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Retrospective Study

Does delaying ureteral stent placement lead to higher rates of preoperative acute pyelonephritis during pregnancy?

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Abstract

BACKGROUND

Pregnancy with renal colic may cause pyelonephritis, decreased renal function, systemic infection and even shock in pregnant women, and cause premature birth and other adverse pregnancy outcomes. When surgery is necessary, the relationship between timing of the operation and the outcome of the mother and child are not known.

AIM

To investigate the association between time to ureteral stent placement and clinical outcomes of patients with renal colic during pregnancy.

METHODS

In this retrospective study, pregnant women with renal colic who underwent surgery were studied. Maternal preoperative acute pyelonephritis (PANP), pregnancy outcome, and length of hospital stay (LOS) were compared between the two groups.

RESULTS

100 patients were included in the analysis, median age was 30 years. Median time to ureteral stent placement was 48 h (interquartile range, 25-96 h), and 32 patients (32%) were diagnosed with PANP. PANP was closely related to hospitalization costs, re-admission to the hospital due to urinary tract infection after surgery and premature delivery. Multivariate analysis found that stone location and time from pain to admission were related to PANP.

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CONCLUSION

Both early and delayed surgery are safe and effective for the treatment of renal colic during pregnancy. Early surgery may be superior to a delayed procedure due to shorter LOS. For pregnant patients with renal colic, delayed surgery within 48 h is not related to the clinical outcome of the mother and child. However, the time from pain to hospital admission was related to PANP.

Key Words: Renal colic; Ureteral stent placement; Acute pyelonephritis; Pregnancy

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Core Tip: Acute renal colic is one of the most common reasons for pregnant women to be hospitalized for non-obstetric reasons. Renal colic in most patients is resolved after conservative treatment. However, when conservative treatment fails, active surgical treatment is necessary, thus the choice of the timing of the operation is very important. In this study, we examined the relationship between the timing of the operation and the outcome of the mother and child.

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INTRODUCTION

Acute renal colic is one of the most common reasons for pregnant women to be hospitalized for non-obstetric reasons. The incidence of renal colic during pregnancy is about 1 in 1500[1]. Renal colic may cause adverse maternal and fetal outcomes, such as premature delivery, premature rupture of membranes, urinary tract infection and sepsis, pregnancy loss and preeclampsia[2-4].

The main causes of renal colic in pregnancy are urinary stones and hydronephrosis. Several anatomical and physiological changes occur during pregnancy and may affect the entire urinary system. Antenatal hydronephrosis and hydroureter are the result of compression of the ureter at the pelvic brim due to the growing uterus and smooth muscle relaxation induced by elevated progesterone levels[5,6]. Moreover, the secretion of placental 1, 25-dihydroxycholecalciferol and parathyroid hormone are reduced, resulting in transient hypercalciuria during pregnancy. These substances in the urine combine with each other and obstruction of the urinary tract leads to the deposition of crystals in the urine in the poorly drained area, thereby forming stones [7]. The above may cause acute pyelonephritis during pregnancy. Acute pyelonephritis is a manifestation of infection of the upper urinary tract and kidneys. Most cases of pyelonephritis occur during the second and third trimesters. Pregnant women are at risk for both medical and obstetric complications resulting from pyelonephritis.

The clinical features of acute pyelonephritis during pregnancy include fever (> 38 °C), chills, low back pain, nausea, vomiting, or costal and spinal angle pain, with or without typical symptoms of cystitis. Pregnant women require special attention when they develop acute pyelonephritis. Acute pyelonephritis not only adversely affects pregnant women, but also causes anemia, renal insufficiency or respiratory insufficiency; It also affects the fetus[8].

Conservative treatment is effective in 70%-80% of patients with renal colic during pregnancy[9]. Pregnant women who develop a stone may need three types of medication: painkillers, antibiotics and anesthetic drugs. Patients with simple renal colic without other complications should be given antispasmodic, analgesic and anti-infective treatment, and if necessary, uterine contraction suppression treatment should be given[10]. However, when conservative treatment is ineffective, active surgical intervention is necessary[5]. Surgical methods include ureteroscopy, ureteroscopic lithotripsy, surgery, and nephrostomy[1].

At present, few studies have investigated the relationship between operation time and the clinical outcome of the mother and child. Therefore, the purpose of this study is to compare the effects of early surgery (less than 48 h from onset of renal colic to surgery) or delayed surgery (more than 48 h from onset of renal colic to surgery) in patients diagnosed with renal colic during pregnancy.

