Aims: The conventional Seldinger and trocar techniques of percutaneous nephrostomy (PCN) have inherent limitations in infants and younger children. We studied the role of a novel coaxial technique of PCN in children under the age of 5 years in comparison to the conventional techniques.

Materials and Methods: This was a single-center feasibility trial based on 24 consecutive patients \((n = 24\) kidneys) under the age of 5 years, conducted over 12 months, substratified into Group I \((n = 10\): PCN with conventional Seldinger \((n = 2)\) and trocar \((n = 8)\) techniques and Group II \((n = 14):\) PCN with proposed coaxial technique. In the proposed technique, catheter was inserted through the bore of a 14-G needle. The observation parameters included successful placement of PCN into the renal pelvis with free drainage of urine, number of needle punctures, duration of procedure, need for fluoroscopy, and procedural complications.

Results: Proposed technique was successful in all cases with single-needle puncture, while conventional techniques were successful in 8/10 (80%) cases with multiple needle punctures required in 3/10 (33.3%) cases \((P = 0.163\) and 0.059, respectively). Proposed technique was associated with lower median procedure time (6 min vs. 10.5 min; \(P < 0.001\)) and lower incidence of fluoroscopy use (0/14, 0% vs. 5/10, 50%; \(P = 0.006\)) than the conventional techniques. No complications were seen with either technique.

Conclusion: The proposed coaxial technique is a feasible alternative to the conventional techniques of PCN in young children. It reduces the procedure time and the need for fluoroscopy in these patients.

Keywords: Interventional radiology, pediatrics, percutaneous nephrostomy, ultrasonography
of the puncture needle.[6-7] Subsequently, two methods, namely the Seldinger technique and the trocar technique, evolved to become the most common techniques used in the current practice. In the Seldinger technique, which is considered the standard technique, the PCS is punctured using a micropuncture needle followed by serial dilatation of the tract over a guidewire until it is wide enough for the catheter of desired caliber to be inserted. With every attempt at tract dilatation, there is progressive decompression of the PCS. Children have a small-sized PCS, and there is a possibility of loss of access following collapse of the PCS.[8-10] Contrarily, the single-step trocar technique involves the use of a puncture needle with sheathed catheter.[10] However, the PCS has to be sufficiently dilated for the needle and the catheter to enter into it, which may not be possible in young children given the small size of the kidneys.

With this background, we studied the role of a novel coaxial technique of PCN in children under the age of 5 years in comparison to the conventional techniques.

Materials and Methods

A single-center feasibility trial was conducted over 12 months (August 2017–August 2018) after obtaining approval from the institute ethics committee. All consecutive patients under the age of 5 years who were referred for PCN were included in the study. The study population consisted of 24 patients (n = 24 kidneys), who were divided into two groups: study Group I – PCN using the conventional techniques and study Group II – PCN using the proposed coaxial technique.

The initial 10 patients (n = 10 kidneys) recruited were included in Group I and the 14 patients (n = 14 kidneys) recruited later were included in Group II.

The prerequisites for the procedure were written informed consent of legally acceptable representatives of the child, international normalized ratio <1.5 and availability of anesthetist for sedation or general anesthesia during the procedure.

Technique

All procedures were performed under general anesthesia in prone position with ultrasound guidance using an Acuson X300 ultrasound machine (Siemens Healthcare, Erlangen, Germany) by a radiologist with 6 years of experience in interventional pediatric radiology. Breath hold was not performed on any of the patients. The puncture of renal parenchyma and the PCS was performed during the phase of end-expiration, when the movement of the kidney was minimal. The procedures were done in an Artis zee fluoroscopy suite (Siemens Healthcare, Erlangen, Germany), so that fluoroscopy guidance could be used whenever necessary. In all cases, a 5-F angiographic pigtail catheter (Cook Medical LLC, Indiana, USA) was used for drainage.

