

Is Ultrasound-Guided Percutaneous Nephrostomy Efficacious and Safe in Pregnant Patients?: A Single Center Experience

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Abstract

Aim: To evaluate the safety and efficacy of ultrasound-guided percutaneous nephrostomy (PCN) placement in pregnancy.

Method: Medical records of 26 pregnant patients who were inserted with a total of 27 PCN catheters between June 2020 to June 2023 were retrospectively analyzed to assess imaging findings, procedural parameters, technical success, delivery outcomes, and procedural complications.

Results: At the time of placement of the PCN, the mean gestational age was 29.04±7.01 weeks (range 7 - 36 weeks). The indications for insertion of the PCN catheter included: 1) obstructing calculi (46.2%), 2) pyelonephritis (34.6%), and 3) symptomatic hydronephrosis without calculi (19.2%). Successful catheter placement was achieved in 25/27 procedures, yielding a success rate of 92.59%, and no major complications. Minor instances of transient hematuria were encountered in three cases. The mean duration of catheter retention was 72.58 days. All patients exhibited significant clinical and symptomatic improvement. Among these patients, 22 patients (84.6%) delivered their babies at full-term, 3 patients (11.5%) delivered prematurely, and 1 patient (3.8%) experienced a miscarriage.

Conclusion: Ultrasound-guided PCN placement is a reliable method with high success and efficacy that can be applied during pregnancy. This procedure avoids the use of ionizing radiation, ensuring safety for both the fetus and the mother.

Keywords: Hydronephrosis, nephrostomy, percutaneous, pregnancy

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ETHICAL STATEMENT: Before the start of the research, a written decision No: 367 was taken from the Ethics Committee of Basaksehir Cam and Sakura City Hospital. Ethics committee was taken on 23.08.2023.

Gebelikte Ultrasonografi Kılavuzluğunda Gerçekleştirilen Perkütan Nefrostomi İşlemi Etkin ve Güvenli Midir?: Tek Merkez Deneyimi

Öz

Amaç: Çalışmanın amacı gebelikte uygulanan ultrason eşliğinde perkütan nefrostomi (PN) yerleştirilmesi işleminin etkinlik ve güvenilirliğini ortaya koymaktır.

Yöntem: Haziran 2020 ile Haziran 2023 tarihleri arasında merkezimizde gebe hastalarda uygulanan PN yerleştirilmesi işlemleri retrospektif olarak taranarak işlem parametreleri, görüntüleme bulguları, teknik başarı, işlem komplikasyonları ve gebelik sonuçları değerlendirilmiştir.

Bulgular: PN yerleştirilmesi uygulanan hastalarda ortalama gebelik yaşı $29,04 \pm 7,01$ hafta olup 7 ile 36 hafta arasında değişmekteydi. PN endikasyonları sırasıyla taş (%46,2), piyelonefrit (%34,6) ve gebeliğe bağlı taşsız semptomatik hidronefroz (%19,2) idi. 27 işlemde 25'inde (%92,59) PN işlemi başarılı şekilde gerçekleştirilmiş olup major komplikasyon saptanmamıştır. Üç vakada geçici hematüri şeklinde minor komplikasyon saptanmıştır. Kateterin ortalama takılı kalma süresi 72,58 gündür. İşlem yapılan tüm hastalarda semptomatik ve klinik iyileşme sağlanmıştır. PN uygulanan 22 gebede (%84,6) zamanında doğum, 3 gebede (%11,5) erken doğum ve 1 gebede (%3,8) düşük saptanmıştır.

Sonuç: Ultrason eşliğinde PN yerleştirilmesi işlemi gebelikte obstrüktif hidronefroz varlığında yüksek başarı oranı ile uygulanabilen etkin ve güvenilir bir yöntemdir. Bu prosedür, iyonlaştırıcı radyasyonun kullanılmasını önleyerek hem fetusun hem de annenin güvenliğini sağlar.

Anahtar Sözcükler: Hidronefroz, nefrostomi, perkütan, gebelik

Introduction

Dilation of the urinary system is commonly observed in the third trimester of pregnancy, often affecting the right kidney. It usually presents as a mild condition and is generally accepted as a physiological process¹. Factors such as the pressure of the uterus, iliac artery, or dilated uterine veins on the ureter, reduction in ureteral smooth muscle peristalsis due to hormonal effects, and the presence of kidney stones are considered potential etiological factors for pregnancy-related hydronephrosis². While the majority of physiological hydronephrosis cases remain asymptomatic, it can progress in some instances, resulting in symptoms such as flank pain, hematuria, proteinuria, acute kidney failure, and severe urinary tract infections^{1,2}. Mildly symptomatic patients can be managed conservatively with pain relievers and/or antibiotics, while cases with significant obstruction may require procedures like percutaneous nephrostomy (PCN) placement or ureteral stenting¹.

