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Özgün Araştırma / Original Research

Percutaneous Nephrostomy Catheter Insertion Through Ultrasound Guided Direct Punction in Pediatric Patients

Pediatrik Hastalarda Ultrason Kılavuzluğunda Direkt Ponksiyon ile Perkütan Nefrostomi Kateteri Yerleştirilmesi

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Özet

Amaç: Çalışmamızda pediatrik hastalara, US kılavuzluğunda, kontrast madde ve x ışını kullanmaksızın, anestezi süresini kısaltarak perkütan nefrostomi (PN) kateterinin trokar yöntemle yerleştirilmesinin etkinliğini ve avantajlarını değerlendirmeyi amaçladık.

Gereç ve Yöntemler: Bu çalışma Eylül 2016 ve Aralık 2019 tarihleri arasında 41 hastada toplam 48 PN yerleştirilmesini kapsamaktadır. Hastaların tıbbi kayıtları retrospektif olarak incelenip anestezi ve prosedür süreleri, komplikasyonlar, hastanede kalış ve kateterizasyon süreleri, tedavi öncesi ve sonrası kan üre ve kreatin düzeyleri değerlendirilmiştir.

Bulgular: PN yerleştirilen hastaların %36,59 u (n15) kadın, %63,41' i (n 26) erkekti ve yaşları 1 gün ile 2100 gün (70 ay) arasında değişmekte idi. Nefrostomi kateteri yerleştirilen böbreklerin %35,42 (n 17) grade 2 hidronefroz, % 64,58inde (n31) grade 3 hidronefroz bulunmaktaydı. Tüm işlem ilk seansta başarı ile gerçekleştirildi (%100). Teknik başarıya ek olarak, serum üre, kreatinin ve lökosit düzeylerinde azaltma ile klinik başarıda gözlemlendi. Majör komplikasyonlar hiçbir olgumuzda gerçekleşmemiştir. İşlemden sonra 25 hastada (%52,08) ilk 24 saatte kendini sınırlayan hafif hematüri olmuştur.

Sonuç: US eşliğinde trokar yöntemle PN sunduğu avantajlardan biri anestezi süresinin kısalması, genel anestezi ihtiyacının kalmaması dolayısı ile anesteziye bağlı birçok komplikasyonun

Abstract

Objetive: In this study, we aimed to evaluate the efficiency and advantages of percutaneous nephrostomy (PN) catheter insertion through the trocar method in pediatric patients with US guidance and without using contrast matter and X-ray.

Material and Methods: This study included a total of 48 PN insertions in 41 patients between September 2016 and December 2019. Medical records of the patients were retrospectively assessed and anesthesia and procedure durations, complications, hospitalization and catheterization durations, and pre and post-treatment blood urea and creatinine levels were evaluated.

Results: Of the PN inserted patients, 36.59% were female (n=15) and 63.41% (n=26) male with ages changing between 1 day and 2100 days (70 months). Of the nephrostomy installed kidneys, 35.42% (n=17) had grade II and 64.58% had (n=31) grade III hydronephrosis. The whole operation was successfully performed in the first session (100%). In addition to the technical success, clinical success was also observed with the decrease in serum urea, creatinine and leukocyte levels. None of our cases had major complications. During the first 24 hours of postoperative period, 25 patients (52.08%) had self-limiting mild hematuria.

Conclusion: Shortened anesthesia duration, non-requirement of general anesthesia and thus minimization of many anesthesia-related complications constitute one of the advantages provided

This study was approved by Ethics Committee of Necmettin Erbakan University (Approval number: 2020/2307). All research was performed in accordance with relevant guidelines/regulations, and informed consent was obtained from all participants.

en aza indirilmesidir. US eşliğinde trokar yöntemle PN seçilmiş hastalarda güvenilir, kolay, düşük maliyetli ve hızlı bir yöntemdir, komplikasyon oranları düşük olup başarı oranları yüksektir.

