# Urologic Issues During Pregnancy

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**NOTE FROM THE PUBLISHER:**  
This publication has been developed without involvement of or review by the American Board of Urology.

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INTRODUCTION

Pregnancy induces several unique physiologic changes in women that can greatly affect the genitourinary system. Urologists must be highly attuned to the changes that occur throughout pregnancy as well as be aware that any diagnostic or therapeutic maneuvers may impact not only the pregnant patient but also the fetus. In fact, prior to proceeding with any intervention that could be harmful to a developing fetus, any woman of child-bearing age should be considered potentially pregnant until proven otherwise. This manual discusses several urologic problems that may arise during pregnancy, including asymptomatic bacteriuria (ASB) and symptomatic urinary tract infection (UTI), urolithiasis, pregnancy after urinary diversion, and urologic malignancy, and describes the approach to the urologists’ role in their management.

PHYSIOLOGIC CHANGES DURING PREGNANCY

CASE 1 PRESENTATION

A 17-year-old gravida 1, para 0 girl at an estimated 14 weeks of gestation presents with vague abdominal discomfort and urinary frequency. Renal ultrasonography reveals bilateral hydronephrosis, which is greater on the right side as compared with the left. The patient’s serum creatinine level is 0.5 mg/dL. Urinalysis is normal. The radiologist’s interpretation of the findings is physiologic hydronephrosis of pregnancy, with no other abnormalities.

- What physiologic changes occur during pregnancy?
- What effects do these changes have on diagnostic and therapeutic interventions?

PHYSIOLOGIC CHANGES BY ORGAN SYSTEM

Cardiovascular

In pregnancy, the cardiovascular system becomes hyperdynamic to meet the increasing metabolic demands of the growing fetus. Cardiac output increases by 30% to 50% by the third trimester with preferential blood flow to the placenta, uterus, skin, kidneys, and mammary glands. Progesterone and prostacyclin induce vascular relaxation and decrease systemic vascular resistance. In the latter half of pregnancy (from 28 weeks' gestation to delivery), the gravid uterus may compress the great vessels, reducing arterial blood flow below the level of uterine pressure and decreasing venous return to the heart.

Hematologic

Total blood volume increases by 25% to 40% during pregnancy. However, while plasma volume increases approximately 50% by 24 to 28 weeks of gestation, the red blood cell volume increases only approximately 15%. This results in relative hemodilution and a decrease in hematocrit, or the so-called “physiologic anemia of pregnancy.” As a consequence of the hemodilution, the free fraction of protein-bound drugs increases, which can alter the drugs’ effects and toxicity.

The blood of pregnant women also becomes hypercoagulable due to: (1) an increase in factors VII, VIII, and X and fibrinogen; (2) a decrease in fibrinolytic activity; and (3) a reduction of velocity of venous blood flow in the lower extremities. These factors significantly increase the risk of venous thromboembolism in the third trimester and immediate postpartum period to 5 to 6 times greater than the risk in the nongravid woman.

Pulmonary

Pregnant women have a more rapid decline in \( \text{PaO}_2 \) than nonpregnant women due to a combination of a 20% reduction in functional residual capacity (by the fifth month of pregnancy) and a 15% increase in oxygen consumption. Therefore, the pregnant woman has a greater risk of hypoxemia during high-demand ventilation states, such as during exercise and times of stress, sepsis, and induction of and emergence from anesthesia.

Gastrointestinal

Progesterone production during pregnancy inhibits gastric and intestinal motility and relaxes the gastrointestinal sphincter. The gravid uterus also pushes the abdominal contents toward the diaphragm, which reduces the size of the gastric reservoir and may
compromise the competence of the gastroesophageal sphincter. The delay in gastric emptying occurs as early as 8 to 12 weeks of gestation.11

**Upper Urinary Tract**

The upper urinary tract is greatly affected by pregnancy. Dilation of the renal calyces, pelvis, and proximal ureter leads to a phenomenon known as “physiologic hydronephrosis of pregnancy,” as occurred in the case patient. Physiologic hydronephrosis occurs in 90% of pregnant women and affects the right side more than the left side.12,13 Dilation is usually limited to the ureter proximal to the pelvic brim. Originally thought to be due to the smooth muscle relaxing effects of progesterone, it is now believed that direct compression from the enlarging uterus is the most significant cause of hydronephrosis.14,15 The right ureter is affected more than the left as a result of compression by an engorged uterine vein and derotation of the enlarged uterus; the left ureter is also protected from dilation by the gas-filled sigmoid colon.15 Physiologic hydronephrosis is evident as early as 6 weeks of gestation and does not completely resolve until 4 to 6 weeks postpartum.