The ultrasound-guided PCN placement procedure can be safely conducted with a low risk of complications and a high rate of technical success in the general population^{1,3}. However, there is dearth of information in the literature concerning the efficacy and reliability of ultrasound-guided

PCN placement in the pregnant population. This study aimed to evaluate the effectiveness and safety of ultrasound-guided PCN placement carried out during pregnancy.

Material and Methods

This retrospective study received approval from the institutional review board of Basaksehir Cam and Sakura City Hospital (protocol number: 23.09.2020-722). The investigation involved 26 pregnant patients who underwent PCN placement at our hospital between June 2020 and June 2023. The decision for PCN placement was made collaboratively by urologists and gynecologists. All pregnant individuals received approval for PCN, including consent for potential X-ray exposure if required. Before the procedure, detailed information about potential complications such as preterm birth, miscarriage, hemorrhage, and X-ray-related concerns for the fetus was provided. During this period, four pregnant individuals did not grant permission for PCN placement, and consequently, the procedure was not performed for them. Patient data, including age, gestational week, presenting complaints, indications for nephrostomy, pre-procedure values of blood urea, creatinine, C-reactive protein (CRP), white blood cell count (WBC), pre-procedure urinalysis results, the imaging method used during the procedure, side of the inserted nephrostomy, pre-procedure level of hydronephrosis, indication and duration of catheter replacement, and pregnancy outcomes were extracted from the hospital information system.

PCN Placement Technique

All procedures were performed by the same interventional radiologist with 8 years of experience in the same angiography suite. Patients provided written consent and met the criteria of a platelet count above 50,000/dL and an INR value below 1.5. Those not on antibiotics received 1 gram of IV cefazolin before the procedure.

Patients were initially placed prone for PCN insertion. Pregnant patients with an enlarged uterus were positioned laterally for right or left PCN placement. Using a 1-5 MHz convex ultrasound probe (ARIETTA 65, Hitachi, Tokyo, Japan), we assessed kidney, bladder, and fetal cardiac activity. Pre-procedure renal calyceal dilation followed the Society of Fetal Urology (SFU) grading system. Local anesthesia with 2% lidocaine was administered, and an 18-Gauge Chiba needle (Cook Medical Inc., Bloomington, Indiana, USA) accessed the chosen calyx. Successful puncture was confirmed by visualized urine and ultrasound (Figure 1). Subsequently, a cautious 0.035-inch guidewire (Shun Skyline PTFE coated guidewire, Shunmei Med, Guangdong, China) insertion was performed, followed by tract dilatation, and an 8 F pigtail catheter insertion (Cook Medical Inc., Bloomington, Indiana, USA) completed the procedure, as confirmed by ultrasound (Figure 2).

Figure 1. A) A 20-year-old pregnant individual presenting with symptomatic pregnancy hydronephrosis in the right kidney, displaying grade 3 hydronephrosis with a notable target calyx at the inferior pole (empty arrow). B) Successful puncture achieved using a Chiba needle, as indicated by the white arrow.

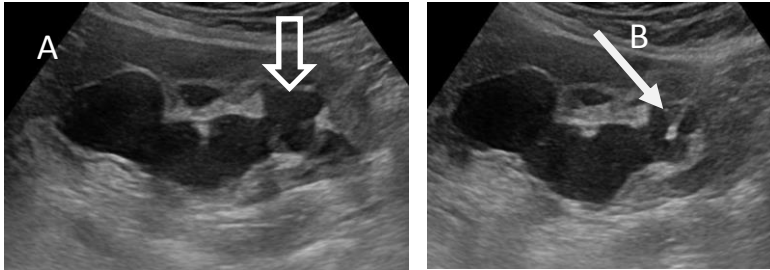
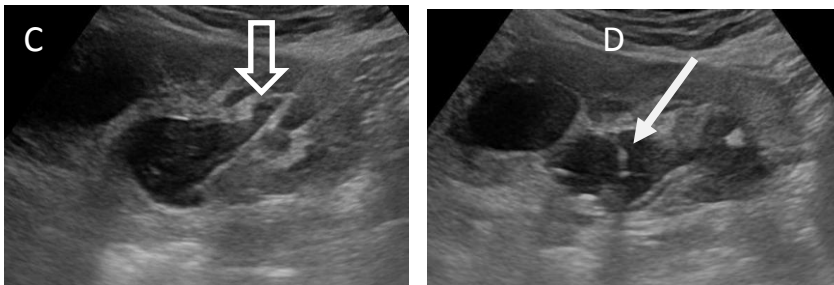