Anahtar Kelimeler: Perkütan Nefrostomi, Ultrason Kılavuzluk, Pediatrik Hastalar

by US-guided trocar method PN. US-guided trocar method PN is a reliable, easy, low-cost and quick method in selected patients with low rates of complication and high rates of success.

Keywords: Percutaneous Nephrostomy, Ultrasound Guided, Pediatric Patients

INTRODUCTION

Percutaneous nephrostomy (PN) is an invasive operation rarely applied in newborns and infants. It provides temporary urinary diversion until a certain intervention is possible and aims to protect renal functions. While urolithiasis and malignity are commonly observed in adult age groups, congenital urinary system anomalies are more common in pediatric patients. The most common indications for PN in the pediatric age group are ureteropelvic junction stenoses, ureterovesical junction stenoses, posterior urethral valves, megaureter and obstruction following pyeloplasty, vesicoureteral reflux, stone disease, tumoral blockage, pelvicalyceal system drug applications (antifungal treatment and complex urinary tract infections) [1-4]. Kidneys of the children are more close to the skin surface and dilatation degree is generally extreme, which makes the determination of a large calyx easier for access. However, kidneys are more mobile in pediatric patients and surrounding supportive tissue is less, so; more attention should be paid when inserting a drainage catheter to the collecting system [5-7]. The procedure requires sedation or anesthesia. Different complications such as procedure-related bleeding, pelvic injury, or anesthesia-related airway obstruction and blood pressure irregularities may occur. Anesthesia procedure can be more difficult especially in newborns than adults due to sedation, anesthesia, or post-operative follow-up related factors [8]. In the standard Seldinger technique, the collecting system is accessed with access needle, monitored under fluoroscopy, and then nephrostomy catheter is inserted after serial dilatations [9]. In our study, we aimed to evaluate the efficiency and advantages of US-guided percutaneous nephrostomy catheter insertion through the trocar method in pediatric patients without following all the stages in the Seldinger method or using contrast matter and X-ray and by shortening the anesthesia duration.

MATERIAL AND METHODS

Our study was performed in line with the ethical principles approved by the local ethics committee (Approval number: 2020/2307). The advantages and complications of the procedure were explained to the parents of all patients who were inserted percutaneous nephrostomy and their informed consent was obtained.

48 PNs were inserted in 41 patients with ages between 1 day and 2100 days (70 months) between September 2016 and December 2019. Medical records of the patients were evaluated retrospectively. Pre and post-treatment blood urea and creatinine levels were evaluated with complete blood counts and urinary analyses were evaluated with bladder urinary culture. Laboratory tests were repeated after PN.

The patients who did not take suitable antibiotics an hour before the procedure were intravenously given 40-50 mg/kg cefazolin. All operations were performed under an average degree of sedoanalgesia given by an external anesthesia team and the local anesthetic we administered. Ketamine (Ketalar 500mg, Pfizer), fentanyl (fentanyl 0.05 mg/ml Johnson&Johnson), and midazolam were used for sedation. Local anesthesia was provided with jetocaine (jetocaine 2 ml) or prilocaine (citanest) [8]. Oxygen was given through a nasal canula to in all patients who were constantly observed with a pulse oximeter.

The procedures were performed using 5-10 MHz linear probes of Samsung and Siemens antrares US devices. Bioteq (Bioteq, Taipei, Taiwan) and argon (SKATER™ All-Purpose, Nephrostomy&Biliary Drainage Catheters) brand 6 and 8F nephrostomy catheter. In the US-guided trocar method, all interventional operations were performed by a single interventional radiologist with an experience of 15 years.

The patients were positioned in a 30-degree oblique prone position with a support under the abdomen and the corresponding side was cleaned and covered.