Both the glomerular filtration rate (GFR) and renal plasma flow increase 30% to 60% during normal pregnancy.16 As a result, normal values for serum creatinine and blood urea nitrogen are approximately 25% lower during pregnancy. For example, an average value for serum creatinine is 0.5 mg/dL during pregnancy compared with 0.8 mg/dL in nonpregnant women.16 These parameters are important to remember, as medications administered during pregnancy may be rapidly excreted in the urine and doses may need adjustment.

**Lower Urinary Tract**

The gravid uterus causes indentation on the dome of the bladder and lateral expansion later in pregnancy.17 In animal studies, pregnancy also induced a decrease in the contractile response of the bladder neck to α-adrenoceptor stimulation.18 These effects on the bladder and sphincter contractile response, when combined with decreased support for the anterior vaginal wall and urethra during pregnancy, may contribute to the high rate of pregnancy-induced stress urinary incontinence.19,20 Increased urinary frequency also appears to be a normal part of pregnancy, but the exact factors promoting the changes in urinary habits are not fully understood.21

**CASE 1 RESOLUTION**

The patient is diagnosed with mild gastroesophageal reflux and increased urinary frequency associated with pregnancy. The patient is reassured that gastroesophageal reflux and increased urinary frequency are common in pregnancy. Lifestyle and dietary modifications are recommended, including eating smaller meals, not eating late at night, avoiding acidic/spicy foods and alcohol, and elevating the head of the bed.

### ASYMPTOMATIC BACTERIURI A AND SYMPTOMATIC URINARY TRACT INFECTION

**CASE 2 PRESENTATION**

A 32-year-old gravida 3, para 1 woman presents for her 16-week check-up. Urine culture obtained for routine screening reveals greater than 100,000 colony-forming units of _Escherichia coli_, which is sensitive to all antibiotics. The patient is completely asymptomatic.

- Is screening for bacteriuria necessary in pregnant women? Does this patient need treatment? What antibiotics are safe in pregnancy?

UTI is a common complication in pregnancy, with a reported prevalence of 4% to 7%.22,23 UTIs can present as ASB, acute cystitis, or pyelonephritis. Overall, the prevalence of UTI in pregnant women is similar to that in nonpregnant, sexually active women of child-bearing age, but the risk of developing upper tract pyelonephritis is much greater in pregnant women.24 This increased risk is thought to be due to the physiologic changes of the urinary tract as previously discussed. Pyelonephritis during pregnancy can cause significant morbidity for both the mother and fetus.25

### ASYMPTOMATIC BACTERIURI A OF PREGNANCY

ASB of pregnancy is essentially an asymptomatic UTI. ASB is defined as greater than 100,000 colony-forming units of a single pathogen per milliliter of urine in a properly collected specimen without any associated findings of frequency, urgency, dysuria, or hematuria.26 ASB is generally not treated in nonpregnant women. However, as many as 20% to 40% of pregnant women with untreated ASB will develop pyelonephritis.24,27 The incidence of pyelonephritis can be reduced by 90% if bacteriuria is treated early in pregnancy.28 Untreated bacteriuria has also been linked to prematurity, low birth weight, intrauterine growth retardation, and neonatal death, but these findings are controversial and may have been a result of lower socioeconomic status of patients in those studies.29

Because of the risk of pyelonephritis and potential complications of ASB during pregnancy, the American
College of Obstetricians and Gynecologists currently recommends screening for ASB in all pregnant women at approximately 16 weeks of gestation. If the initial culture is negative, additional cultures are not recommended unless the patient has had recurrent UTIs in the past or has genitourinary anatomic abnormalities. If the culture is positive, a repeat urine culture should be performed approximately 1 week after treatment is initiated with continued follow-up throughout pregnancy.

