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Urolithiasis in Pregnancy: A Review of Current Management Strategies

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Abstract

Background. Urolithiasis during pregnancy is a complex clinical challenge occurring in approximately 8.3 per 10,000 pregnancies. Physiological changes increase stone risk, while standard diagnostic and therapeutic options (e.g., CT, ESWL) are restricted due to fetal safety concerns. Unmanaged symptomatic stones significantly elevate the risk of pyelonephritis, premature labor, and preeclampsia.

Aim. To synthesize recent evidence and outline the current multidisciplinary consensus for managing pregnant patients with urolithiasis.

Materials and methods. A review of 19 key studies, including large population-based cohorts, meta-analyses, and clinical surveys, focusing on imaging, conservative management, and endourological interventions.

Results. Pregnant women frequently present with atypical symptoms. Ultrasound remains the gold-standard first-line imaging modality, with non-contrast MRI as the preferred second-line option. Approximately 95% of cases can be successfully managed conservatively. When

intervention is required, both temporary drainage using a JJ stent and primary ureteroscopy (URS) demonstrate high obstetric safety (>99% normal pregnancy outcomes). However, URS provides definitive stone clearance with an approximately 1% complication rate, compared with a 45% rate of minor complications and rapid stent encrustation associated with temporary drainage.

Conclusions. A multidisciplinary approach based on shared clinical judgement is essential. Conservative therapy is prioritized, however, primary URS by experienced teams is the preferred definitive treatment if intervention is required.

Key words: urolithiasis, pregnancy, ureteroscopy, renal colic, multidisciplinary approach.

1. Introduction

Urolithiasis is a significant and escalating global health concern, affecting approximately 10% of the general population at some point in their lives, with a rising incidence driven by lifestyle, dietary, and environmental factors [19]. As the demographic of stone formers shifts to include a higher proportion of young females, the intersection of urolithiasis and childbearing has become an increasingly common clinical scenario. Among the various urological emergencies, symptomatic urolithiasis during pregnancy represents one of the most demanding challenges for modern medicine. It requires a delicate, constant balance between resolving maternal morbidity and ensuring fetal safety [6, 13]. Although it is not an everyday occurrence, with an estimated incidence ranging from 8.3 per 10,000 hospitalizations [4] to approximately 0.8% of all pregnancies [18], it remains one of the most frequent non-obstetric cause of acute abdominal pain leading to hospital admission in pregnant women [5].

The predisposition to stone formation during gestation is driven by a profound and complex interplay of physiological, hormonal, and anatomical changes. Pregnancy induces significant alterations in the urinary tract. Hormonally, the elevation of serum progesterone causes smooth muscle relaxation, leading to a decrease in ureteral peristalsis and subsequent urinary stasis. Mechanically, the enlarging gravid uterus typically undergoes dextrorotation, which compresses the right ureter more significantly than the left. This combination results in physiological hydronephrosis, which can be observed in up to 80% of pregnancies and becomes symptomatic in about 3% of cases [18]. Furthermore, pregnancy is characterized by a 40-50% increase in the glomerular filtration rate (GFR). This metabolic shift leads to an increased

filtered load of calcium and uric acid, resulting in absorptive hypercalciuria. While this pro-lithogenic state is partially counterbalanced by an increased excretion of stone inhibitors such as citrate and magnesium, the overall altered urinary environment creates a unique and highly susceptible setting for lithogenesis, particularly in the second and third trimesters [9, 14, 19].

Managing acute renal colic in this specific cohort is associated with both diagnostic and therapeutic dilemmas, often described as a highly stressful situation for the patient and physician alike [13]. The clinical presentation is frequently atypical; pregnant women with obstructing stones are significantly less likely to present with classic symptoms such as intense flank pain, hematuria, or fever compared to their non-pregnant counterparts [15]. The diagnostic process is further complicated by significant limitations in the standard urological tools available. Ionizing radiation, particularly computed tomography (CT) (the gold standard in the general population) is strongly avoided due to teratogenic risks, while alternative imaging modalities like magnetic resonance imaging (MRI) suffer from lower sensitivity in detecting small, calcified calculi [12, 16].

The risks associated with managing these patients are exceptionally high. Failure to promptly diagnose and appropriately manage symptomatic stones can lead to devastating obstetric and systemic complications. Evidence consistently demonstrates that urolithiasis in pregnancy is associated with a significantly increased risk of adverse outcomes, including preeclampsia, gestational diabetes, premature rupture of membranes, preterm labor, and even maternal death. [2, 4]. Notably, the development of an infected obstructed kidney (pyelonephritis or urosepsis) in a pregnant patient represents a life-threatening emergency requiring immediate intervention and decompression [4, 11, 19]. Furthermore, standard definitive treatments such as extracorporeal shockwave lithotripsy (ESWL) and percutaneous nephrolithotomy (PCNL) are strictly contraindicated during pregnancy, leaving endourologists with a narrowed field of surgical options [12, 19].