Following the kidney monitorization on a long axis through the US, lower pole or medium section posterior calyx was accessed through posterolateral transparenchymal (Brödel's line) tract under local anesthesia and sedoanalgesia. Inner mandren was removed after passing the parenchyma and reaching minor-major calyx, urine arrival was validated through aspiration from the catheter set and the catheter was advanced towards renal pelvis through a metal hardener. The catheter was locked and left for bag drainage following skin fixation after observing that it reached to the renal pelvis and took pigtail form (Figure 1 a, b, c, d).

Periods between anesthesia application and recovery and between local anesthesia application and nephrostomy catheter fixation on the skin were recorded.

All patients were performed antegrade pyelography under elective conditions 12-24 hours later to clarify obstruction etiology (Figure 2 a, b).

RESULTS

48 PNs were inserted in 41 patients between September 2016 and December 2019. Of the patients, 36.59% were females (n=15) and 63.41% (n=26) were males aged between 1 day and 2100 days (70 months). Of the nephrostomy catheters, 41.66% (n=20) were inserted in the left kidney, 29.16% (n=14) in the right kidney and 29.16% (n=14) in both kidneys. Of the nephrostomy installed kidneys, 35.42% (n=17) had grade II and 64.58% (n=31) grade III hydronephrosis. The rate of the patients who had urinary tract infection was 33.33% (n=16). Indications for PN were presented in Table 1.

The operation was successfully performed in the first session (100%). In addition to the technical success, clinical success was also observed with the decrease in serum urea, creatinine and leukocyte levels (Table 2).

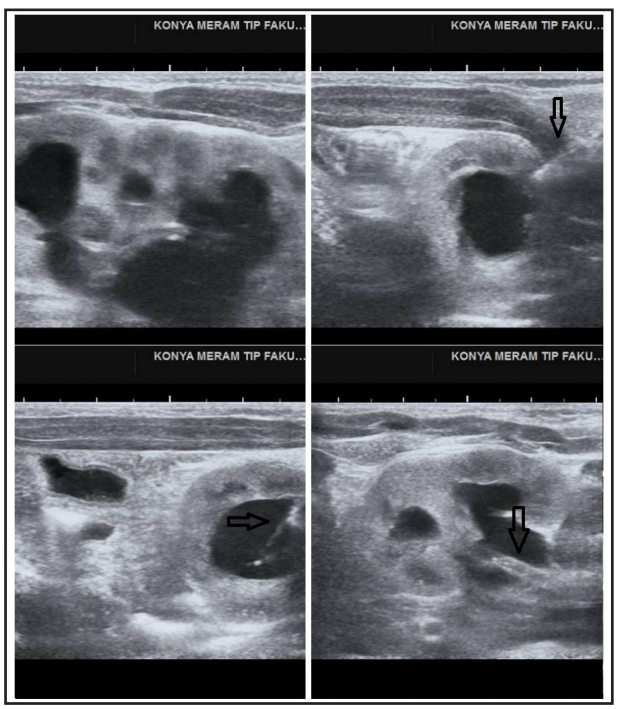

Figure 1 a,b,c,d. Grade 3 ectasia is observed in the sagittal plane in the kidney based on US image (a), US guided drainage catheter was advanced to the collecting system through trochar method (arrow) (b), after observing through US that the catheter end entered the collecting system (arrow), inner mandren was removed and urine coming from catheter was confirmed (c) and the catheter was positioned in renal pelvis through metal hardener (arrow) (d).