**SYMPTOMATIC URINARY TRACT INFECTION**

**Lower Urinary Tract**

The presence of symptoms traditionally associated with cystitis (e.g., frequent and painful urination, hematuria) has a low predictive value for identifying women with bacteriuria (i.e., women may have ASB). Likewise, many women have frequency and urgency without having an infection. However, approximately 1% to 2% of pregnant women will have signs and symptoms of cystitis associated with a positive urine culture.

**Upper Urinary Tract**

Pyelonephritis is most commonly seen during the third trimester of pregnancy. The overall incidence is low, but patients with untreated ASB in pregnancy may develop pyelonephritis, as noted above. The symptoms of pyelonephritis are the same as in nonpregnant women and include fever, chills, nausea, vomiting, and costovertebral angle tenderness. Complications of pyelonephritis include maternal anemia, renal failure, respiratory distress syndrome, and sepsis. For the fetus, complications include prematurity, low birth weight, and neonatal death. Given the possible complications, preventive steps and aggressive treatment are needed to avoid pyelonephritis.

**APPROACH TO TREATMENT**

All pregnant patients with ASB, acute cystitis, and/or pyelonephritis should be treated with antimicrobial therapy. The choice of antimicrobial agent must be safe for both the mother and fetus. Although treatment duration is debated, ASB can be treated with a 3-day course of antibiotics, and acute cystitis is generally treated with a 7- to 10-day course of antibiotics. Patients with acute pyelonephritis should be admitted to the hospital and treated with parenteral agents followed by oral antibiotics to complete a 2-week course. Penicillins, cephalosporins, and nitrofurantoin have been the mainstay of therapy in pregnancy without adverse fetal outcomes. Antimicrobial agents generally contraindicated in pregnancy include fluoroquinolones, chloramphenicol, erythromycin, and tetracycline (Table). After completing therapy, a follow-up urine culture is recommended 1 week later to ensure that bacteriuria has been eliminated. If the initial treatment fails, patients require culture-specific treatment for an extended time and then periodic urine cultures throughout the remainder of pregnancy to identify a recurrence. Antimicrobial suppression can be considered in patients with recurrent infections and/or an initial infection during pregnancy associated with a history of recurrent UTIs.

**CASE 2 RESOLUTION**

The patient is treated with amoxicillin 500 mg 3 times daily for 3 days. One week later, repeat urine culture is negative. However, at her 24-week check-up, the patient again demonstrates ASB on urine culture. Treatment with amoxicillin is reinitiated, and the patient is given a suppressive dose of 50 mg nitrofurantoin, which is to be taken nightly for the remainder of her pregnancy. Subsequent urine cultures return negative.

**UROLITHIASIS IN PREGNANCY**

**CASE 3 PRESENTATION**

A 28-year-old gravida 3, para 2 woman with a history of kidney stones presents to the emergency department with acute-onset, severe right flank pain. In the emergency department, the pain waxes and wanes, and it is difficult to make the patient comfortable. She is afebrile and her vitals are stable. Physical examination reveals a gravid woman at an estimated 32 weeks of gestation; no urolithiasis is definitely identified; however, absence of right ureteral jet raises possibility of ureteral stone. The radiologist recommends further imaging as clinically indicated.

- What are the risk factors for urolithiasis in pregnant women? How does urolithiasis present in pregnant women?

Urinary stones present a difficult diagnostic and treatment dilemma for the urologist. The incidence of urolithiasis is approximately 1 per 1500 deliveries, which is similar in the nonpregnant population.
Pregnancy-associated causes of abdominal pain are much more common than urolithiasis; thus, a high index of suspicion is necessary to make the correct diagnosis. If improperly managed, urolithiasis can jeopardize the pregnancy.

**PATHOPHYSIOLOGY OF UROLITHIASIS IN PREGNANCY**

Other than physiologic hydronephrosis of pregnancy, which causes urinary stasis and may contribute to stone formation, various metabolic conditions during pregnancy also affect the risk of developing urolithiasis. The most common metabolic factors that influence stone formation are hypercalciuria, hyperuricosuria, and hypercitraturia.

