

Safety and feasibility of percutaneous nephrolithotomy (PCNL) during pregnancy: A review of literature

Meghana Ramachandra , Bhaskar K. Somani 

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ABSTRACT

Objective: Management of nephrolithiasis during pregnancy can be challenging because of the potential risks to the mother and fetus. Diagnosis and treatment can be a dilemma owing to the anatomical and physiological changes, besides the limitation in the use of X-rays. The aim of this article was to identify any case series or case reports where percutaneous nephrolithotomy (PCNL) was used as a treatment modality for nephrolithiasis in pregnancy.

Material and methods: A review of the literature was performed using Medline, EMBASE, CINAHL, and Scopus from 1990 to October 2019. A search was conducted using the following search terms: “urolithiasis,” “renal stones,” “stone disease,” “kidney stones,” “pregnancy,” “pregnant,” “percutaneous nephrolithotomy,” “PNL,” and “PCNL.” The initial search strategy retrieved 52 articles, but after going through them, only 7 were suitable for inclusion in this review.

Results: Overall, seven studies reported regarding 16 patients who underwent PCNL procedure during pregnancy. The patients were aged 18–34 years and had the procedure between 11 and 32 weeks of gestation. Most stones were in the renal pelvis or pelvic-ureteric junction and sized 8–40 mm, with the most common indication for the intervention being refractory pain. Most treatments used ultrasound guidance, and X-ray fluoroscopy was employed only in two cases. No complications occurred to the mother or fetus in any of the case reports, suggesting that PCNL is a safe and feasible treatment for patients with persistent symptoms when conservative treatment has failed.

Conclusion: All the reported cases of PCNL achieved stone-free status with no complications. Although PCNL has been evidenced to be safe, it must be performed by experienced endourologists after careful consultation with the obstetricians. Patient counseling and multidisciplinary team decision-making are paramount in such complex scenarios.

Keywords: Kidney stones; PCNL; percutaneous nephrolithotomy; pregnancy; outcomes; urolithiasis.

ORCID ID of the author:
M.R. 0000-0001-7252-5576;
B.K.S. 0000-0002-6248-6478

Urological Surgery
Department, University
Hospital Southampton NHS
Trust, Southampton, UK

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Corresponding Author:
Bhaskar K. Somani
E-mail:
bhaskarsomani@yahoo.com

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Introduction

Management of nephrolithiasis during pregnancy can be challenging because of the potential risks to the mother and fetus.^[1] The obstetric complications of renal calculi include the premature onset of labor, gestational diabetes mellitus, higher incidence of cesarean section, obstructive uropathy, pre-eclampsia, and hypertension.^[2,3] The incidence of urinary calculi during pregnancy is approximately 1 in 1200.^[4] Over 80% of patients present with this condition in their second or third trimester. The risk of stone formation is roughly three times higher in multiparous than primiparous women.^[5] Furthermore, stone formation is associated with

pre-existing renal disease and hypertension.^[6] Diagnosis can be difficult, and management can be a dilemma owing to the limitation in the use of X-rays and shock wave lithotripsy.^[7]

Normal anatomic changes within the urinary tract that occurs during pregnancy cause physiological hydronephrosis (up to 90% on the right side and 67% on the left side).^[8] Various theories have been postulated regarding ureteral obstruction, dilatation, and urinary stasis leading to the stone formation during pregnancy (Table 1).^[2,9] Traditionally, nephrostomy insertion or ureteral stent insertion have been common practice. Nonetheless, definitive management is warranted occasionally for symp-

Table 1. Summary—Changes in pregnancy, etiology of stones in pregnancy, and indications for surgical management**Changes during pregnancy**

- Increase in renal size and volume
- Dilatation of pyelocalyceal system
- Increase in plasma flow and glomerular filtration rate
- Increased uric acid and glucose excretion
- Hydroureter (right > left)
- Reduced peristalsis
- Increased vesicoureteral reflux

Factors that lead to renal stone formation in pregnancy

- Urinary tract dilatation during pregnancy and postpartum up to 6 weeks
- Increased glomerular filtration rate results in urine stasis and super-saturation of the mineral components of urinary calculi
- Alterations in urine pH secondary to dietary habits