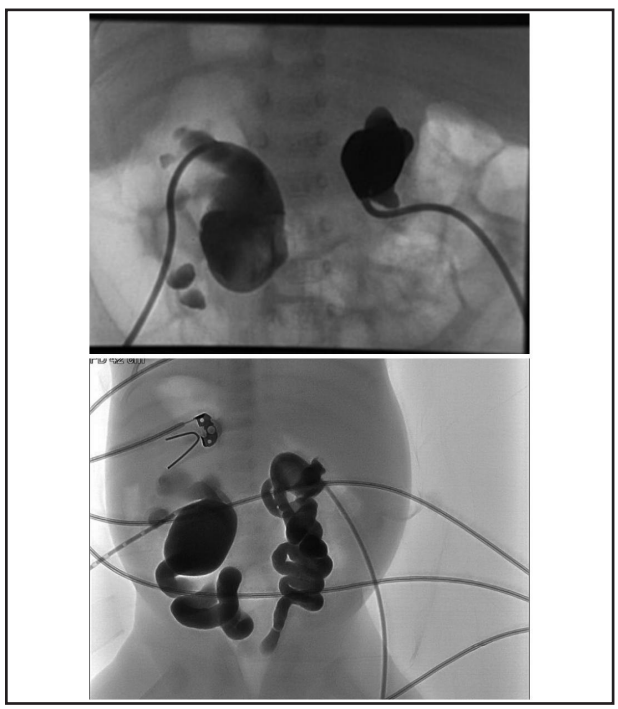

Figure 2a,b. US guided nephrostomy catheters were inserted in both kidneys of the patient who had UP stricture on both sides. UP stricture is observed in antegrade pyelography acquired one day after the operation (a). US guided nephrostomy catheters were inserted in both kidneys of the patient who had UV stricture on both sides. UV stricture and partial double collecting system were observed in antegrade pyelography acquired one day after the operation(b).

Table 1. Indications for PN

Diagnosis				
Diagnosis	**Frequency**	**Percent**	**Cumulative Frequency**	**Cumulative Percent**
Ureteropelvic stricture	26	54.17	26	54.17
Ureterovesical stricture	10	20.83	36	75.00
Ureteral valve	2	4.17	38	79.17
Ambiguous genitalia	2	4.17	40	83.33
Vesicoureteral reflux	6	12.50	46	95.83
Abscess	1	2.08	47	97.92
Stone	1	2.08	48	100.00

Table 2. Serum markers for patients who were applied PN

Label	N	Mean	Std Dev	Median	Lower Quartile	Upper Quartile
preoperative urea	48	32.94	38.86	19.70	11.90	29.30
preoperative creatine	48	0.64	0.44	0.48	0.39	0.75
preoperative blood leukocyte	48	11.36	3.44	11.15	9.29	13.45
postoperative urea	48	19.76	16.01	14.90	11.45	23.40
postoperative creatine	48	0.51	0.32	0.43	0.34	0.59
postoperative blood leukocyte	48	10.73	4.06	10.15	7.83	12.40

The patients recovered on an average of 15 minutes after the anesthesia was started. PN insertion and its fixation on the skin lasted five minutes on average.

None of the cases had major bleeding findings such as perinephric hematoma or hematoma in the pelvicalyceal system, major complications such as renal pelvis rupture, and neighboring organ injury. After the operation, 25 patients (52.08%) had self-limiting mild hematuria in the first 24 hours. There were no patients who developed transfusion that required massive hematuria. Catheter malposition was not detected in any of the patients. Two patients (4.16%) who were responsive to antibiotic treatment had an infection.

Mean catheterization duration changed ranged from three to 180 days. Catheters were changed in the third month in long-term catheterization and nine of the patients (18.75%). Five of the patients (12.19%) had catheter infection and their catheters were changed without waiting for three months. Three patients (7.31%) removed their nephrostomy catheter by mistake at home or in the hospital. The opaque matter was given through the removed catheter tract and fistulography was acquired. The collecting system was monitored and recatheterization was provided by reaching the collecting system with the catheter. Guidewire manipulations through the fistula tract and re-access with a needle were not required in all of these patients.