Urinary calcium excretion can nearly double during pregnancy due to increased GFR (which decreases tubular reabsorption), increased intestinal absorption of calcium and mobilization of calcium from the bone (driven by placental formation of 1,25-dihydroxycholecalciferol), and feedback suppression of parathyroid hormone. These changes lead to a condition similar to absorptive hypercalciuria.

Hyperuricosuria is thought to be due to the increased GFR in pregnancy and subsequent increase in net urinary excretion of uric acid. The increased uric acid secretion can contribute a nidus to calcium oxalate stone formation and has been suggested as a reason for the high rate of stent encrustation during pregnancy.

Pregnancy increases the urinary citrate level. Citrate is a known inhibitor of crystal growth and aggregation and can bind with calcium to form a soluble calcium salt. Hypercitraturia actually provides a protective effect against stone formation in pregnancy.

Other protective factors, such as magnesium and glycoproteins, may also increase to help maintain balance during pregnancy.

**CLINICAL PRESENTATION**

The majority of pregnant women with urolithiasis present in the second or third trimester. Although physiologic hydronephrosis preferentially affects the

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**Table. Antimicrobial Use in Pregnancy**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Potential Toxicity</th>
<th>Comments</th>
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<tr>
<td><strong>Safe</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penicillins</td>
<td>No known fetal toxicity</td>
<td></td>
</tr>
<tr>
<td>Cephalosporins</td>
<td>No known fetal toxicity</td>
<td></td>
</tr>
<tr>
<td>Clindamycin</td>
<td>No known fetal toxicity</td>
<td>Use for penicillin-allergic mother</td>
</tr>
<tr>
<td><strong>Possible adverse effects, but commonly used</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>Theoretical fetal hemolytic anemia (third trimester, maternal G6PD-deficient)</td>
<td>Not effective in pyelonephritis, hemolysis in G6PD-deficient mom</td>
</tr>
<tr>
<td>Aminoglycosides</td>
<td>Theoretical fetal oto- and nephrotoxicity</td>
<td>Mainstay for pyelonephritis, no reported congenital anomalies</td>
</tr>
<tr>
<td>Sulfonamides</td>
<td>Theoretical antifolate activity first trimester</td>
<td>Increasing Escherichia coli resistance, hyperbilirubinemia with kernicterus in third trimester</td>
</tr>
<tr>
<td>Trimethoprim</td>
<td>Theoretical antifolate activity first trimester (concern for neural tube defects)</td>
<td>TMP/SMX often used second trimester, maternal megaloblastic anemia</td>
</tr>
<tr>
<td><strong>Avoided</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluoroquinolones</td>
<td>Abnormality of cartilage development</td>
<td>Not currently used in pregnancy (animal studies); reports of tendonitis in humans</td>
</tr>
<tr>
<td>Chloramphenicols</td>
<td>“Gray baby syndrome”</td>
<td>Potential marrow toxicity in mother</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>Tooth dysplasia, inhibition of tooth growth</td>
<td></td>
</tr>
<tr>
<td>Erythromycin</td>
<td>No known fetal toxicity</td>
<td>Generally avoided due to maternal cholestatic jaundice</td>
</tr>
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G6PD = glucose-6-phosphate dehydrogenase; TMP/SMX = trimethoprim/sulfamethoxazole.
right side, urolithiasis affects both sides equally. Presenting symptoms vary but generally consist of flank or abdominal pain, microscopic or gross hematuria, and irritative lower urinary tract symptoms. Although symptoms are similar to those in nonpregnant women, the anatomic changes that occur during pregnancy can make diagnosis difficult.

- Should additional imaging be performed in this patient? What are the risks to the developing fetus?

**IMAGING STUDIES**

Performing a reliable imaging study to diagnose urolithiasis without substantial fetal exposure to radiation is a critical decision point for both the patient and physician. The rapidly dividing cells of the fetus are most susceptible to the teratogenic effects of radiation during the first trimester, but radiation exposure during the second and third trimesters can also cause untoward effects on the developing fetus. At high doses of radiation exposure (25–80 cGy), the rate of congenital anomalies is approximately doubled. Doses of 5 cGy or lower are not believed to cause intrauterine growth retardation or other fetal anomalies; 5 cGy is considered the maximum safe dose. At a dose of 10 cGy, the risk of fetal malformation is increased approximately 5%. Therefore, the possibility of termination of the pregnancy should be discussed in women exposed to greater than 5 cGy of radiation during the first trimester.

