of this study is to assess the effect of needle size in pediatric percutaneous nephrostomy (PN) placement in terms of complications and success rates.

Methods: Seventy one percutaneous nephrostomies were performed in 51 patients aged 1 month to 18 years (mean 6.03 ± 5.88 years) between May 2012 and March 2020. Demographic data, indication for PN placement, puncture technique (calyceal entry level: upper, middle, lower pole or pelvis) and needle size, anesthesia type (general or local anesthesia), duration of catheter use and complications were retrospectively retrieved from the hospital electronic recording system.

Results: Thirty procedures were performed using a 21 gauge needle and 41 procedures using a 18 gauge needle. There was no statistically significant difference between the two groups in terms of age, gender, degree of hydronephrosis, and calyceal entry level. Technical success and complication rates were similar in two groups ($p = 0.423$).

Conclusions: In the pediatric age group, both 18 and 21 gauge needle techniques can be used safely based on the preference of the interventionalist.

Keywords: Pediatric patient, percutaneous nephrostomy, 18 gauge needle, 21 gauge needle

Percutaneous nephrostomy (PN) is a widely used method for urinary diversion. It has been widely performed in adults after its initial description by Goodwin *et al*. in 1955 [1]. In the pediatric population, it has been started to be performed in the 1980s and continues to be widely used today [1].

In pediatric patients, PN is most often performed in urinary obstruction due to congenital causes or compression by mass lesions. PN can be applied temporarily to preserve kidney function until definitive treatment [2-5]. PN can also be used for functional assessment in hydronephrotic kidneys, temporary urinary diversion in obstructive uropathies or as a bridge to more complex interventions [5, 6].

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PN has a certain different aspects in pediatric patients compared to adults. The procedure is mostly performed under general anesthesia in pediatric patients due to limited cooperation. The close proximity of the kidney to the skin in children makes it easier to access the pelvicalyceal system, however, in newborns, mobility of kidney hinders tract dilatation over small wires [7].

PN in both adult and pediatric patients is usually performed under ultrasonography (US) and fluoroscopy guidance. US-guided thick (18 Gauge) or fine (21 Gauge) needles can be used to access the pelvicalyceal system. The use of a larger gauge size is the easiest approach in large collector systems [7]. Increased renal parenchyma stiffness in non-dilated collecting systems makes the fine needle method easier [5].

Our aim in this study is to assess the effect of needle size in pediatric PN placement in terms of complications and success rates.

METHODS

The Institutional Review Board approved the study protocol. Due to the retrospective and anonymous nature of this study, informed consent was waived. Between May 2012 and March 2020, 51 patients underwent PN in our interventional radiology department. Patient data were evaluated retrospectively. Demographic data, indications for PN, puncture technique (calyceal entry level: upper, middle, lower pole or pelvis) and needle size, size of catheter placed, anesthesia type (general or local anesthesia), duration of catheter use and complications were recorded. Placement of an appropriately sized catheter to ensure adequate drainage was considered as technical success [6].

The degree of hydronephrosis was assessed based on the US examinations obtained prior to the procedure. Hydronephrosis grading was performed according to the Society for Fetal Urology guidelines: Grade 0, no expansion; grade 1, slight enlargement of the pelvis without enlargement in calyxes; grade 2, enlargement of the pelvis and major calyxes; grade 3, grade 2 without parenchymal changes and enlargement of minor calyxes; grade 4, grade 3 and thinning in the parenchyma [8].

All patients' parents were informed in detail about the procedure and consent was obtained for each procedure. Complete blood count and coagulation parameters (International normalized ratio [INR] < 1.5 and Platelet count > 50,000/μL) were checked prior to procedures. All patients received 25 mg/kg ampicillin one hour before the procedure as prophylaxis. PN procedure was performed under local or general anesthesia. The 18 and 21 gauge needle selection was made based on the preference of interventionalists.

Fine Needle Technique (21 Gauge)

A 21 gauge fine needle was used to access the kidney collecting system under US guidance and usually preferred lower pole calyx. The collecting system was opacified by injecting contrast material through the needle. If calyceal access was achieved, 0.018" microwire was sent through the needle, and a 6F coaxial access was advanced over the wire. In the second stage, a 0.035" or 0.038" thicker guidewire with a stiff body was placed. Gradually the entry tract was dilated over this wire with dilators of appropriate diameter for nephrostomy catheter placement.

Thick Needle Technique (18 Gauge)

An 18 gauge needle was inserted under US guidance into the collecting system usually from a lower point by targetting the lower pole of the kidney. The collecting system was opacified by injecting contrast material from the needle. The needle was removed after inserting a guidewire with a diameter of 0.035" or 0.038". The nephrostomy catheter was placed through the wire by dilating the entrance tract according to the diameter of the catheter.