MATERIALS AND METHODS

Study design

A retrospective study of all pregnant women with the diagnosis of renal colic admitted to The First Affiliated Hospital of Guangzhou Medical University from January 1, 2009 to December 31, 2019 was performed. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was reviewed and approved by the First Affiliated Hospital of Guangzhou Medical University Institutional Review Board (Approval No. V1.0). Diagnosis of renal colic was as follows: left or right low back pain, with or without fever, frequent urination, urgency, hematuria, obvious percussive pain in the kidney area, and B-ultrasound confirmed stones or hydronephrosis on the affected side. The patients diagnosed with renal colic met the following criteria: percussion pain in the renal area, and B-ultrasound revealed hydronephrosis. Two hundred and twelve patients were diagnosed with renal colic. Patients with complications (such as diabetes, hypertension, immune system diseases, *etc.*) were excluded. All patients initially underwent conservative treatment, including hydration, pain relief and antibiotic treatment if necessary. If conservative treatment failed, patients with persistent renal colic, febrile urinary tract infection, sepsis, acute renal failure, or single kidney with obstruction, surgical intervention was necessary. The surgical method evaluated in this study was ureteral stent placement. Ureteroscopy was generally performed before ureteral stent placement. Among the 102 eligible patients who underwent surgery, two patients did not have follow-up data. Therefore a total of 100 patients were included in the study.

Time to ureteral stent placement (TTU), was defined as the period from diagnosis of renal colic to surgery. The median TTU in our hospital was 48 h. The patients were divided into two groups according to the TTU, the early TTU (< 48 h, $n = 42$) and delayed TTU (≥ 48 h, $n = 58$) groups. The demographic (age, BMI [body mass index], gestation) and clinical characteristics including history of stones, laboratory examination such as white blood cell (WBC) count and C-reactive protein (CRP), imaging data (stone size, stone location, and hydronephrosis), clinical outcome (PANP, preoperative fetal obstetric complications, UTI after surgery, newborn weight, cesarean section rate and preterm delivery), length of hospital stay (LOS) and total charges were compared between the two groups. Acute pyelonephritis was suggested by the presence of flank pain, nausea/vomiting, fever (> 38 °C or 100.4 °F), and/or costovertebral angle tenderness, with or without typical symptoms of cystitis, or was confirmed by the presence of bacteriuria in the setting of these symptoms. The diagnosis was confirmed if the patient met the following three criteria: renal colic, fever, and positive urine culture. Once acute pyelonephritis was diagnosed, broad spectrum intravenous antibiotics (Cephalosporin-based therapy) were administered immediately for about 7-10 d after surgery. If a susceptibility test was carried out before treatment, we used antibiotics sensitive to bacteria according to the susceptibility test results. Fetal obstetric complications were defined as premature delivery, threatened premature delivery, premature rupture of membranes, or fetal loss. UTI after surgery was defined as patients who underwent surgery for renal colic and were re-admitted to the hospital for UTI after surgery.

Parametric distributed numerical data are presented as mean \pm standard deviation. Non-parametric distributed continuous variables are presented as interquartile ranges (Q1, Q3). Categorical data are presented as numbers and percentages. T tests and Mann-Whitney U tests were used to evaluate the difference between quantitative measurements that had non-parametric distribution. Chi-squared tests were used for categorical data. The associations of preoperative and operative characteristics with the TTU and with acute pyelonephritis were evaluated using Pearson χ^2 tests.

Statistical analysis was performed with SPSS 26.0 software (SPSS, Mac). The α value was set at 0.05, and all statistical tests were 2-tailed. A logistic regression model was used to test whether the risk factors were related to the outcome variables.

RESULTS

Among 212 patients with renal colic in pregnancy, 102 patients underwent surgery. Due to missing data in 2 women, 100 pregnant women with renal colic were included in this study. If conservative treatment failed or the patient developed any of the following conditions, surgical intervention was required: clinical indications included all situations that require emergency intervention for patients with non-pregnant stones, such as isolated renal obstruction, bilateral obstruction, deterioration of renal function, intractable symptoms and related urosepsis.

The characteristics of patients in the early and delayed surgery groups are listed in [Table 1](#). The median age was 30 years and median gestation was 22 wk. The median surgery time was 48 h. Forty-two patients (42%) underwent early surgery and 58 patients (58%) underwent delayed surgery. There were no differences in basic information such as age, BMI, gestation, and history of stones between the two groups. There was no significant difference with regard to WBC count and CRP when laboratory examination data were compared. In addition, there was no significant difference in stone size, stone location, and hydronephrosis between the groups when the imaging data were compared. In terms of clinical outcome, there was a significant difference in the length of hospital stay between the two groups (7 d *vs* 9 d), but there was no difference in preoperative-fetal complications, PANP, UTI, total cost, newborn weight, cesarean section rate, and preterm delivery between the two groups. We found that the timeliness of consultation was related to the time of surgical intervention. The consultation time in early surgery group was 19 h, which was significantly earlier than that in the delayed surgery group (48 h) ([Table 1](#)).