DISCUSSION

Newborns and children have different kidney dimensions, structures and structures of surrounding tissues than adults. Kidneys are much closer to the skin surface due to less perirenal fatty tissue and subcutane-

ous fatty tissue in the pediatric age group. Parenchyma is usually very thin and provides less resistance and support. Dilatation degree is generally extreme in case of blockage, which makes it easier to find a large accessible calyx, however; the operation area is too small and it is difficult to position the guidewire in the ureter in case of UP structure. Urine extravasation to perirenal zone, quick disappearance of the collecting system tension, and damaging of the thin renal pelvis due to forcing during dilatation are possible in serial dilatations. The catheter can be mislocated in the extrarenal zone in case of a renal pelvis which lost tension. So, there are some differences in the procedures performed on children and adults [5-7].

A limited number of studies were performed on PN in the pediatric age group. High success rates of the procedures are the most interesting aspect of these studies [1-8, 10]. In line with the literature, we obtained successful results from all patients in our study, which we think resulted from the inclusion of only grade II-III and IV hydronephrosis patients.

PN procedure can be applied through different techniques. In the classic Seldinger technique, the renal collecting system is accessed with US-guided 17 gauge needle (geotec) and monitored with the opaque matter after observing urine arrival and obtaining a sample. Serial dilatations are performed after inserting 0.035-38 guidewire through a needle in the collecting system and if possible, in the ureter. The catheter is positioned in the renal pelvis through the guidewire, control nephrograms are taken and the catheter is fixed on the skin and the procedure is ended with bag drainage [9]. There is another technique similar to the Seldinger technique in which double needles are used. However, after reaching the collecting system, air or contrast matter is injected to visualize the rear calyx and this calyx is re-entered through US and fluoroscopy and the catheter is positioned in the renal pelvis in a way resembling catheter single needle technique [11]. We inserted catheters with US-guided trocar method in all patients in our study. The duration of the operation was shortened because we did not facilitate most of the steps in the Seldinger method. So, the duration of anesthesia and complication rates, which are riskier for the pediatric age group, were decreased. Lack of access needle, guidewire, micropuncture set, dilatators and contrast matter lowered the operation cost considerably. Our perirenal collection and hematoma risks were minimized as a result of the lack of serial dilatations.

PN is mostly performed under ultrasound and/or fluoroscopic guiding and rarely under CT or MR guided nephrostomy. All three techniques were applied with extremely high success rates. [12-14]. The ultrasound-guided operation had advantages such as the lack of ionizing radiation and contrast matter, portability of ultrasonography and a shorter duration of procedure and anesthesia. Ultrasound-guided nephrostomy insertion is usually more simple in children than adults as kidney monitorization is generally easier and superficial high-frequency probes are preferred over low-frequency convex probes used in adults [4, 5, 8, 13]. Serial dilatations through guidewire, which may become complex, are sometimes difficult as the kidney is mobile in newborns [3, 4, 7]. The fact that the kidney lacked a deep location provided us the opportunity to use high-frequency superficial probes and follow the catheter easily at each stage.

The use of the US as a guided imaging method also prevents the ionizing radiation the child experiences. Considering that even low doses of radiation pose a risk in the pediatric age group, radiation exposure should be avoided due to the known cumulative effect [14-16]. All PN procedures in our study were performed under US guidance without radiation. Diagnostic antegrade images were acquired in a minimum of 12-24 hours after the operation. Thus, hematoma, which may form due to the procedure in the kidney collecting system; regressed and more informative images were acquired. The pressure of the collecting system was lowered and monitoring related pyelotubular reflux and the possibility of sepsis decreased in pyelonephritis patients.

Nephrostomy insertion in adults can be performed sometimes only under local anesthesia and mostly under sedation or general anesthesia. However, because children are less compatible, sedation or general anesthesia is always required [8, 17]. We operated under general anesthesia and a medium level of sedoanalge-

sia in all patients. The sedation was started by an experienced anesthesiologist. Stabilization of the intubation tube and the respiratory control is difficult in a newborn and child lying in a supine position with a 30-degree slope. General anesthesia was not required in any of our patients. We injected a local anesthetic agent in the access region immediately after the starting of sedation, so, there was less requirement of sedoanalgesia. Approximate mean time we spent for quick catheter insertion through US-guided trocar method and for the provision of skin fixation was five minutes. General anesthesia was not required and there were no general anesthesia-related complications. Our results showed that the PN procedure can be performed without general anesthesia. We believe that effective sedation and anesthesia infiltration can be used in patients to prevent potential complications caused by general anesthesia.