Summary of indications for surgical management

- Persistent pain
- Untreated infection
- Fever
- Progressive hydronephrosis
- Obstructed single kidney

tomatic renal stones during pregnancy, especially when conservative management has failed.^[10] During the 1970s, percutaneous nephrolithotomy (PCNL) was described as a minimally invasive therapeutic option to treat kidney stones. With further advancements, PCNL has proven to be better when treating large and multiple renal stones.^[11,12] However, the need for fluoroscopy, prone positioning, and general anesthesia preclude PCNL from being routinely recommended during pregnancy. Nevertheless, few case reports have described PCNL during pregnancy with no major complications, suggesting it to be a feasible option when performed by experienced hands. The aim of this article

Main Points:

- PCNL during pregnancy is feasible, but it should be tailored for an individual patient.
- Patient counselling and multi-disciplinary team decision making are paramount.
- It must be performed by experienced endourologists working closely with obstetricians.

was to provide a synopsis of PCNL, review the case reports, identify key features, and learning points from them.

Methods and search strategy

A literature search was performed using Medline, EMBASE, CINAHL, and Scopus databases from 1990 to October 2019. Abstracts, case series, and suitable case reports were used for this review. The inclusion criterion was stone disease during pregnancy treated using PCNL, obtained from all publications in the English language. The search terms used were “urinary calculi,” “stones,” “urolithiasis,” “renal stones,” “stone disease,” and “pregnancy.” Medical Subject Heading phrases included “kidney stones AND pregnancy,” “urolithiasis AND pregnancy,” and “PCNL AND pregnancy.” This search strategy retrieved 709, 52, and 13 articles, respectively. After careful evaluation, eligible articles were included for the final review.

Results

Overall, seven studies had reported regarding 16 patients who underwent PCNL procedure during pregnancy (Table 2).^[13-19] The patients were aged 18-34 years and had the procedure between 11 and 32 weeks of gestation. Most stones were noted in the renal pelvis or pelvic-ureteric junction (PUJ) and sized 8-40 mm. Of these patients, 4 (25%) had a preoperative stent in situ, and the most common indication for intervention was refractory pain. The nephroscope size used was 26-30 F. Of the reported cases, 10 patients had general anesthesia, and 4 had spinal anesthesia. Most treatments used ultrasound (US) guidance, with X-ray fluoroscopy being used only in two cases. No complications occurred in the mother or fetus in any of the case reports, suggesting that PCNL is a safe and feasible treatment for patients with persistent symptoms when conservative treatment has failed (Table 3).

The initial case reports by Kavoussi et al.^[13] in 1992 revealed six patients between 12 and 32 weeks of pregnancy who presented with stone disease. All patients were treated with a nephrostomy tube, and only two patients underwent PCNL at 29 and 32 weeks with no postoperative complications. Shah et al.^[14] reported PCNL to treat an 18-mm renal calculus obstructing the PUJ in a 33-year old pregnant patient at 14 weeks gestation period. Documented X-ray radiation exposure was 6 seconds confined to the right kidney. No complications occurred in the patient or fetus. In 2005, Toth et al.^[15] described a case of a 31-year-old, 11-week pregnant female who had recalcitrant pain because of an 8-mm stone located in the lower calyx. As she was in the first trimester, the use of X-rays was avoided. The procedure was performed under left lateral spinal anesthesia initially, and then the patient was placed in the prone position. The tract dilatation was controlled under US