Studies have suggested that intrauterine exposure as low as 1 cGy can increase the relative risk of leukemia by 1.6 and all other cancers by a relative risk of 3.2. However, a recent review of currently available data failed to identify evidence of a link between low-dose intrauterine radiation exposure and leukemia. According to the National Radiological Protection Board, mean fetal radiation exposure for an abdominal radiograph (KUB), limited excretory urogram (also known as intravenous pyelogram [IVP]), and pelvic computed tomography (CT) is 0.14, 0.17, and 2.5 cGy, respectively. However, if not properly performed, the fetal dose of KUB, limited IVP, and pelvic CT can be as high as 0.42, 1.0, and 7.9 cGy, respectively. The actual dose delivered to the fetus is affected by the distance of the radiation source from the fetus and the size of the mother.

**Ultrasonography**

In general, abdominal ultrasonography is the preferred initial study in a pregnant patient suspected of having urolithiasis because there is no fetal radiation exposure. Unfortunately, due to physiologic hydronephrosis of pregnancy and poor visualization of the ureters, abdominal ultrasonography is fairly unreliable for the diagnosis of urolithiasis and is highly dependent on the skill of the ultrasonographer. In a retrospective study of pregnant women admitted for nephrolithiasis, only 60% of stones were diagnosed correctly using standard abdominal ultrasonography.

However, other techniques, such as resistive index (RI) calculation, ureteral jet identification, and vaginal ultrasonography, can improve the diagnostic utility of ultrasonography. RI measures renovascular resistance. RI increases in the first 6 to 48 hours in acute renal obstruction, and neither pregnancy nor physiologic hydronephrosis alters RI. RI values greater than 0.70 and changes in RI greater than 0.06 are considered positive for obstruction.

Color Doppler ultrasonography can be used to document the presence or absence of ureteral jets and can raise suspicion of unilateral obstruction. The absence of a ureteral jet when a pregnant patient is in the supine position should be confirmed with the patient in the contralateral decubitus position. Both RI and ureteral jets can add diagnostic information to suggest obstruction, but these techniques do not allow visualization of the stone. Vaginal ultrasonography has also been suggested to improve the diagnosis of distal ureteral stones, but its use in pregnancy for diagnosing stones has not been well studied.

**Excretory Urogram (IVP)**

IVP is considered the diagnostic imaging standard for evaluating urolithiasis in pregnancy and is usually performed if ultrasonography is equivocal or inconclusive. It is superior to ultrasonography for diagnosing a stone and exposes the fetus to much less radiation as compared with CT. A 3-shot IVP (scout film, 30-second film, and 20-minute film) is recommended. Films obtained after 20 minutes rarely yield additional diagnostic information. The patient should be placed in the prone position, and the fetus should be maximally shielded (contralateral unaffected side), with judicious collimation, to limit fetal radiation exposure. This limited IVP can give excellent anatomic and functional information; however, prior to ordering a test involving radiation (even small doses), the risks and benefits to the mother and fetus must be carefully assessed.

**Computed Tomography and Magnetic Resonance Imaging**

CT scans are the standard of care for diagnosing urolithiasis in the nonpregnant population. Newer low-dose and ultra low-dose CT renal colic protocols may expose the patient to only 0.88 to 1.2 cGy of radiation.
but have yet to be evaluated in pregnancy. Therefore, the current recommendation is to avoid CT in pregnancy due to the high radiation exposure.

Magnetic resonance imaging (MRI) is used extensively during pregnancy for fetal evaluation due to the lack of exposure to ionizing radiation. Therefore, some radiologists have used MRI urograms to evaluate for urolithiasis in pregnancy. Unfortunately, calculi are not directly visualized by MRI, but need to be inferred by signal voids. MRI is also time-consuming, costly, and not often available in the acute setting. The role of MRI in diagnosing urolithiasis will likely remain limited.

- How should urolithiasis be managed in pregnancy?
  - What are the risks to the developing fetus?