Despite these well-documented risks, practice patterns vary wildly across the globe, and a significant proportion of medical institutions still lack standardized, evidence-based management protocols for pregnant patients presenting with acute renal colic [10]. Recent literature emphasizes that the cornerstone of successful management is not just technical surgical skill, but a highly coordinated multidisciplinary approach. The optimal care pathway requires the active collaboration of urologists, obstetricians, radiologists, and anesthesiologists, engaging in shared decision-making directly with the fully informed patient [8, 11, 14, 18].

This review summarizes evidence from the past decade on the pathophysiology, diagnosis, and management of urolithiasis in pregnancy. It aims to provide a practical guide for clinicians and proposes a structured approach to support safe and effective care in this patient population.

2. Research Materials and Methods

A comprehensive review of the scientific literature was conducted to identify relevant studies concerning the diagnosis and management of urolithiasis during pregnancy. The search was performed across major medical databases, including **PubMed** and **Google Scholar**.

2.1 Search Strategy

The search strategy utilized a combination of Medical Subject Headings (MeSH) terms and relevant keywords, including: "urolithiasis", "nephrolithiasis", "renal colic", "pregnancy", "diagnostic imaging", "ureteroscopy", and "ureteral stent". To ensure the review reflects the most current evidence-based practices, the focus was primarily placed on peer-reviewed articles, meta-analyses, and large-scale retrospective studies published between 2014 and 2022.

2.2 Data extraction and Synthesis

A total of 19 key publications were selected for final analysis. These included a diverse range of evidence: meta-analyses, systematic reviews, large-scale national insurance database analyses, and clinical surveys regarding practice patterns. The data extracted from these sources were qualitatively synthesized to identify consensus on diagnostic hierarchies, the efficacy of conservative vs. surgical management, and the incidence of obstetric complications.

3. Research Results

3.1 Clinical Presentation and Diagnostic Challenges

The clinical presentation of urolithiasis during pregnancy frequently deviates from the classic patterns observed in the general population, making the initial assessment highly challenging. While renal colic remains a primary complaint, a massive population-based cohort study (n = 42,113 pregnant patients) demonstrated that pregnant women are significantly less likely to present with classic flank pain (OR 0.63) or fever (OR 0.22) compared to age-matched non-pregnant women with urolithiasis [15].

This atypical presentation requires high clinical vigilance. Furthermore, physiological changes during pregnancy, particularly the dilatation of the pelvicalyceal system and ureters

(predominantly on the right side), can easily mimic an acute stone event. In an emergency department setting, a study evaluating pregnant patients presenting with acute renal colic found that no actual stone was identified in 36.1% of cases despite rigorous evaluation with ultrasound and diagnostic ureteroscopy [16]. This highlights a critical diagnostic dilemma: the presence of pain and hydronephrosis in a pregnant patient is not strictly synonymous with obstructing urolithiasis.

3.2 Imaging Modalities: Guidelines vs. Clinical Reality

Restrictions related to ionizing radiation demand a personalized approach to imaging, which is fundamental to effective treatment [18, 19]. The evidence shows a structured hierarchy of preferred diagnostic modalities, alongside a noticeable difference between guideline recommendations and real-world practice.

Ultrasonography (US): Ultrasound remains the undisputed gold standard, first-line imaging modality due to its safety profile, accessibility, and lack of ionizing radiation [1, 8, 11, 18, 19]. However, its diagnostic accuracy is heavily operator-dependent and limited by physiological gestational changes. Studies show that US can be highly deceptive; in one cohort, US failed to identify stones in 22.6% of symptomatic patients who were subsequently diagnosed during ureteroscopy [16].

Magnetic Resonance Imaging (MRI): When US results are equivocal, non-contrast MRI is officially recommended as the second-line modality of reserve [8, 18]. While MRI avoids radiation risks and accurately outlines the anatomical level of obstruction, it possesses a crucial weakness: it is significantly less sensitive than computed tomography in detecting small, calcified calculi [12].

Computed Tomography (CT): The use of CT in pregnancy is a subject of intense debate due to teratogenic and carcinogenic risks to the fetus [13]. Although low-dose CT may be considered in strictly limited, highly selected cases where other modalities fail and life-threatening complications are suspected [18], it is generally avoided.

Interestingly, there is a profound contrast between physician reported behavior and actual claims data regarding CT usage. A global survey of practitioners revealed that when faced with unclear ultrasound results, 34.6% of physicians would choose non-contrast CT as their second-line imaging choice over MRI, and 42.5% admitted to having requested a CT scan during pregnancy previously [10]. Conversely, a review of a large national insurance claims database

(n = 14,298) showed that in actual billed practice, abdominal imaging consisted of US in 74.3% of cases, X-ray in 9%, and MRI in 2.8%, with CT scans effectively not being utilized as a diagnostic modality during pregnancy (0%) [17]. These findings underline the challenges and stress involved in acute clinical decision-making [13], while also demonstrating adherence to safety standards in national cohort data.