Table 2. Summary of the literature review

| No. of patients | Study | Age | Trimester | Stone size-site | Preop stent | Indication of patient | Position | Scope size | Diagnostic imaging | Type of Anesthetic | Stone retrieval | Fluoroscopy | Postop Stent | Postop nephrostomy tube | Complications | Stone-free rate |
|----------------------------------|-------|----------------------------|----------------------------------|--|----------------|---|-------------------------------|-------------------|---------------------------|----------------------------|---|----------------|-------------------|--------------------------|----------------------|-----------------|
| Kavoussi et al. ^[13] | 2 | 30 yrs 18 yrs | 29 weeks 32 weeks | 15 mm renal pelvis 2-3 mm renal pelvis | Yes Yes | Occluded & displaced stent | Unknown | Unknown | USS+ IVP USS | General General | Unknown No | Yes No | No No | Present Present | None None | 2/2 |
| Shah et al. ^[14] | 1 | 33 yrs | 14 weeks | 18 mm right PUJ | No | Pain | Unknown | Unknown | XR | Unknown | Unknown | Yes | Unknown | Unknown | None | 1/1 |
| Toth et al. ^[15] | 1 | 31 yrs | 11 weeks | 8 mm lower calyx | Yes | Refractory pain | Prone | 26F | USS | Spinal | Forceps | No | No | Yes | None | 1/1 |
| Fregonesi et al. ^[16] | 1 | 24 yrs | 22 weeks | 27 mm renal pelvis | No | Refractory pain | Supine | Unknown | USS | Unknown | Pneumatic lithoclast+ forceps | No | Yes | Unknown | None | 1/1 |
| Giusti et al. ^[18] | 1 | 27 yrs | 13 weeks | 40 mm renal pelvis | Yes | Refractory pain | Supine | 20F | USS | General | Unknown | No | No | Yes | None | 1/1 |
| Basiri et al. ^[17] | 3 | 26 yrs 25 yrs 34 yrs | 16 weeks 20 weeks 28 weeks | 24 mm 15/9/43 mm | No No No | Refractory pain in all 3 patients | Supine Supine Supine | 28F 30F 30F | USS USS+MRI USS+MRI | Spinal Spinal Spinal | Pneumatic lithoclast+ forceps (in all 3) | No No No | Yes Yes Yes | No Yes No | None None None | 3/3 |
| Hosseini et al. ^[19] | 7 | 23-32 yrs | 8-13 weeks | 14-40 mm (22 mm) Re- nal pelvis | No | Recurrent renal colic, (in all patients) | Prone (in all patients) | 27F | USS | General | Pneumatic lithoclast+ forceps (in all patients) | No | Yes | Yes (in all patients) | None | 7/7 |

yrs: years; mm: millimeter; NT: nephrostomy tube; USS: ultrasound scan

Table 3. Summary of indications for PCNL during pregnancy (listed in the case reports included in our review)

| |
|--|
| Single obstructed kidney. |
| Stones greater than 20 mm ³ , staghorn calculus, stones in CKD. |
| Refractory and stent-related pain. |
| Persistent UTI. |
| Necessity for stent change (every 6–8 weeks to avoid encrustation). |
| Stent encrustation (hypercalciuria, hyperuricosuria of pregnancy). |
| Failure of conservative management. |
| Failure of nephrostomy tube (bacterial colonization, mishandling of nephrostomy tube, dislodgement). |

PCNL: percutaneous nephrolithotomy; CKD: chronic kidney disease; UTI: urinary tract infection

guidance. The stone was then removed from the lower calyx with stone forceps, with no complications.

Fregonesi et al.^[16] treated a 24-year-old female patient at 22 weeks of pregnancy with PCNL under US guidance in a supine position. No complications were observed. Basiri et al.^[17] reported their experience with three patients who were pregnant at 16, 20, and 28 weeks, respectively. US imaging was used in these cases with the insertion of a temporary nephrostomy catheter. No complications were reported in this series. Giusti et al.^[18] described their experience in a 27-year-old female who presented with right-sided reno-ureteral colic with episodes of hematuria, irritation of the lower urinary tract, and pyrexia. Interestingly, the patient had undergone a double-J (DJ) stent placement for similar symptoms. She was lost to follow-up, and at the time of presentation, she was in the thirteenth week of pregnancy. US revealed a 40-mm stone in the renal pelvis and a 45-mm stone at the distal end of the previously inserted DJ stent. Calcifications were noted along the ureteral tract. She was initially managed with a nephrostomy tube and observation as an inpatient. However, because of persistent bladder irritation, flank and abdominal pain, PCNL was performed under US guidance to remove the stone and the encrusted stent. The patient's recovery was uneventful, and she completed the pregnancy without any complications. More recently, Hosseini et al.^[19] presented their series on seven pregnant females with refractory pain because of obstructive renal stones. All patients underwent PCNL under US guidance successfully without any complications.

Discussion

Role of initial drainage for urolithiasis in pregnancy

Urolithiasis during pregnancy is rare but theoretically can lead to significant morbidity to the mother and fetus. In a majority

of symptomatic patients, calculi pass with conservative management without any sequelae.^[17,20] However, 30% of patients experience fever, infection, chronic pain, and hydronephrosis—the potential indications for surgical intervention. Guidelines recommend placement of nephrostomy or ureteral stent initially for symptomatic pregnant women with renal calculi.^[21,22] These interventions are occasionally not tolerated because of the requirement of periodic exchange every 6–8 weeks. Patients have reported discomfort carrying a nephrostomy tube and being bothered by the irritative lower urinary tract symptoms (LUTS) associated with DJ stents. Another concern is the encrustation of the DJ stent, which mandates further intervention.^[23] When the symptoms become unbearable, and the temporary options have failed, definitive intervention is warranted. In such patients, PCNL seems feasible, and the illustrated case reports have revealed it to be a safe procedure. Per the European Association of Urology (EAU) guidelines, even though PCNL is feasible during pregnancy, the procedure remains an individual decision and should be performed only at experienced centers.^[21]