Statistical Analysis

Shapiro-Wilk test was used to check the normal distribution of the data. Descriptive statistics were expressed as mean ± standard deviation or median (minimum-maximum) for continuous variables and frequency for categorical data. For non-normally distributed data, Mann Whitney U test was used for two-group comparisons. Pearson Chi-square test and Fisher's exact Chi-square test were used for the analysis of categorical data. Duration of catheter use without complications was estimated by considering the time until a complication occurs based on Kaplan Meier analysis. The significance level was determined to be $\alpha = 0.05$. Statistical analysis was performed

using IBM SPSS 23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.)

RESULTS

A total of 71 PN procedures were performed in 51 patients (32 boys, 19 girls). Mean age was 1 month-18 years (mean 6.03 ± 5.88 years). Fine needle technique was used in 30 procedures, and thick needle technique was used in 41 procedures. Fifty-nine procedures were performed under general anesthesia and 12 procedures were performed under local anesthesia. Seventy procedures (70/71; 98.6%) were technically successful. The most common indication for catheter placement was ureteropelvic junction (UPJ) stenosis (13/71; 18.3%). Other PN placement indications are given in Tables 1 and 2.

Table 1. Patient demographic data and PN indications

Patient characteristics	N = 51
Age	6.03 ± 5.88
Gender	
Male	32
Female	19
Indications	
UPJ stenosis	11
Postoperative anastomotic strictures	8
UVJ stenosis	8
Obstruction due to urinary stone	7
Obstruction due to mass compression	5
Neurogenic bladder	3
Vesicoureteral reflux	3
PUV	2
Ureteral injury	2
Urinary fistula to the skin	1
Urinary trauma	1

Descriptive statistics are specified as mean, standard deviation, minimum and maximum for quantitative data; frequency for qualitative data.

UPJ = Ureteropelvic junction, UVJ = Ureterovesical junction, PUV = Posterior urethral valve, PN = Percutaneous nephrostomy

The mean duration of catheter dwell time was 34.3 ± 32.9 (1-148) days. Other data related to the procedures are given in detail in Table 2.

There was no statistically significant difference be-

Table 2. Procedural data

Procedure data	n = 71
Anesthesia type	
Local	12
General	59
Technical success	
Successful	70
Failure	1
Indication	
UPJ stenosis	13
Postoperative anastomotic strictures	11
UVJ stenosis	9
Obstruction due to urinary stone	8
Obstruction due to mass compression	8
Neurogenic bladder	5
Vesicoureteral reflux	5
PUV	5
Ureteral injury	5
Urinary fistula to the skin	1
Urinary trauma	1
Hydronephrosis	
Absent	5
Grade 1	0
Grade 2	16
Grade 3	37
Grade 4	13
Level of entry	
Upper pole	4
Middle pole	22
Lower pole	30
Pelvis	15
Duration of catheter use	34.3 ± 32.9 (1-148)

Descriptive statistics are specified as mean, standard deviation, minimum and maximum for quantitative data; frequency for qualitative data.

UPJ = Ureteropelvic junction, UVJ = Ureterovesical junction, PUV = Posterior urethral valve

Table 3. Statistical comparisons of procedures with fine and thick needle methods

Procedure Data	Fine Needle (n = 30)	Thick Needle (n = 41)	*p* value
Age(years)	4.5(0.1-18.0)	6.0(0.1-17.0)	0.766[1]
Gender			
Male	22	21	0.060[2]
Female	8	20	
Type of anesthesia			
Local anesthesia	8	4	0.060[2]
General anesthesia	22	37	
Technical success			
Successful	29	41	0.423[3]
Unsuccessful	1	0	
Hydronephrosis			
Absent	5	0	0.063[3]
Grade 1	0	0	
Grade 2	6	10	
Grade 3	14	23	
Grade 4	5	8	
Level of entry			
Upper pole	2	2	0.098[3]
Middle pole	8	14	
Lower pole	17	13	
Pelvis	3	12	
Indication			
UPJ stenosis	7	6	0.141[3]
Postoperative anastomotic strictures	5	6	
UVJ stenosis	3	6	
Obstruction due to urinary stone	2	6	
Obstruction due to mass compression	3	5	
Neurogenic bladder	2	3	
Vesicoureteral reflux	0	5	
PUV	5	0	
Ureteral injury	2	3	
Urinary fistula to the skin	1	0	
Urinary trauma	0	1	

Descriptive statistics are specified as mean, standard deviation, minimum and maximum for quantitative data; frequency for qualitative data.

[1]Mann Whitney U test

[2]Pearson Chi-Square test

[3]Fisher's exact chi-square test

UPJ = Ureteropelvic junction, UVJ = Ureterovesical junction, PUV = Posterior urethral valve

tween the two groups in terms of age, gender, degree of hydronephrosis, and calyceal entry levels (Table 3). There was no statistically significant difference in technical success rate between the two techniques (p = 0.423).

No major complications were encountered. Minor complications were seen in 13 procedures: Dislocation (7 procedures), leakage (4 procedures), infection (1 procedure), and obstruction (1 procedure). Apart from these, 6 patients had temporary hematuria, and these patients recovered without additional treatment or intervention.

