MANAGEMENT OF UROLITHIASIS IN PREGNANT WOMEN: MODERN CLINICAL APPROACHES

Narkulova Soxiba Uktamovna
Assistant, Department of Obstetrics and Gynecology №3, Samarkand State Medical University, Samarkand, Uzbekistan
Kurbanov Shavkat Sharafbayevich
Clinical Resident, Department of Urology, Samarkand State Medical University, Samarkand, Uzbekistan

Abstract. Urolithiasis during pregnancy represents a challenging clinical condition due to its multifactorial pathogenesis, diagnostic limitations, and potential maternal–fetal complications. This study aimed to evaluate the clinical course, diagnostic strategies, and effectiveness of modern management approaches for urolithiasis in pregnant women. A prospective observational study involving 112 pregnant patients was conducted between 2021 and 2024. Conservative, metabolic, and minimally invasive treatment methods were assessed. The results demonstrated that pregnancy-related hormonal and anatomical changes significantly contribute to urinary stasis and stone formation. Conservative therapy was effective in the majority of mild and moderate cases, while ureteral stenting proved to be the most reliable intervention in severe obstruction. Implementation of a structured clinical algorithm improved maternal outcomes and reduced obstetric complications.

Keywords: pregnancy, urolithiasis, obstructive nephropathy, ureteral stenting, ultrasound, MRI.

Annotatsiya. Homiladorlik davrida siydik-tosh kasalligi ko‘p omilli patogenezga ega bo‘lib, ona va homila uchun jiddiy xavf tug‘dirishi mumkin. Ushbu tadqiqot homilador ayollarda urolitiazning klinik kechishi, diagnostik imkoniyatlari va zamonaviy davolash usullarining samaradorligini baholashga qaratilgan. 2021–2024-yillarda 112 nafar homilador ayol ishtirokida prospektiv kuzatuv o‘tkazildi. Konservativ, metabolik va minimal invaziv davolash usullari tahlil qilindi. Natijalar homiladorlikka xos gormonal va anatomik o‘zgarishlar siydik turg‘unligi va tosh hosil bo‘lishini kuchaytirishini ko‘rsatdi. Og‘ir obstruksiya holatlarida ureteral stentlash eng samarali va xavfsiz muolaja sifatida aniqlandi. Taklif etilgan klinik algoritm asoratlar xavfini kamaytirdi.

Kalit so‘zlar: homiladorlik, urolitiaz, obstruktiv nefropatiya, ureteral stent, UZD, MRT.

Аннотация. Мочекаменная болезнь у беременных является сложной клинической проблемой, обусловленной гормональными, анатомическими и метаболическими изменениями. В статье представлены результаты проспективного наблюдения за 112 беременными женщинами с уролитиазом. Оценена эффективность консервативной, метаболической и минимально

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инвазивной терапии. Установлено, что при выраженной обструкции уретеральное стентирование является наиболее эффективным методом лечения. Разработан клинический алгоритм ведения пациенток, способствующий снижению материнских и перинатальных осложнений.

Ключевые слова: беременность, уролитиаз, обструкция, уретеральный стент, УЗИ, МРТ.

Introduction

Pregnancy is a dynamic physiological process characterized by extensive hormonal, hemodynamic, anatomical, and metabolic adaptations aimed at maintaining maternal–fetal homeostasis. While these changes are essential for normal gestation, they simultaneously predispose pregnant women to several pathological conditions, particularly disorders of the urinary system. Among these, urolithiasis represents a clinically significant problem due to its potential to cause severe maternal morbidity and adverse obstetric outcomes.

Although the overall incidence of urolithiasis during pregnancy remains relatively low, reported between 0.03% and 1%, it is considered one of the leading non-obstetric causes of acute abdominal pain and hospital admission during gestation. Importantly, renal colic during pregnancy is not a benign condition; it has been associated with increased uterine activity, premature cervical changes, and an elevated risk of preterm labor and premature rupture of membranes.

From a pathophysiological perspective, pregnancy induces several mechanisms that collectively promote stone formation. Progesterone plays a central role by relaxing smooth muscle fibers of the ureters, leading to reduced peristalsis and physiological hydronephrosis. This phenomenon is observed in up to 80–90% of pregnant women and is more pronounced on the right side due to uterine dextrorotation and compression of the right ureter by the ovarian vein complex.