**MANAGEMENT OF UROLITHIASIS IN PREGNANCY**

The first consideration in the management of urolithiasis in pregnancy should be conservative therapy (ie, appropriate hydration and analgesia). With conservative therapy, approximately 70% to 80% of stones will pass spontaneously during pregnancy. For stones that do not pass, approximately 50% will pass in the immediate postpartum period. However, conservative therapy must be active (ie, some patients may require repeat admissions for intravenous hydration and pain control throughout the pregnancy).

In some patients, conservative therapy fails and surgical intervention is required. Absolute indications for surgical intervention are similar to those for nonpregnant patients and include infected, obstructive stones (usually associated with UTI, fever, and sepsis), an obstructed solitary kidney, or acute renal failure. Relative indications include intractable pain, nausea, and vomiting. The patient’s wishes, opinions of the obstetrician and anesthesiologist, and additional resources available at one’s institution (eg, availability of an interventional radiologist, intensive care unit services, neonatal care) should be taken into consideration prior to determining a planned intervention.

**Temporary Drainage**

Most pregnant women who need an intervention for symptomatic urolithiasis undergo placement of a ureteral stent or nephrostomy tube. Definitive treatment for urolithiasis is then deferred until after delivery. Ureteral stents have been placed with ultrasound guidance with the patient under local anesthesia; however, unless highly skilled in ultrasonography, most urologists use fluoroscopy to place stents. Placing stents with fluoroscopy is well established, and radiation exposure is minimized by obtaining only a few images to confirm adequate wire and stent placement in the kidney while directly visualizing the tail of the stent in the bladder with the cystoscope. The lower abdomen/fetus must be completely shielded with lead during the procedure. Consultation with the obstetrician is also necessary, as fetal heart rate monitoring may be required throughout the procedure.

The disadvantages of having an indwelling ureteral stent during pregnancy are well known to practicing urologists. Irritative urinary symptoms (eg, frequency, urgency, flank discomfort) are common with a stent, especially as the uterus continues to expand and compress the ureter and bladder. Rapid stent encrustation is a common problem during pregnancy and is attributable to the hypercalciuria and hyperuricosuria of pregnancy. Therefore, stents should be changed every 4 to 8 weeks during pregnancy to avoid encrustation.

Given the problems associated with ureteral stents, many urologists prefer to place percutaneous nephrostomy tubes during pregnancy, especially for patients requiring an intervention early in pregnancy, who may need to undergo several stent or nephrostomy tube changes. Nephrostomy tubes are typically placed by interventional radiologists, but some institutions may not have the necessary resources, in which case the urologist will place the stent or the patient is transferred to a facility with appropriate resources. Nephrostomy tubes are placed easily under ultrasound guidance and a local anesthetic. If patients are severely ill, this procedure can be performed in the intensive care unit. The nephrostomy tubes can be subsequently changed easily every 4 to 8 weeks with minimal anesthetic. The disadvantages of nephrostomy tubes include the need for an externalized drainage bag (which can be dislodged) and bacterial colonization of an externalized tube. The benefits and disadvantages of each approach should be discussed with the patient and consulting physicians prior to determining the best treatment option during pregnancy.

**Definitive Therapy**

Various surgical treatment options exist for nonpregnant patients with urolithiasis, including extracorporeal shock wave lithotripsy (SWL), ureteroscopy with lithotripsy and stone extraction, percutaneous nephrolithotomy, and open stone extraction. Unfortunately, options are limited during pregnancy.

SWL is associated with serious fetal effects and animal studies have confirmed fetal death after SWL. Therefore, pregnancy is a strict contraindication for SWL. Likewise, percutaneous stone extraction should be avoided during pregnancy due to significant fluoroscopy time required for the procedure and the need for
prone positioning. Open surgery is rarely used for stone disease even in the nonpregnant patient given the available less invasive modalities; therefore, it should be extremely limited during pregnancy and used only in unusual circumstances.