Figure 2. C) Successful insertion of a 0.035-inch guidewire (empty arrow). D) Completion of the procedure with the insertion of an 8 F pigtail catheter, confirmed by ultrasound guidance (white arrow).



Fluoroscopy assistance was used in two instances to address the challenge of advancing the 8F pigtail catheter and facilitating wire manipulation. To ensure minimal radiation exposure during the placement of the PCN for these two patients, a range of precautionary measures were implemented such as pelvic shielding, intermittent utilization of fluoroscopy in lieu of continuous exposure, avoidance of magnification fluoroscopy, and the adoption of precise collimation to concentrate the X-ray beam. Furthermore, a conscious effort was made to abstain from capturing fluoroscopic images of the pelvis and bladder to minimize any risk to the developing fetus. The complications observed during the procedure were classified as either minor or major complications according to the Society of Interventional Radiology (SIR) guidelines⁴.

Post-Nephrostomy Management

Patients received catheter care instructions, including daily saline flush. Scheduled catheter changes occurred at 6 weeks, with possible earlier changes for issues like leakage, reduced fluid flow, decreased urine output, bleeding, or catheter site discharge. Patients were advised to contact us before the 6-week mark if obstructive issues were resolved, stone removal occurred, the stone shifted, or gravid uterine pressure on the catheter arose.

Statistical Analysis

Statistical analyses were performed using IBM Corp.'s Statistical Package for the Social Sciences (SPSS), version 23.0, (Armonk, NY, USA). The analysis encompassed descriptive statistics, wherein frequencies were reported as percentages for categorical variables. Continuous variables were characterized using mean values for normally distributed variables. Measures of variability, including standard deviations, were incorporated to provide insights into data spread around the mean. Demographic characteristics such as age, gestational age, and laboratory values were analyzed using mean values to express central tendency, while minimum and maximum ranges were provided to convey variability within each variable, thus ensuring a comprehensive understanding of the dataset.

Results

This study examined 27 PCN placement procedures in 26 patients, with 11 on the right, 14 on the left, and 1 bilateral. The patients had a mean age of 25.31 years (range:18-44±6.12). Pre-procedure lab values (Table 1) included mean urea of 15.49 mmol/L (range:7.1-48±9.2), creatinine of 0.63 mmol/dL (range:0.33-1.94±0.35), CRP of 85.54 mg/l (range:0.70-331±92.54), and WBC of 11.06 $\times 10^3/\mu\text{L}$ (range:1.40-21.81±4.29).

Table 1. Demographic characteristics and laboratory values of the patients

Characteristic	Measurement
Age (years)	Mean \pm SD: 25.31 \pm 6.12
Gestational age (weeks)	Mean \pm SD: 29.04 \pm 7.011
<u>Side of hydronephrosis</u>	<u>N (%)</u>
Right	11 (40.74%)
Left	14 (51.85%)
Bilateral	2 (7.4%)
<u>Hydronephrosis grade</u>	<u>N (%)</u>
Grade 1	1 (3.7%)
Grade 2	11 (40.74%)
Grade 3	14 (51.85%)
Grade 4	1 (3.7%)
Serum BUN (mmol/L)	Mean \pm SD: 15.49 \pm 9.2
Serum creatinine (mmol/dL)	Mean \pm SD: 0.63 \pm 0.35
WBC ($\times 10^3/\mu\text{L}$)	Mean \pm SD: 11.06 \pm 4.29
CRP level (mg/l)	Mean \pm SD: 85.54 \pm 92.54

Abbreviations: BUN: blood urea nitrogen, WBC: white blood cell count, CRP: C-reactive protein, SD: standard Deviation, N: number, %: percentage

Among patients, 1 (3.84%) was in the first trimester, 4 (15.38%) were in the second trimester, and 21 (80.7%) were in the third trimester with a mean gestational age of 29.04 weeks (range: 7-36 \pm 7.011). Ultrasound revealed grade 1 hydronephrosis in 1 kidney (3.70%), grade 2 in 11 kidneys (40.74%), grade 3 in 14 kidneys (51.85%), and grade 4 in 1 kidney (3.70%).