3.3 Conservative Management and Pharmacotherapy

The consensus across the reviewed literature is definitive: unless specific contraindications exist, conservative management should always be the preferred first-line approach for pregnant women presenting with symptomatic urolithiasis [14, 18, 19].

For asymptomatic calculi incidentally discovered during routine screening, a strict policy of "watchful waiting" is recommended, requiring no active intervention [9]. In symptomatic cases without complications, the primary goal is to facilitate a spontaneous trial of passage while ensuring adequate pain management and hydration [19]. This approach is remarkably successful; a large national cohort study revealed that conservative management is sufficient for the vast majority of patients, with only 5.2% ultimately requiring any form of procedural intervention [17]. Quantitatively, conservative therapy achieves a spontaneous stone-free rate of approximately 54% and provides adequate symptom relief in 62% of women [7].

The standard observation period for a trial of passage is typically 24 to 48 hours [10]. During this window, safe pharmacotherapy is vital. While options are limited, specific analgesic and antiemetic agents can be safely administered to manage symptoms without harming the fetus [11].

However, conservative management is strictly contraindicated in the presence of an infected, obstructed urinary system. In this situation, immediate surgical intervention is required [11, 19]. Furthermore, an extended delay in intervention when conservative measures fail strongly correlates with an increased risk of urosepsis and premature uterine contractions (PUC) [16].

3.4 Surgical Intervention: Temporary Drainage vs Definitive Treatment

When conservative management fails after 24 - 48 hours, or if complications such as intractable pain, acute kidney injury, or sepsis arise, surgical intervention must be planned as soon as possible [10, 16]. It must be explicitly stated that extracorporeal shockwave lithotripsy (ESWL) and percutaneous nephrolithotomy (PCNL) are strictly contraindicated during pregnancy due to fetal risks [12, 19]. Consequently, endourological options are narrowed to temporary urinary

drainage (ureteral Double-J stent or percutaneous nephrostomy - PCN) and definitive treatment via ureteroscopy (URS).

Temporary Drainage (Double-J Stent and PCN): Historically, the placement of a Double-J (JJ) stent or PCN has been the standard of care for rapid decompression. Real-world claims data indicate that JJ stenting remains the most performed procedure (3.3% of all pregnant stone formers) [17]. While temporary drainage is highly effective (success rates up to 97%), it is associated with significant drawbacks. The pooled incidence of minor complications associated with internal stents is approximately 45%, primarily consisting of severe lower urinary tract symptoms (LUTS) and recurrent infections [3]. Furthermore, due to the pro-lithogenic state of pregnancy, both stents and nephrostomy tubes require frequent exchanges, typically every 6 weeks, to prevent severe encrustation [10, 11]. Most importantly, temporary drainage obligates the patient to undergo a second, definitive surgery postpartum [5].

Definitive Treatment (Ureteroscopy - URS): Recent evidence strongly advocates for primary URS as the preferred interventional modality when clinical conditions permit, as it offers definitive stone clearance in a single procedure [3, 5, 11]. The efficacy of URS in pregnancy is outstanding, boasting an operative success rate of 99% and a pooled stone-free rate of 91%, which is comparable to non-pregnant populations [3, 5]. Moreover, the complication rate is remarkably low (approximately 1%), making it significantly less demanding for the patient than inserting stents [3, 11]. Various intracorporeal lithotripsy methods can be used during URS, with stone removal (basket/forceps) achieving 95.4% efficacy, pneumatic lithotripsy 88.5%, and laser lithotripsy 76.4% [7].

Despite its advantages, claims data show URS is performed in only 1.3% of cases, predominantly before 34 weeks of gestation, likely to minimize the risk of inducing premature labor late in pregnancy [17]. Therefore, while primary URS is highly recommended, it requires a careful patient selection process and should optimally be performed in centers with appropriate endourological expertise [14, 18].

3.5 Complications and Obstetric Outcomes

The presence of urolithiasis during pregnancy significantly elevates the risk profile for both the mother and the fetus, making it a high-risk obstetric condition. The literature reveals a stark contrast between the systemic risks caused by the disease itself and the relatively low complication rates of modern surgical interventions.