Conventional techniques

Conventional techniques involved the use of either the trocar technique or the Seldinger technique. In the trocar technique, a 5-F pigtail catheter was cut to an appropriate length and sheathed over the 18-G puncture needle of the pigtail catheter set. The assembly was then used to puncture the PCS under ultrasound guidance. Once the access was gained, the inner needle was kept stable while the outer sheath was advanced into the PCS. The needle was finally withdrawn while the catheter was left in the PCS.

In children in whom the thickness of the renal parenchyma was normal, the Seldinger technique was performed using a PCN catheter set. The PCS was punctured using an 18-G puncture needle, following which a 0.035” guidewire was inserted. After serial tract dilatation with 4-F and 5-F dilators, the 5-F pigtail catheter was deployed over the guidewire.

Proposed coaxial technique

The PCS was punctured with a 14-G puncture needle of a core biopsy needle set (Cook Medical LLC, Indiana, USA) under ultrasound guidance. After confirming access into the system, the inner stylet of the needle was withdrawn and removed. Subsequently, the 5-F pigtail catheter was passed through the bore of the outer needle. The hub of the pigtail catheter was cut to remove the outer needle, following which the cut hub of a 7-F infant feeding tube was snugly fit into the cut end of the puncture needle. Subsequently, the inner stylet of the needle was inserted into the cut end of the infant feeding tube until the hub reached the hub of the pigtail catheter. Finally, the infant feeding tube was removed, leaving the pigtail catheter in the PCS.
of the pigtail catheter and secured using elastic adhesive bandage [Figures 2 and 3].

**Postprocedure follow-up**
Patients were followed up on the next day to check for adequate catheter fixation and pericatheter leak, if any. A repeat ultrasound scan was performed on all the patients to ascertain the position of the catheter.

**Observation parameters**
The observation parameters included (a) successful placement of PCN into the renal pelvis with free drainage of urine; (b) number of needle punctures required for puncturing the PCS; (c) duration of the procedure from induction of anesthesia to catheter deployment; (d) need for fluoroscopy; and (e) procedural complications, if any, substratified into minor and major as per the Quality Improvement Guidelines of Society of Interventional Radiology.\(^1\)

**Statistical analysis**
Statistical analysis was performed using Stata, version 14.2 (StataCorp LP, Texas, USA). Fisher’s exact test was used to compare the qualitative variables while Wilcoxon rank-sum test was used for the quantitative variables. All statistical tests were two-sided, and \(P < 0.05\) was considered statistically significant.

**RESULTS**
The procedure was performed on 24 kidneys of 24 consecutive patients – 10 patients in Group I and 14 patients in Group II. Among the 10 patients included in Group I (conventional techniques), the Seldinger and trocar techniques were deployed in two (with mild hydronephrosis) and eight patients, respectively. The demographic details, indications for PCN, and observation parameters of the patients in the two groups are summarized in Table 1. The procedure had to be abandoned in two patients with the conventional techniques as the system got decompressed and further punctures were not possible. Multiple needle punctures were needed in \(\frac{1}{2}\) patients (50\%) with Seldinger technique and 2/8 patients (25\%) with the trocar technique. The median procedure time was 15.5 min (range, 14–17 min) with the Seldinger technique and 10 min (range, 7–12 min) with the trocar technique. Fluoroscopic assistance was required in 2/2 patients (100\%) with the Seldinger technique to confirm the position of the guidewire and 3/8 patients (37.5\%) with the trocar technique to confirm that the catheter was placed within the PCS and not in the perinephric space.

One patient in each group sustained accidental catheter dislodgement within 72 h of the procedure. Repeat PCN was performed in both children with the proposed coaxial technique after an interval of 7 days.

Statistical comparison of the quantitative observation parameters between the two groups showed that the median procedure time and use of fluoroscopy were significantly lower in the proposed coaxial technique as compared to the conventional techniques (\(P < 0.001\) and \(P = 0.006\), respectively). However, the success rates and the frequency of multiple needle punctures were not significantly different between the two groups (\(P = 0.163\) and \(P = 0.059\), respectively) [Table 1].