The incidence of PANP was 32%. PANP was closely related to hospitalization costs, LOS, postoperative infection, re-admission to hospital due to UTI after surgery and premature delivery ([Table 2](#)).

In univariate analyses, increased risk of PANP was associated with BMI, gestation, time from pain to admission, time from pain to surgery, hydronephrosis and stone location ([Table 2](#)). Multivariate analysis showed that stone location and time from pain to admission were closely related to PANP ([Table 3](#)).

Renal colic symptoms were eliminated after surgery in all patients. Laboratory data were also improved ([Table 4](#)). As the patients' creatinine levels were normal before and after surgery, creatinine levels were not compared.

DISCUSSION

In this study, we assessed the relationship between the timing of surgery and clinical outcomes of the mother and child in pregnant patients with renal colic. The results showed that longer TTU was not associated with an increased risk of complications or adverse outcomes when surgery was performed within 48 h of presentation. The timeliness of surgery was closely related to urology consultation. Nevertheless, the length of hospital stay in patients with early surgical intervention was significantly shortened. Furthermore, we analyzed the relationship between acute pyelonephritis and the timing of surgical intervention and found time from pain to admission and the location of stones were risk factors for acute pyelonephritis caused by renal colic during pregnancy. Taken together, these results suggest that it is unlikely that the timing of surgery affected the risk of complications and adverse outcomes if performed within a reasonable time frame.

The timing of surgery is very important due to the impact of surgical emergencies and their complications. Previous studies showed that a delay in appendectomy within 24 h of presentation was not associated with increased risk of complicated appendicitis or surgical site infections[11,12]. Both early and delayed laparoscopic common bile duct exploration are safe and effective for the treatment of common bile duct stone-related non-severe acute cholangitis during emergent admissions[13]. Renal colic during pregnancy is an acute abdomen caused by non-obstetric reasons, and there are few reports on the timing of surgery.

The median time from admission to surgical intervention in pregnant patients with renal colic was 48 h. Based on this, we divided the patients into the early and delayed intervention groups, with 42% in the early intervention group and 58% in the delayed intervention group. The results showed that the 48-h delay from admission to surgery was not associated with an increased risk of poor clinical outcome in the mother and child. There was no difference in the effect of early and delayed surgery [see [Table 4](#)]. Management of renal colic as an urgent rather than emergency procedure was

Table 1 Patient characteristics associated with early and delayed time to ureteral stent placement

Demographic data/clinical parameters	Total (n = 100)	Early TTU (n = 42)	Delayed TTU (n = 58)	P value
Age (yr), mean ± SD	30 ± 4.55	31 ± 4.87	29 ± 4.19	0.06
BMI (kg/cm ²), mean ± SD	23.05 ± 3.06	23.38 ± 3.28	22.81 ± 2.89	0.36
Gestation (wk), mean ± SD	22 (18, 27)	22 ± 7.83	22 ± 5.02	0.99
History of stones, n (%)	26 (76)	14 (53.8)	12 (46.2)	0.16
WBC count (× 10 ⁹ /L), mean ± SD	13.48 ± 3.49	14.19 ± 4.12	12.97 ± 2.87	0.10
CRP (mg/dL), median (Q1, Q3)	2.64 (1.04, 4.35)	4.25 (1.9, 5.89)	1.77 (0.98, 4.0)	0.12
Stone size (mm), median (Q1, Q3)	8.25 (4.28, 14)	9.98 (4.5, 12)	9.07 (0, 15)	0.59
< 10 mm, n (%)	55 (55)	21 (38.2)	34 (61.8)	0.39
≥ 10 mm, n (%)	45 (45)	21 (46.7)	24 (53.3)	
Hydronephrosis (mm), median (Q1, Q3)	26.5 (15, 62)	47 (15, 80)	34 (15, 42)	0.30
None/light, n (%)	62 (62)	21 (40.4)	31 (59.6)	0.73
Moderate/severe, n (%)	38 (38)	21 (43.8)	27 (56.3)	
Stone location, n (%)				0.09
None	24 (24)	11 (45.8)	13 (54.2)	
Ureter	48 (48)	24 (50)	24 (50)	
Kidney	28 (28)	7 (25)	21 (75)	
Urology consultation time (h), median (Q1, Q3)	27 (19, 52)	19 (13, 23)	48 (24, 90)	0.001
≤ 24 h, n (%)	53 (53)	34 (64.2)	19 (35.8)	0.00
> 24 h, n (%)	47 (47)	8 (17)	39 (83)	
Preoperative fetal complications, n (%)	12 (12)	6 (50)	6 (50)	0.55
PANP, n (%)	32 (32)	15 (46.9)	17 (53.1)	0.50
UTI after surgery, n (%)	22 (22)	11 (50)	11 (50)	0.39
LOS (d), mean ± SD	7 ± 3.56	6 ± 3.03	8 ± 3.60	0.001
Total cost (Yuan in RMB), mean ± SD	12382.79 ± 5665.26	10448.95 ± 2412.28	13783.16 ± 6841.61	0.001
Newborn weight (g), mean ± SD	2893.30 ± 542.10	2891.67 ± 509.18	2894.48 ± 569.15	0.98
Cesarean section rate, n (%)	38 (38)	17 (44.7)	21 (55.3)	0.66
Preterm delivery, n (%)	8 (8)	6 (75)	2 (25)	0.07