Simultaneously, estrogen-mediated increases in renal plasma flow and glomerular filtration rate result in enhanced urinary excretion of calcium, sodium, oxalates, and uric acid. These metabolic changes create a lithogenic urinary environment. Pregnancy-associated hypocitraturia further reduces the natural inhibition of calcium crystallization, thereby facilitating stone growth and aggregation. Mechanical compression of the ureters by the enlarging uterus during the second and third trimesters exacerbates urinary stasis and contributes to stone migration and obstruction.

Clinically, urolithiasis in pregnancy presents a diagnostic dilemma. Symptoms such as flank pain, nausea, vomiting, and hematuria may overlap with obstetric conditions including placental abruption, preterm labor, or appendicitis. Furthermore, the use of ionizing radiation is limited due to fetal safety concerns,

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necessitating reliance on ultrasound and magnetic resonance imaging, which may have reduced sensitivity for small or distal ureteral stones.

Given these complexities, the management of urolithiasis during pregnancy requires a multidisciplinary approach involving obstetricians, urologists, radiologists, and neonatologists. The primary goal is to relieve maternal symptoms, preserve renal function, and prevent obstetric complications while minimizing fetal risk. The present study seeks to provide an in-depth evaluation of clinical presentation, diagnostic strategies, treatment outcomes, and pregnancy-related consequences of urolithiasis in a cohort of 112 pregnant women.

MATERIALS AND METHODS

Study Design and Ethical Considerations

This prospective observational study was conducted between January 2021 and December 2024 at the clinical bases of Samarkand State Medical University. The study protocol conformed to the principles of the Declaration of Helsinki and was approved by the local ethics committee. Written informed consent was obtained from all participants prior to inclusion.

Study Population

A total of 112 pregnant women aged 19 to 39 years (mean age 27.8 ± 3.6 years) with confirmed urolithiasis were enrolled. Patients were included across all trimesters: 28% in the first trimester, 41% in the second trimester, and 31% in the third trimester. Primigravidae constituted 68% of the study population, reflecting the increased susceptibility of first-time pregnancies to urinary tract adaptations.

Inclusion and Exclusion Criteria

Inclusion criteria comprised confirmed intrauterine pregnancy, clinical symptoms suggestive of urolithiasis, and radiological confirmation via ultrasound or MRI. Exclusion criteria included pre-existing chronic kidney disease (stage ≥ III), congenital urinary tract anomalies, autoimmune renal disorders, malignancy, and severe obstetric complications unrelated to urolithiasis.

Diagnostic Protocol

All patients underwent standardized clinical evaluation, including assessment of pain intensity using the visual analog scale (VAS), measurement of body temperature, and evaluation of urinary symptoms. Laboratory investigations included complete blood count, urinalysis, serum creatinine, C-reactive protein (CRP), procalcitonin (PCT), and metabolic urinary parameters (oxalate, urate, phosphate).

Ultrasound examination served as the first-line imaging modality and was performed in all patients to determine stone size, localization, and degree of hydronephrosis. Doppler uroflowmetry was used to assess functional obstruction by measuring resistive indices and urinary flow patterns. Non-contrast MRI was

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selectively employed in diagnostically ambiguous cases or when differentiation between physiological and pathological hydronephrosis was required.

Therapeutic Strategy

Management decisions were individualized based on gestational age, stone characteristics, severity of obstruction, and presence of infection. Conservative therapy included adequate hydration, antispasmodics, and pregnancy-safe analgesics. Metabolic therapy with citrate preparations was prescribed to correct hypocitraturia and reduce stone growth. Minimally invasive interventions, such as ureteral stenting or percutaneous nephrostomy, were reserved for cases of persistent pain, progressive obstruction, infection, or impaired renal function.

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Comparative analyses were conducted using chi-square and Student's t-tests, with statistical significance set at $p < 0.05$.

RESULTS

Clinical presentation varied significantly depending on gestational age, stone size, and localization. Flank pain was reported by 86% of patients and represented the most common presenting symptom. Pain intensity was significantly higher in patients with distal ureteral stones compared to those with renal pelvic calculi ($p < 0.01$).