Common symptoms included pain (61.53%), nausea and vomiting (26.9%), and pain with fever (11.53%). Indications for PCN placement were stones in 12 patients (46.15%), pyelonephritis in 9 patients (34.61%), and symptomatic pregnancy-related hydronephrosis without stones in 5 patients (19.23%) (Table 2).

Table 2. Distribution of nephrostomy procedures by side and indications

PCN placement side	Indications	Frequency
<u>Left</u>	Stones	9
	Pyelonephritis	3
	Symptomatic pregnancy-related hydronephrosis without stones	2
<u>Right</u>	Stones	5
	Pyelonephritis	3
	Symptomatic pregnancy-related hydronephrosis without stones	3
<u>Bilateral</u>	Pyelonephritis	2
<u>Total</u>		27

PCN: percutaneous nephrostomy

Out of 27 PCN placement procedures under ultrasound guidance, 25 were successful, yielding a technical success rate of 92.59%. In two cases where catheter manipulation posed challenges, fluoroscopy assistance was employed. In these instances, the mean Dose Area Product (DAP) was 11.26 Gy/cm², and the Total Air Kerma (TAK) measured 33.04 mGy. No adverse fetal outcomes have been noted at the time of delivery in these cases. Temporary microscopic hematuria occurred in 3 patients, resulting in a minor complication rate of 11.11%. No major complications were observed. Pregnancy outcomes were miscarriage in 1 patient (3.8%), preterm birth in 3 patients (11.5%), and full-term birth in 22 patients (84.6%). The mean catheter retention was 72.58 days (range: 15-180, \pm 39.73). The catheter was changed a mean of 1.27 times (range: 1-3), with a mean post-PCN placement hospital stay of 12.38 days (range: 0-60, \pm 12.01 days). Among the 27 catheters, 18 were removed for reasons including postpartum relief (n=5), pyelonephritis recovery (n=1), spontaneous stone passage (n=8), and post-pregnancy nephrolithotomy (n=4). Of the 9 replaced catheters, 3 followed the 6-week schedule, and 6 were changed earlier due to decreased

urine output (n=3), catheter dislodgement (n=1), tube discomfort (n=1), and catheter leakage (n=1).

Discussion

Asymptomatic hydronephrosis can be observed in approximately 90% of pregnant women; however, the rate of symptomatic hydronephrosis varies between 0.2% and 3%⁵⁻⁷. If left untreated, symptomatic hydronephrosis during pregnancy can lead to complications such as preterm birth, or maternal or fetal death, highlighting the importance of appropriate treatment. Symptomatic pregnancy-related hydronephrosis can be managed conservatively in 70-80% of cases, but invasive procedures may be required in 20-30% of cases⁸. PCN placement and ureteral stent placement are the commonly used methods for treating symptomatic hydronephrosis. While both methods have high success rates, the advantage of PCN placement lies in its ability to be performed under local anesthesia, which is important during pregnancy⁹. All PCN placement procedures in the current study were conducted using only local anesthesia, similar to the protocol described by Kavoussi et al. and Khoo et al.^{3,10}.

Numerous studies have demonstrated the effectiveness and reliability of PCN placement in the general population; nonetheless, only a few studies with a limited number of patients have reported the effectiveness of ultrasound-guided PCN placement in pregnant women^{10,11}. Van Sonnenberg et al., reported 9 cases, while Kavoussi et al., reported 6 cases of successful PCN placement procedures under ultrasound guidance in pregnant women^{10,11}. Of 27 PCN procedures evaluated in the current study, 25 were performed under ultrasound guidance and showed a technical success rate of 92.59%. The current study therefore presents the largest case series demonstrating the effectiveness and reliability of ultrasound-guided PCN placement procedures in pregnant patients to date.

Several published studies have reported data from sample sizes ranging between 1 and 52 on the application of PCN placement during pregnancy; however, a combination of fluoroscopy and ultrasound was frequently utilized in these studies^{1-3,12}. The potential adverse effects of radiation on the fetus are well established¹. Although the relationship between radiation doses used for diagnostic purposes and fetal anomalies or intellectual disabilities is still debatable, the procedure of ultrasound-guided PCN placement, which does not use ionizing radiation and is, therefore, a safer method, should be preferred for symptomatic hydronephrosis in the pregnant population^{11,12}. We achieved a very high success rate (92.59%) with ultrasound-guided PCN placement in the current study.