TTU: Time to ureteral stent placement; PANP: Preoperation acute pyelonephritis; UTI: Urinary tract infection; LOS: Length of stay.

reasonable during pregnancy. We found that timeliness of intervention was related to the urology consultation. This is consistent with previous research that the availability of specialists to perform the necessary procedures has been implicated in delays in acute stone intervention[14,15]. Faw *et al*[16] reported that patients who were stented within 6, 10, and 14 h of admission had more expeditious urologic consults compared with their counterparts, indicating that early urologic consultation is vital to ensure prompt intervention.

Pyelonephritis is a severe complication of pregnancy. It has been estimated that as many as 20% of women with severe pyelonephritis develop complications that include septic shock syndrome or its variants, such as acute respiratory distress syndrome (ARDS)[17-19]. We further analyzed the risk factors for PANP, time from pain to admission and stone location, and we found that stone location was closely related to PANP. According to our data analysis, most of the patients with delayed visits were transferred to our hospital due to poor results after treatment in another hospital, which may be the reason for pyelonephritis. Therefore, we should strengthen the management of patients referred from other hospitals, and active intervention is necessary. When patients with suspected acute pyelonephritis are admitted to our hospital, empirical antibiotic use is very important to control the disease.

Table 2 Associations between preoperative characteristics and preoperative acute pyelonephritis

Demographic data/clinical parameters	PANP (n = 32)	No-PANP (n = 68)	P value
Age (yr), mean ± SD	29 ± 5.01	30 ± 4.04	0.53
BMI (kg/cm ²), mean ± SD	21.66 ± 2.44	23.30 ± 2.97	0.007
Gestation (wk), median (Q1, Q3)	20 (19, 25)	23 (20, 28)	0.04
History of stones, n (%)	12 (46.2)	14 (53.8)	0.07
Pain to surgery (h), median (Q1, Q3)	114.5 (70, 140)	84.5 (61, 120)	0.00
< 96 h, n (%)	9 (17.6)	42 (82.4)	0.002
≥ 96 h, n (%)	23 (46.9)	26 (53.1)	
Admission to surgery (h), median (Q1, Q3)	53 (24, 160)	50 (36, 90)	0.81
< 48 h, n (%)	15 (35.7)	27 (64.3)	0.81
≥ 48 h, n (%)	17 (29.3)	41 (70.7)	
Pain to admission (h), median (Q1, Q3)	90 (50, 120)	24 (12, 48)	0.00
< 48 h, n (%)	3 (6.1)	46 (93.6)	0.00
≥ 48 h, n (%)	29 (56.9)	22 (43.1)	
WBC count (× 10 ⁹ /L), mean ± SD	14.59 ± 4.40	12.96 ± 2.84	0.06
CRP (mg/dL), median (Q1, Q3)	3.20 (1.47, 6.32)	2.23 (0.97, 3.86)	0.01
Stone location, n (%)			0.00
None	6 (25)	18 (75)	
Ureter	8 (16.7)	40 (83.3)	
Kidney	18 (64.3)	10 (35.7)	
Stone size (mm), median (Q1, Q3)	8.25 (4.5, 17)	8 (0, 12)	0.25
< 10 mm, n (%)	18 (32.7)	37 (67.3)	0.86
≥ 10 mm, n (%)	14 (31.1)	31 (68.9)	
Hydronephrosis (mm), median (Q1, Q3)	31 (20, 60)	19.5 (14, 62)	0.05
None/light, n (%)	12 (23.1)	40 (76.9)	0.05
Moderate/severe, n (%)	20 (41.7)	28 (58.3)	
Urology consultation time (h), median (Q1, Q3)	23 (13, 68)	34 (20, 53)	0.23
≤ 24 h, n (%)	16 (30.2)	37 (69.8)	0.68
> 24 h, n (%)	16 (34)	31 (66)	
Total cost (Yuan in RMB), mean ± SD	16522.59 ± 8871.61	10236.07 ± 3281.16	0.001
Preoperative fetal complications, n (%)	6 (50)	6 (50)	0.27
UTI after surgery, n (%)	12 (54.5)	10 (45.5)	0.01
LOS (d), mean ± SD	11 ± 5.34	7 ± 2.98	0.001
Newborn weight (g), mean ± SD	2706.56 ± 649.47	2978.97 ± 460.58	0.02
Cesarean section rate, n (%)	14 (36.8)	24 (63.2)	0.42
Preterm delivery, n (%)	6 (75)	2 (25)	0.02