Some studies reported major complications such as hemorrhage, vascular damage, septic shock; renal pelvis rupture, catheter disposition; perirenal collection, failed drainage related pyelonephritis, urinary leakage; kidney failure and death at different rates [3, 6, 10]. Complications with low possibilities such as intestinal perforation and pneumothorax, empyema, hydrothorax and hemothorax were also mentioned in literature [18, 19]. Mild hematuria disappearing in the first 24 hours was the most commonly observed complication in our study (n=25, 52.08%). None of our cases had transfusion requiring massive bleeding. Sepsis risk is highly significant in stone-related pyonephrosis [5]. Antibiotic treatment was effective in two patients with mild infection findings after the operation. None of our patients had sepsis.

Ureteropelvic junction and ureterovesical junction stenosis were reported as the most common indications with an approximate rate of 87% in PN cases in the pediatric age group [1, 6, 8, 16]. The indications in our study (75%) were in line with the literature. The duration of PN ranged from three to 120 days based on etiology. Pediatric surgeons waited to perform the surgical operations in newborns, infants and pre-school children with very low body mass indexes and body weights. During this period, three patients experienced spontaneous catheter removal or disposition at home. The patients received opaque matter through the catheter tract and after monitoring the collecting system, the catheter was inserted from the fistula tract without entering the new collecting system.

Exclusion of the patients with grade zero and I dilatation from our study increased the success of our procedure while also being a limitation of our study. Not using a catheter much thicker than the needle prevented repetitive intervention and it should only be applied by doctors with adequate experience.

CONCLUSION

Newborns and children have different kidney dimensions, structures and structures of surrounding tissues than adults. Kidneys are much closer to the skin surface due to less perirenal fatty tissue and subcutaneous fatty tissue in the pediatric age group. Parenchyma is usually very thin and provides less resistance and support. Dilatation degree is generally extreme in case of blockage, which makes it easier to find a large accessible calyx, however; the operation area is too small and it is difficult to position the guidewire in the ureter in case of UP structure. Urine extravasation to perirenal zone, quick disappearance of the collecting system tension, and damaging of the thin renal pelvis due to forcing during dilatation are possible in serial dilatations. The catheter can be mislocated in the extrarenal zone in case of a renal pelvis which lost tension. So, there are some differences in the procedures performed on children and adults [5-7].

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system and if possible, in the ureter. The catheter is positioned in the renal pelvis through the guidewire, control nephrograms are taken and the catheter is fixed on the skin and the procedure is ended with bag drainage [9]. There is another technique similar to the Seldinger technique in which double needles are used. However, after reaching the collecting system, air or contrast matter is injected to visualize the rear calyx and this calyx is re-entered through US and fluoroscopy and the catheter is positioned in the renal pelvis in a way resembling catheter single needle technique [11]. We inserted catheters with US-guided trocar method in all patients in our study. The duration of the operation was shortened because we did not facilitate most of the steps in the Seldinger method. So, the duration of anesthesia and complication rates, which are riskier for the pediatric age group, were decreased. Lack of access needle, guidewire, micropuncture set, dilatators and contrast matter lowered the operation cost considerably. Our perirenal collection and hematoma risks were minimized as a result of the lack of serial dilatations.

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Conflict of interest

All authors declare no conflict of interest.

Financial Disclosure

The authors have declared no financial support.

Ethical Approval

The study was approved by the Ethics Committee of Necmettin Erbakan University (Approval number: 2020/2307) and written informed consent was received from all participants. The study protocol conformed to the ethical guidelines of the Helsinki Declaration.

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