Ureteroscopy has gained increasing popularity for the definitive diagnosis and management of urolithiasis during pregnancy. Several studies have established the safety and efficacy of ureteroscopy during all trimesters of pregnancy.\(^{65-70}\) Given the advances in endoscopic equipment and endourologic techniques, some consider ureteroscopy a first-line treatment for pregnant patients who have failed conservative management.\(^{65,66}\) The advantages of ureteroscopy include the need for only 1 surgical intervention during pregnancy (as opposed to repeated stent changes), avoidance of stent or nephrostomy tube complications, quicker resolution of symptoms as compared with stenting alone, and treatment of the stone to prevent future interventions. General anesthesia may be needed in these patients, but a spinal or deep sedation can also be used successfully.\(^{67-69}\) If during the procedure a floppy tipped wire meets resistance, limited use of fluoroscopy may be required.\(^{66}\) Ureteral dilation is usually not required due to the physiologic hydronephrosis of pregnancy, which makes ureteral navigation fairly easy. Contraindications to ureteroscopy in pregnancy include stones larger than 1 cm, presence of multiple stones, and sepsis.\(^{71}\) Ureteroscopy in pregnancy should be performed by experienced endoscopists. However, its use during pregnancy is still debated, with opponents citing the risks of general anesthesia, fluoroscopy, and ureteral damage/perforation.\(^{61}\)

If ureteroscopy is undertaken and the stone is too large to be basketed, the holmium laser is the current preferred modality of lithotripsy. The holmium laser appears to be safe for both the mother and fetus provided that the tip is kept at least 1 mm from the ureteral wall.\(^{66}\) It is also effective for treating almost every type and composition of stone. The only theoretical concern is the production of cyanide with the use of a holmium laser on uric acid stones, which is thought to be of minimal clinical significance but needs further study.\(^ {72}\) Electrohydraulic lithotripsy should be avoided during pregnancy due to the large treatment area affected and the possibility of inducing premature labor.\(^ {72}\) Likewise, ultrasonic lithotripsy should be avoided due to concerns of effects on fetal hearing.\(^ {67}\)

The decision to proceed with ureteroscopic management of urolithiasis in pregnancy is based on multiple factors and should be discussed with all the caregivers involved. From an anesthetic and obstetric standpoint, however, the optimal time for nonobstetrical surgery is during the second trimester due to the increased risk of miscarriage during the first trimester and premature labor during the third trimester.\(^ {73}\)

**CASE 3 RESOLUTION**

After discussing the risks and benefits of additional imaging with the patient and treating obstetrician, the patient undergoes a 3-shot IVP, which demonstrates a 6-mm stone at the pelvic brim with moderate obstruction. The patient is admitted for intravenous hydration and analgesics, but she continues to have pain, nausea, and vomiting 48 hours after admission. The physician discusses the options with the patient, which include continued expectant management, ureteral stent or nephrostomy tube placement, or ureteroscopy. Because the patient had previous ureteral stent placement with great discomfort, she elects to undergo nephrostomy tube placement under ultrasound guidance. Nephrostomy tube placement is successful, and the patient’s pain resolves. A healthy baby is delivered at 38 weeks and the patient passes her ureteral stone spontaneously 2 days after delivery.

**PREGNANCY AFTER URINARY DIVERSION**

**CASE 4 PRESENTATION**

A 22-year-old gravida 1, para 0 woman with myelomeningocele and a history of augmentation enterocystoplasty for a neurogenic bladder presents to the urologist at 8 weeks of gestation. She has concerns regarding the likelihood of successful pregnancy and delivery given her previous bladder surgery and current bladder management of clean intermittent catheterization 4 times daily.

- Can the patient continue the pregnancy? What special issues need to be addressed?

**MANAGEMENT**

Pregnancy after urinary diversion poses several difficult decisions for the patient and physician, and management should be individualized. Several successful pregnancies have been reported after continent and standard urinary diversions.\(^ {74}\) One issue to consider is the high rate of symptomatic UTIs during pregnancy in women with urinary diversion. Nearly all women with urinary diversion will have ASB during pregnancy, and severe UTIs with pyelonephritis occur in approximately 20% of patients.\(^ {75}\) Patients with urinary diversion may
have an increased incidence of premature labor, which is thought to be partially due to UTIs and acute episodes of pyelonephritis.\textsuperscript{76}