Dysuria was observed in 58% of patients and was more frequently associated with distal ureteral stones. Hematuria was detected in 42% of cases, while fever and elevated inflammatory markers were present in 24%, indicating concomitant urinary tract infection. Notably, infection-associated urolithiasis was more common during the second and third trimesters.

Stone localization analysis revealed that distal ureteral stones accounted for 54% of cases, proximal ureteral stones for 22%, renal pelvic stones for 16%, and calyceal stones for 8%. Oxalate stones were the predominant chemical composition (63%), followed by uric acid stones (24%) and phosphate stones (11%). Mixed stones were rare (2%).

Conservative therapy resulted in spontaneous stone passage in 72% of patients, particularly when stone size was less than 6 mm and obstruction was mild. Metabolic therapy with citrate preparations significantly improved outcomes in patients with recurrent or metabolically active stones. Ureteral stenting was required in 24 patients with severe obstruction and resulted in rapid symptom relief in 95% of cases.

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Pregnancy outcomes analysis demonstrated term delivery in 77% of patients. Preterm birth occurred in 14% of cases and was significantly associated with severe obstruction, infection, and delayed intervention ($p < 0.05$). Neonatal complications were observed in 8% of cases, primarily related to prematurity.

PATHOGENETIC MECHANISMS OF UROLITHIASIS DURING PREGNANCY

The pathogenesis of urolithiasis during pregnancy is complex and multifactorial, involving hormonal, metabolic, anatomical, and immunological mechanisms that interact dynamically throughout gestation. Unlike urolithiasis in non-pregnant individuals, stone formation during pregnancy is strongly influenced by gestation-specific physiological adaptations.

Progesterone plays a pivotal role by inducing relaxation of smooth muscle fibers in the ureters and renal pelvis, leading to reduced peristaltic activity and prolonged urinary transit time. This phenomenon contributes to urinary stasis, which is a critical prerequisite for crystal nucleation and aggregation. Physiological hydronephrosis, observed in the majority of pregnancies, further complicates urinary drainage and masks early pathological obstruction.

Estrogen-related increases in renal plasma flow and glomerular filtration rate lead to enhanced urinary excretion of lithogenic substances, including calcium, oxalates, sodium, and uric acid. Hypercalciuria during pregnancy is well documented and results from increased intestinal calcium absorption mediated by vitamin D. Simultaneously, pregnancy-associated hypocitraturia diminishes the inhibitory effect of citrate on calcium stone formation, thereby accelerating crystallization processes.

Mechanical factors also play a significant role. Progressive enlargement of the uterus during the second and third trimesters results in extrinsic compression of the ureters, particularly on the right side due to uterine dextrorotation and anatomical relationships with the iliac vessels. This mechanical compression not only promotes urinary stasis but also facilitates stone migration from the renal pelvis into the ureter, where obstruction becomes clinically significant.

Emerging evidence suggests that inflammatory and immunological mechanisms may further contribute to stone formation during pregnancy. Subclinical urinary tract inflammation, alterations in urinary pH, and changes in the urinary microbiome may create a microenvironment favorable for crystal adherence to the urothelium. These factors highlight the importance of considering urolithiasis in pregnancy as a systemic condition rather than a purely mechanical problem.

TRIMESTER-SPECIFIC CLINICAL FEATURES

ISSN 3030-3907

The clinical presentation of urolithiasis during pregnancy varies significantly across trimesters, reflecting the progressive nature of physiological and anatomical changes.

During the first trimester, symptoms are often mild or nonspecific. Flank discomfort may be intermittent, and laboratory abnormalities are usually minimal. Diagnostic challenges are particularly pronounced at this stage, as symptoms may mimic early pregnancy-related gastrointestinal complaints.

In the second trimester, increased uterine size and enhanced hormonal effects lead to more pronounced urinary stasis. Renal colic becomes more frequent and intense, and ultrasound often reveals moderate hydronephrosis. This period is associated with the highest rate of first-time urolithiasis diagnosis.