**DISCUSSION**
The procedure of image-guided PCN was first described in children in 1984 by Winfield et al.\(^{11}\) Since then, several other investigators also found the technique to be as effective in children as in adults in initial studies.\(^{12,13}\) Ball et al., in 1986, were the first to recognize the difficulty in the micropuncture technique in young infants. Although there were no unsuccessful attempts in their study, they conceded that conventional techniques used in adults might be ineffective and unsafe in children, and therefore, minor modifications in technique and hardware are necessary when used in

---

**Figure 2:** Schematic diagram demonstrating the proposed coaxial technique. (a) A wide bore needle is used to puncture the pelvicalyceal system. (b) Inner stylet is removed and the catheter is inserted through the bore of the outer needle. *Created with BioRender.com.

**Figure 3:** Steps of the proposed coaxial technique. (a) 14-G needle inserted into the pelvicalyceal system under ultrasound guidance. (b and c) 5-F PCN catheter inserted through the 14-G needle. (d) The 14-G needle is removed over the deployed catheter. PCN: Percutaneous nephrostomy.
neonates and young children. Subsequently, similar difficulties in neonates and infants were described by several investigators.

Multiple modifications of the technique have been described to overcome these problems. Yavascan et al. described a technique in which, after the standard puncture, the catheter was passed through a peelable dilator. Bas et al. described the 14–4 technique for PCN in children in view of the yielding nature of tissues in children. They described a new technique in which the PCS was punctured using a 14-G intravenous cannula and a 4-F feeding tube was inserted into the PCS.

We propose a modified technique for PCN, which involves passing the pigtail catheter through the bore of a 14-G puncture needle. The conventional techniques had significantly longer procedure time than the proposed technique because of the difficulty in deploying the catheter in the former. The difficulty arises due to the fact that soft tissues in children, being softer than in adults, tend to get pushed instead of getting pierced. This can also lead to the deployment of the catheter in the perinephric space instead of the PCS, although no such incident was observed in our study. Even though the difference in procedure time might not be practically significant as far as the procedure is concerned, shorter procedure time using the proposed technique translates to shorter duration of anesthesia, which in turn can spare the young children of the potential adverse effects associated with prolonged anesthesia.

The need for fluoroscopy did not arise in any of the procedures done using the proposed technique, while the conventional techniques were associated with significantly higher fluoroscopy use. This assumes great significance as children are at higher risk of adverse effects from radiation exposure, majorly due to the longer life span after the exposure than adults. The proposed technique was successful in all patients, with none of them requiring multiple needle punctures. However, there was no statistically significant difference in these parameters as compared to the conventional techniques. Completing the procedure in a single-needle puncture is essential because the PCS in young children gets decompressed quickly due to the smaller volume of urine within it as compared to adults, hampering catheter placement, as happened in two of our cases with the conventional techniques. A theoretical risk of pericatheter leak was anticipated since the bore of the needle used was bigger than the catheter deployed. However, this was not seen on follow-up in any of our patients.

Our study has a few limitations. In our study, we recorded a higher failure rate with the conventional techniques (two patients in whom the procedure was abandoned) in comparison to that reported in the literature. This may be due to the fact that being a tertiary care hospital, our patients would have undergone multiple failed attempts at other centers before being referred to our center. The small sample size is another limitation of our study.