Systemic and Obstetric Risks: A massive population-based retrospective cohort study highlighted that pregnant women with urolithiasis have a drastically higher risk of developing severe complications compared to healthy pregnancies. Most notably, the risk of pyelonephritis skyrockets (OR 88.87), accompanied by increased risks of preeclampsia / eclampsia (OR 1.35), gestational diabetes (OR 1.29), abruptio placenta (OR 1.41), placenta previa (OR 1.55), and venous thromboembolism (OR 1.65) [4]. Consequently, maternal death is significantly more common in this cohort (OR 2.85) [4]. Fetal outcomes are also negatively impacted, with a higher incidence of premature rupture of membranes, prematurity (OR 1.92), and congenital anomalies (OR 2.84) [2, 4].

From a clinical triage perspective, fever at initial presentation is a critical "red flag" strictly associated with an increased risk of sepsis and premature uterine contractions (PUC) [16]. Interestingly, one study identified a specific biochemical marker: lower maternal serum magnesium levels were found to be highly correlated with a more frequent occurrence of PUC during renal colic episodes [16].

Surgical Complications: Conversely, when intervention is required, modern endourological procedures demonstrate excellent safety profiles regarding obstetric outcomes. Whether temporary drainage (JJ stent) or definitive treatment (URS) is chosen, the rate of normal fertility outcomes remains remarkably high (99%), with pooled rates of premature birth and abortion remaining below 1% for both groups [3]. A review of 3,424 interventions reported 167 cases of preterm labor, resulting in only 24 premature births, confirming that the surgical interventions themselves (including anesthesia) do not significantly compromise the pregnancy when performed correctly [5, 16].

4. Discussion and Conclusions

The management of urolithiasis in pregnancy represents a unique intersection of urology, obstetrics, and emergency medicine. Despite the escalating prevalence of this condition and the well-documented risks of severe maternal and fetal morbidity, such as premature labor, preeclampsia, and pyelonephritis [2, 4, 19], a glaring systemic gap remains. The literature reveals that up to 66.2% of hospitals globally lack established management protocols for this specific clinical scenario [10].

This absence of standardized pathways forces clinicians into stressful, ad-hoc decision-making processes [13]. This stress is vividly illustrated by the discrepancy in diagnostic imaging. While

national claims data confirm that official guidelines are generally adhered to (with ultrasound dominating and CT scans effectively avoided in documented practice) [17], anonymous surveys reveal a persistent temptation among physicians to utilize non-contrast CT scans when faced with ambiguous ultrasounds. This highlights a critical diagnostic desperation that exposes the fetus to unnecessary ionizing radiation [10].

Synthesis of Evidence-Based Practice to mitigate these risks and alleviate clinical stress. The reviewed literature unanimously calls for a transition toward a structured, multidisciplinary approach anchored in "shared decision-making" [6, 8, 11, 14, 18]. Rather than relying on individual intuition, the current evidence dictates a clear consensus.

Diagnostics: Immediate renal ultrasonography (US) remains the absolute gold standard. If findings are equivocal, non-contrast MRI serves as the safest second-line modality [8, 18].

First-line Therapy: In the absence of infection, acute kidney injury, or intractable pain, a 24- to 48-hour trial of conservative management (hydration, safe analgesia) is the preferred initial approach, successfully resolving the issue in most cases [10, 11, 14, 17].

Emergency Decompression: The presence of fever, signs of urosepsis, or an infected obstructed system dictates the immediate abandonment of conservative measures in favor of rapid surgical decompression (JJ stent or PCN) [11, 16].

Definitive Treatment: When conservative management fails in a non-septic patient, primary ureteroscopy (URS) is highly advocated. Compared to the high minor complication rates (approx. 45%) and rapid encrustation associated with prolonged stenting, URS provides excellent stone-free rates (91%) in a single procedure. However, to maximize safety, it must be performed by endourologists with appropriate expertise and is optimally scheduled before 34 weeks of gestation [3, 5, 17, 18].

Limitations of Current Literature and Future Directions: While these management strategies are widely accepted, it is crucial to acknowledge the limitations of the existing body of literature. The vast majority of available data stems from retrospective cohort studies, insurance database claims, and clinical surveys [7, 15, 17]. There is a distinct lack of large-scale, prospective Randomized Controlled Trials (RCTs) directly comparing surgical modalities in pregnant women. This is largely due to the ethical constraints of randomizing pregnant patients to potentially inferior or more invasive treatments. Consequently, the overall quality of evidence is often graded as moderate [7]. Future research should focus on establishing multi-

institutional prospective registries to systematically track maternal and fetal outcomes following URS and stenting, which would provide higher-quality, real-world data.

Conclusions: Urolithiasis in pregnancy is a complex, high-risk condition that demands meticulous care. Strict adherence to established, literature-backed diagnostic and therapeutic pathways, coupled with the involvement of experienced multidisciplinary teams, is essential. By prioritizing conservative management where appropriate and utilizing primary URS judiciously, clinicians can navigate this challenging scenario safely, consistently ensuring excellent outcomes for both mother and child.

5. Disclosure

Author's contribution

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