Role of imaging in PCNL during pregnancy

PCNL during pregnancy seems to have been performed at high-volume centers specializing in supine PCNLs with experience in US-guided access for it.^[10,24,25] Basiri et al.^[10] had published their results with X-ray-free, supine PCNL in 19 patients previously. They described a few tips to ensure safety and efficacy, such as applying the needle holder under US guidance to achieve a highly accurate entry into the selected target calyx, with the US facilitating to check the depth of dilator insertion. The tract was dilated with a single-shot technique, and the US was used from the anterior abdominal wall.^[17,24] In addition, Hosseini had previously described the feasibility of US-guided PCNL in 357 patients in either the lateral or supine positions.^[19,24] PCNL has been performed in the supine, flank, and prone-flexed positions by using X-ray, ultrasonography, and computed tomography scan.^[20-22] A supine position may be more suitable for pregnant women. Most authors have recommended a US-guided procedure because this reduces radiation exposure and increases the accuracy of placement.

Role of anesthesia in PCNL during pregnancy

A general anesthetic is avoided typically in the first trimester owing to the risk of morphogenetic anomaly from exposure to volatile gases. Furthermore, in the second trimester, the fetal risk is low, and in the final trimester, there are issues with positioning the patient because of the gravid uterus compressing the ureter. With advancements in general anesthesia, definitive procedures, such as PCNL, can be offered in selective and appropriately counseled patients. Nonetheless, safety and feasibility of PCNL under regional anesthesia in the general population have been described.^[25-27]

Indications, tips, and tricks for PCNL during pregnancy

Specific technical tips have been identified during this analysis. In most cases, PCNL was performed in the supine position. The main advantage was the easy access to the urethra and ureteral orifice. However, Hosseini et al.^[24,25] have reported excellent results with prone position. Basiri et al.^[10] reported that applying the needle holder under USS guidance resulted in a highly accurate entry into the selected target calyx. Moreover, the dilator was used under USS guidance to measure the depth and achieve accurate triangulation. USS has been invaluable in measuring the pelvic diameter and color Dopplers aid the surgeon with their improved imaging.^[17] In an earlier study, Toth et al.^[15] described the use of methylene blue dye to identify the location before puncturing the collecting system.

Over the last decade, PCNL has evolved into being minimally invasive with smaller sized tracts and excellent outcomes in patients with chronic kidney disease and solitary kidney, as well as the pediatric patients.^[28-30] However, per the guidelines, conservative management should be the initial step during pregnancy.^[21,22] Nonetheless, in cases with recurrent or persistent symptoms where the conservative approach is impossible, PCNL could be performed for definitive management after appropriate counseling.

Role of ureteroscopy in stone disease during pregnancy

Ureteroscopy (URS) has been increasingly performed for stone disease during pregnancy.^[31] Even though high success rates have been achieved, evidence suggests a rise in the risk of complications related to the procedure. Nevertheless, advancements in procedural technique, laser technology, and costs associated with it have led to the rise in these procedures.^[32-34] EAU guidelines suggest non-urgent URS should be performed in the second trimester, and when compared with temporary DJ stenting, it results in fewer needs for stent exchange, less irritative LUTS, and better patient satisfaction.^[21]

Strengths, limitations, and areas of future research

Our study is one of the first reviews on PCNL for stone disease during pregnancy. Even though this is a comprehensive study, data is limited to small retrospective case series or case reports and hence prone to publication bias. Nonetheless, it serves as a useful guide for endourologists and provides essential tips and tricks to both clinicians and patients to handle such difficult situations. Considering it is a specialized procedure, it should be conducted at high-volume endourological centers in close collaboration with obstetricians and radiologists. Therefore, future studies should explore the definition of stone-free rate and quality of life in such patients because it will facilitate the standardization of outcomes with a patient-centered approach.^[35,36] Similarly, the role of newer minimally invasive PCNL techniques and the cost of these procedures need to be explored further.^[37]

Conclusion

All the reported cases of PCNL during pregnancy achieved stone-free status with no complications. Even though PCNL has been evidenced to be safe, it must be performed by experienced endourologists after careful consultation with the obstetricians, radiologists, and anesthetists. Moreover, patient counseling and multidisciplinary team decision-making are paramount in such complex scenarios.

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