**Conclusion**

The technique described herewith is a feasible and safe alternative to the conventional Seldinger and trocar techniques. Besides overcoming the drawbacks of the conventional techniques in the pediatric age groups, it reduces the need for fluoroscopy, thereby reducing the radiation exposure. In addition, the procedure time is reduced as compared to the conventional techniques. However, in view of the small sample size and a single-center study design, a larger study is required.
to establish the clinical protocols for the use of this technique.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. Pabon-Ramos WM, Dariushnia SR, Walker TG, d'Othée BJ, Ganguli S, Midia M, et al. Quality improvement guidelines for percutaneous nephrostomy. J Vasc Interv Radiol 2016;27:410-4.
2. Shellikeri S, Daulton R, Sertic M, Connolly B, Hogan M, Marshalleck F, et al. Pediatric percutaneous nephrostomy: A multicenter experience. J Vasc Interv Radiol 2018;29:328-34.
3. Hwang JY, Shin JH, Lee YJ, Yoon HM, Cho YA, Kim KS. Percutaneous nephrostomy placement in infants and young children. Diagn Interv Imaging 2018;99:157-62.
4. Koral K, Saker MC, Morello FP, Rigsby CK, Donaldson JS. Conventional versus modified technique for percutaneous nephrostomy in newborns and young infants. J Vasc Interv Radiol 2003;14:113-6.
5. Goodwin WE, Casey WC, Woolf W. Percutaneous trocar (needle) nephrostomy in hydronephrosis. J Am Med Assoc 1955;157:891-4.
6. Cobb B. Silverman needle nephrostomy. J Urol 1967;98:309-13.
7. Ogg CS, Saxton HM, Cameron JS. Percutaneous needle nephrostomy. Br Med J 1969;4:657-60.
8. Jonson M, Lindberg B, Risholm L. Percutaneous nephro-pyelostomy in cases of ureteral obstruction. Scand J Urol Nephrol 1972;6:51-3.
9. Sancaktutar AA, Bozkurt Y, Tüfek A, Söylemez H, Önder H, Atar M, et al. Radiation-free percutaneous nephrostomy performed on neonates, infants, and preschool-age children. J Pediatr Urol 2013;9:464-71.
10. Özbek O, Kayad HE, Nayman A, Saritas TB, Guler I, Koc O, et al. Rapid percutaneous nephrostomy catheter placement in neonates with the trocar technique. Diagn Interv Imaging 2017;98:315-9.
11. Winfield AC, Kirchner SG, Brun ME, Mazer MJ, Braren HV, Kirchner F Jr. Percutaneous nephrostomy in neonates, infants, and children. Radiology 1984;151:617-9.
12. Stanley P, Diament MJ. Pediatric percutaneous nephrostomy: Experience with 50 patients. J Urol 1986;135:1223-6.
13. Irving HC, Arthur RJ, Thomas DF. Percutaneous nephrostomy in paediatrics. Clin Radiol 1987;38:245-8.
14. Ball WS Jr., Towbin R, Strife JL, Spencer R. Interventional genitourinary radiology in children: A review of 61 procedures. AJR Am J Roentgenol 1986;147:791-6.
15. Towbin RB, Ball WS. New pediatric 5-F drainage system. Radiology 1987;163:827.
16. O'Brien WM, Matsumoto AH, Grant EG, Gibbons MD. Percutaneous nephrostomy in infants. Urology 1990;36:269-72.
17. Yavascan O, Aksu N, Erdogan H, Aydin Y, Kara OD, Kangin M, et al. Percutaneous nephrostomy in children: Diagnostic and therapeutic importance. Pediatr Nephrol 2005;20:768-72.
18. Bas A, Gülşen F, Emre S, Samanci C, Uzunlu O, Cantasdemir M, et al. Ultrasound-guided percutaneous nephrostomy performed on neonates and infants using a “14-4” (Trocar and Cannula) technique. Cardiovasc Intervent Radiol 2015;38:1617-20.
19. Schneuer FJ, Bentley JP, Davidson AJ, Holland AJ, Badawi N, Martin AJ, et al. The impact of general anesthesia on child development and school performance: A population-based study. Paediatr Anaesth 2018;28:528-36.
20. Frush DP. Radiation risks to children from medical imaging. Rev Med Clin Condes 2013;24:15-20.