**Antibiotic Prophylaxis**

Aggressive antibiotic therapy is recommended for patients with urinary diversion and symptomatic UTIs during pregnancy. Antibiotic prophylaxis is recommended throughout pregnancy in patients with a febrile UTI at any time during pregnancy, baseline hydronephrosis worsened during pregnancy, impaired renal function, ureteral reflux, current clean intermittent catheterization, and/or enterocystoplasty.\textsuperscript{74–77}

**Mode of Delivery**

Generally, mode of delivery should be guided by obstetric indications, and many of the deliveries can be performed vaginally. However, vaginal delivery may not be possible due to risks of damaging the pelvic floor and continence mechanism in women with orthotopic neobladders, enterocystoplasty, and augmentation enterocystoplasty.\textsuperscript{74,78} Vaginal delivery is contraindicated in patients with a narrow bony pelvis, artificial sphincters, a history of bladder neck reconstruction, and/or contracted hips. Vaginal delivery also should be used cautiously in patients with cervical prolapse or any fetal malpresentation.\textsuperscript{74} Because of the increased risk of pelvic floor disruption during vaginal delivery in patients with urinary diversion, some recommend cesarean section before the onset of labor.\textsuperscript{77,78} The cesarean section should be performed high midline to avoid the urinary reservoir and mesenteric pedicle. In most cases, the urinary reservoir and mesentery is pushed away from the upper aspect of the gravid uterus.\textsuperscript{77,78} A urologist should be immediately available during cesarean section in these patients to prevent damage to the urinary reconstruction.

**CASE 4 RESOLUTION**

The patient receives antibiotic prophylaxis throughout the pregnancy without any symptomatic UTIs. Given her history of myelomeningocele and distorted pelvic anatomy, a cesarean section is planned. The patient begins having contractions at 36 weeks and proceeds with the planned section at this time. A urologist is present in the operating room; however, the mesentery and enterocystoplasty have been pushed to the right lateral side and away from the gravid uterus, and the urinary reconstruction is not at risk. The cesarean section proceeds without difficulty.

**UROLOGIC MALIGNANCY DURING PREGNANCY**

Malignancies are rare during pregnancy, with an overall incidence of 1 in 1000.\textsuperscript{79} Renal cell carcinoma is the most common urologic tumor of pregnancy followed by benign angiomylipoma.\textsuperscript{80} MRI is a useful diagnostic technique to evaluate renal masses due to the lack of exposure to radiation. Although pregnancy and cancer are the only 2 biologic conditions in which antigenic tissue is tolerated by a normally functioning immune system, no studies demonstrate any difference in tumor progression during pregnancy as compared with the nonpregnant state.\textsuperscript{81} Management of the tumor during pregnancy should consider the biologic behavior of the tumor and survival rate of the fetus at different gestational ages. Advanced tumors should be treated aggressively, despite the increased risk of fetal mortality, whereas smaller tumors may be observed until delivery or until fetal lung maturity is appropriate for cesarean section.\textsuperscript{81}

The finding of pheochromocytoma during pregnancy presents a challenge for the urologist and obstetrician. Deaths from malignant hypertensive crisis have been reported during vaginal delivery in patients with undiagnosed pheochromocytoma.\textsuperscript{82} Antenatal diagnosis is key in these patients to avoid maternal and fetal mortality. Because pheochromocytoma is rare, patients are not screened for this condition; therefore, diagnosis requires a high index of suspicion. Symptoms of pheochromocytoma in pregnancy are similar to those in the nonpregnant state (eg, episodic hypertension, flushing, palpitations, anxiety). Once diagnosed, the patient should be medically stabilized for surgery and undergo preoperative α-blockade and β-blockade. Surgical excision is the definitive treatment and usually is performed prior to delivery. However, the timing is controversial, with some recommending planned cesarean section along with surgical excision to avoid using 2 anesthetics.\textsuperscript{81}

Urothelial tumors are rare during pregnancy. If needed, transurethral resection of bladder tumors can be performed successfully during pregnancy.\textsuperscript{83}

**CONCLUSION**

Several urologic issues can arise during pregnancy. Most obstetricians are familiar with the common urologic conditions that occur during pregnancy and can perform
the initial diagnostic work-ups. However, urologists play a key role in managing more complex urologic disease processes. A coordinated approach between the obstetrician, urologist, and other health care members is essential to provide the best care for both the mother and fetus.

REFERENCES