No major complications such as hematoma, urinoma, or sepsis were encountered during the PCN placement procedure in the current study. However, transient macroscopic hematuria, which was resolved spontaneously within 24 hours, was observed in three patients. The incidence of urosepsis reported in the literature ranges from 2.7% to 12.5%, however, we did not observe any

PCN placement-related urosepsis in this cohort^{3,12}. Discrepancies in case numbers, variations in the utilization of prophylactic antibiotics across different medical centers, and differences in clinical expertise may have contributed to this observed difference.

Among the 26 pregnant women included in this study, 3 (11%) experienced premature birth, and 1 (3.8%) suffered a miscarriage. The patient who suffered from a miscarriage was in the 7th week of gestation, and the miscarriage occurred 5 weeks after the PCN placement procedure. However, there was no indication that the patient's miscarriage was related to the PCN placement procedure.

Epelboym et al. reported a preterm birth rate of 11.5% among 20 pregnant women who underwent PCN placement¹². Similarly, Lindquister et al. reported a premature birth rate of 16% among the 52 patients examined¹. According to the World Health Organization (WHO), the global rate of preterm birth ranges from 5% to 18%; this rate is approximately 10-11%¹³ in Türkiye. Furthermore, the presence of urolithiasis and symptomatic hydronephrosis in pregnant patients is known to be associated with an increased incidence of preterm birth^{3,14}.

The incidence of preterm birth after PCN placement appears to be similar to that of the general population. However, a comparison of pregnancy outcomes after PCN placement with the general population and effectively elucidating the relationship between PCN placement and pregnancy outcomes remains challenging due to the limited number of cases and available data¹.

One of the significant challenges that is encountered after carrying out PCN placement during pregnancy is catheter obstruction due to physiological hypercalciuria in pregnancy^{15,16}. The incidence of catheter obstruction in pregnancy has been reported to range between 15% and 45%, with a higher likelihood of tube obstruction compared to the non-pregnant population^{1,3}. Therefore, daily irrigation and more frequent catheter changes (every 1.5 months rather than 3 months) are recommended in nephrostomy patients who are pregnant. Nonetheless, 6 out of 27 PCN placement procedures in the current study required an early change of catheter due to various reasons such as obstruction, dislodgement, and leakage around the catheter.

Urinary obstruction during pregnancy can arise from various factors such as the presence of stones, pressure from an enlarged uterus, ureteral narrowing, congenital anomalies, and pelvic tumors¹¹. The prevalence of stones during pregnancy can vary, occurring in approximately 1 in 200 to 1 in 5000 cases¹⁷. Spontaneous passage of stones may be observed in 48-84% of cases¹⁸. However, in instances where spontaneous passage does not occur, complications like urinary tract infections, septicemia, and spontaneous miscarriage can occur in pregnant individuals¹¹.

The most frequent indication for PCN placement in the current study was obstruction caused by stones (46.2%). The prevalence of urinary stones among pregnant individuals undergoing PCN has been reported to range from 6.6% to 50%^{1-3,12}. Such a high variation in this incidence might

stem from disparities in case distribution and the varying incidence of the occurrence of stones among diverse ethnic groups¹⁹.

It is also worth noting that pregnancy-related hydronephrosis due to uterine pressure is typically more prominent on the right side, whereas hydronephrosis attributed to stones in pregnancy is evenly distributed on both sides^{11,17}. In contrast to the trend reported in the literature, the cohort examined in the current study exhibited a higher frequency of hydronephrosis on the left side (51.8%). We recorded stone-related obstruction in 46.2% of cases, while hydronephrosis due to uterine pressure was observed in only 19.2% of the patients evaluated. The distinctive characteristics of this study group and its limited size could contribute to the atypical prevalence of left-sided hydronephrosis, deviating from reported findings.

The current study has certain limitations. Although hydronephrosis is common during pregnancy, the use of PCN placement during pregnancy is relatively less frequent. Therefore, although only 26 pregnant patients were evaluated in this study, it has one of the largest sample sizes in the current literature and therefore contributes significantly towards a better understanding of the use of PCN placement during pregnancy. On the other hand, the retrospective nature of this study and the consequent inability to access all medical records pose additional limitations. Furthermore, the absence of a control group in the current study is another restricting factor.

Conclusion

Ultrasound-guided PCN placement is an effective and reliable method that can be successfully employed during pregnancy when the patient presents with symptomatic hydronephrosis.

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