Based on Kaplan Meier analysis, the mean duration of the catheter use without complications was 95 ± 15.9 days. No complications occurred in 82.7% of patients at the end of the first month, and 51.4% of patients at the end of 3 months (Fig. 1).

DISCUSSION

PN is a frequently performed procedure since it can be applied easily, quickly, and safely. However, in the pediatric age group, especially in newborns and infants, the procedure can be technically challenging when compared to adults or the rest of pediatric patients [5]. The kidney is mobile in newborns and infants, making it difficult to perform tract dilation [7]. In addition, smaller kidney sizes compared to adults and older children poses technical difficulties. Generally, two methods are used to access the renal calyx in interventions performed with a combination of US and fluoroscopy guidance. The fine needle method, is generally more widely preferred by physicians [7]. Especially in non-dilated systems, this method is more preferable as there is less damage to the kidney. The thick needle method is more widely adopted in patients with significant hydronephrosis and has the advantage of decreased procedure times [5].

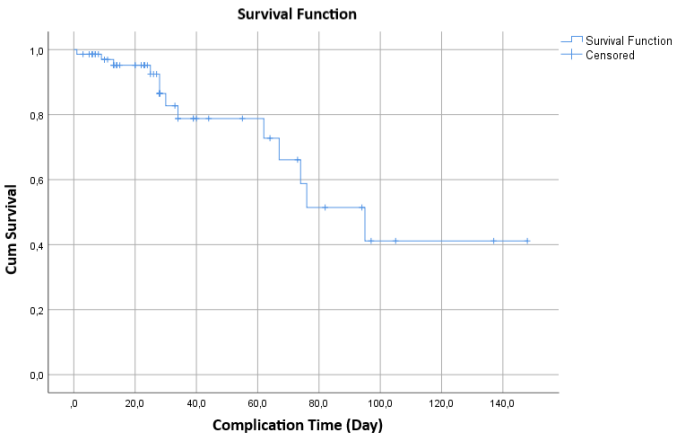

Fig. 1. The mean duration of the catheter use

Koral *et al*. [5] reported that the fine needle technique is advantageous in non-dilated systems and the thick needle technique in patients with ureteropelvic stenosis in their study on newborns and infants. They also reported that the procedure time of thick needle technique was statistically significantly shorter than the fine needle method [5]. In our study, fine and thick needle techniques were compared among groups that had similar variables like age, indication, degree of hydronephrosis, and calyceal entry level that may affect the final technical. Statistically, both methods were not different from each other in terms of technical success. We think that both methods can be adapted in pediatric patients with different indications.

Temporary minor hematuria occurs in approximately 95% of cases and is not considered a complication [9]. Serious bleeding requiring transfusion has been reported in 1-4% of patients [6]. In this study, we did not encounter any patient with hematuria requiring transfusion. Six patients had mild hematuria after the procedure, and these patients recovered without need for additional treatment.

Catheter dislocation poses a problem in young children and infants because providing adequate care in this age group can be challenging [10, 11]. In previous studies, the dislocation rate in the pediatric population has been reported between 1 and 14% [10-12]. In our study, the dislocation rate was (7/71; 10%). Providing adequate fixation and educating parents about catheter care can help to prevent this complication.

In this study, urinary tract infection was encountered only in one patient. Procedure-related sepsis rates have been reported as 0-5% in previous studies [3, 4, 10, 13]. In this study, we did not have any patients progressing to sepsis.

A multicenter study by Shellikeri *et al*. [14] done in 441 pediatric patient groups reported that 75% of patients in 37 days and 50% of patients in 89 days did not develop any complications . In this study, no complications developed in 82.7% of patients in the first month and 51.4% of patients at the end of 3 months. In both our study and the study by Shellikeri *et al*. [14], approximately half of the patients developed

complications after 3 months. Therefore, catheter replacement can be scheduled every 3 months.

Limitations

This study had some limitations including, a limited number of patients, heterogeneous distribution of indications, and retrospective nature. Future studies can be planned to compare the success rates of both techniques in wider and more homogeneous patient groups.

CONCLUSION

Percutaneous nephrostomy can be performed in the pediatric population with low complication and high success rate. Regardless of age, indication, degree of hydronephrosis and entry level, fine and thick needle techniques can be performed successfully based on the preference of the interventionalist.

Authors' Contribution

Study Conception: ÖFN, MFÖ, SC, SGK, CB, MFİ, GÖ, CE; Study Design: ÖFN, MFÖ, SC, SGK, CB, MFİ, GÖ, CE; Supervision: ÖFN; Funding: ÖFN, MFİ, CE; Materials: ÖFN, MFİ, CE; Data Collection and/or Processing: ÖFN, SC; Statistical Analysis and/or Data Interpretation: GÖ; Literature Review: MFÖ; Manuscript Preparation: ÖFN, MFÖ and Critical Review: ÖFN.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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