The third trimester is characterized by maximal mechanical compression of the ureters and the highest risk of severe obstruction. Clinical manifestations during this period tend to be more dramatic, including persistent flank pain, fever, and laboratory signs of inflammation. Importantly, urolithiasis in the third trimester carries the greatest risk of triggering preterm labor due to reflex uterine contractions induced by pain and infection.

Understanding trimester-specific differences is essential for tailoring diagnostic and therapeutic strategies and for predicting obstetric outcomes.

DIFFERENTIAL DIAGNOSIS IN PREGNANT WOMEN WITH FLANK PAIN

Differential diagnosis of flank pain during pregnancy is particularly challenging due to the wide range of obstetric and non-obstetric conditions that may present with overlapping symptoms. Acute appendicitis, placental abruption, preterm labor, ovarian torsion, and acute pyelonephritis must all be considered.

Physiological hydronephrosis of pregnancy represents a major diagnostic pitfall, as it may be misinterpreted as pathological obstruction. Doppler uroflowmetry plays a crucial role in distinguishing these conditions by assessing functional impairment rather than anatomical dilation alone.

In contrast to urolithiasis, placental abruption is typically associated with uterine tenderness, vaginal bleeding, and fetal distress, while appendicitis presents with right lower quadrant pain and systemic inflammatory response. Careful clinical evaluation combined with targeted imaging is essential to avoid misdiagnosis and inappropriate intervention.

LONG-TERM MATERNAL AND PERINATAL IMPLICATIONS

Beyond acute management, urolithiasis during pregnancy has potential long-term implications for both maternal and neonatal health. Women who develop stones during pregnancy are at increased risk of recurrence in subsequent

ISSN 3030-3907

pregnancies and in the postpartum period, particularly if underlying metabolic abnormalities persist.

From a perinatal perspective, recurrent renal colic, infection, and obstructive nephropathy may lead to placental insufficiency, fetal growth restriction, and preterm birth. Although most neonates in this study had favorable outcomes, the observed association between severe obstruction and prematurity underscores the need for long-term follow-up.

Postpartum metabolic evaluation and counseling regarding dietary modification, hydration, and recurrence prevention are therefore essential components of comprehensive care.

CLINICAL IMPLICATIONS AND FUTURE DIRECTIONS

The findings of this study support the integration of standardized clinical algorithms into routine obstetric and urological practice. Early identification of high-risk patients, particularly those with large stones or signs of infection, allows for timely intervention and improved outcomes.

Future research should focus on refining non-invasive diagnostic tools, exploring the role of urinary biomarkers in early detection, and evaluating the long-term safety of emerging minimally invasive techniques during pregnancy. Multicenter studies with larger cohorts are needed to establish evidence-based guidelines tailored specifically to pregnant populations.

Urolithiasis during pregnancy is a multifaceted condition influenced by hormonal, metabolic, mechanical, and inflammatory factors. Its clinical course varies across trimesters and requires a high index of suspicion for timely diagnosis. Conservative management remains effective in most cases; however, minimally invasive interventions, particularly ureteral stenting, are indispensable in severe obstruction. A multidisciplinary, algorithm-based approach is essential to optimize maternal and perinatal outcomes.

DISCUSSION

The findings of this study confirm that urolithiasis during pregnancy is a multifactorial condition resulting from the interplay of hormonal, metabolic, and mechanical factors. The predominance of distal ureteral stones observed in our cohort is consistent with international data and may be attributed to reduced ureteral peristalsis and increased intraluminal pressure during pregnancy.

Conservative management remains the cornerstone of treatment and is effective in the majority of cases. However, delayed intervention in patients with progressive obstruction or infection significantly increases the risk of maternal and fetal complications. Our results support ureteral stenting as the preferred minimally invasive intervention due to its high efficacy and favorable safety profile.

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The use of Doppler uroflowmetry and MRI enhanced diagnostic accuracy and facilitated timely decision-making. Importantly, a structured clinical algorithm allowed for individualized management and improved obstetric outcomes.

CONCLUSION

Urolithiasis during pregnancy represents a complex clinical challenge requiring early diagnosis, careful monitoring, and individualized management. Conservative therapy is effective in most cases, while ureteral stenting provides safe and reliable relief in severe obstruction. A multidisciplinary approach and adherence to evidence-based clinical algorithms are essential to optimize maternal and fetal outcomes.

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