PANP: Preoperation acute pyelonephritis, UTI: Urinary tract infection, LOS: Length of stay.

Ultrasonography is a commonly used examination in obstetric patients with renal colic. The main objective of imaging is to evaluate any processes that may delay response to therapy or warrant intervention, such as a calculus or obstruction[20]. For patients with stones before pregnancy, the risk of pyelonephritis was higher than patients without stones. Pyelonephritis caused by kidney stones had a higher risk than pyelonephritis caused by ureteral stones, which deserves attention. Blackwell *et al*[21]

Table 3 Multivariate analysis of preoperative acute pyelonephritis

Variable	OR (95%CI)	P value
Pain to admission (h)	22.10 (5.31-91.91)	0.000
Stone location		0.003
None	1.0	
Ureter	6.61 (1.48-29.53)	
Kidney	9.91 (2.56-38.42)	

Table 4 Comparison of outcomes in time to ureteral stent placement patients before and after surgery

Variable	Before surgery (n = 100)	After surgery (n = 100)	P value
WBC count ($\times 10^9/L$), mean \pm SD	13.48 \pm 3.48	9.96 \pm 1.95	< 0.01
CRP (mg/dL), median (Q1, Q3)	2.64 (1.04, 4.35)	1.35 (0.54, 2.36)	< 0.01
Hydronephrosis (mm), median (Q1, Q3)	26.50 (15.00, 75.00)	10.50 (0, 18)	< 0.01

showed a benefit with timely decompressive intervention for obstructing urinary stones and sepsis leading to improved health outcomes.

PANP was closely related to re-admission to hospital due to UTI after surgery and premature delivery in our study. This was consistent with previous research[22,23]. Chen *et al*[24] found ureteral stent placement was a risk factor for PANP. Patients with PANP developed UTI after surgery (OR 3.48, 95%CI: 1.31-9.28), which was reported in our previous studies[25]. Therefore, active anti-infection treatment is required during the perioperative period to avoid adverse outcomes in such patients.

It is known that pyelonephritis is associated with adverse pregnancy outcomes. An 18-year retrospective study included more than 500000 singleton pregnancies in a large health care system in the United States. The results showed that among 2894 women with pyelonephritis during pregnancy, the preterm birth rate (mainly at 33-36 wk) was higher than those without pyelonephritis (10.3% *vs* 7.9%, OR 1.3, 95%CI: 1.2-1.5)[26]. The incidence of preterm birth was 8%, and 75% of preterm pregnant women suffered preoperative acute pyelonephritis (OR 7.62, 95%CI: 1.44-40.19).

In addition to the implications for patient health outcomes, our data also suggest an economic benefit with timely intervention. Delayed surgery (≥ 48 h) can lead to longer hospital stay, but did not increase hospitalization costs. The increase in hospitalization costs was mainly related to preoperative acute pyelonephritis. In conclusion, both early and delayed surgery are safe and effective for the treatment of renal colic during pregnancy. Early surgery is recommended for patients with pyelonephritis as it tends to decrease costs and reduce mother and child complications.

The limitation of the current study is its relatively small sample size and lack of patients with very severe complications. Therefore, a large cohort study and randomized controlled trials are needed to validate our findings. We also did not evaluate the degree of pain, which may be an important factor leading to timely intervention of surgery. Despite these limitations, we believe that our findings can still help obstetricians and urologists provide patient consultation.

CONCLUSION

Using local data, we have identified the association between time to ureteral stent placement and clinical outcomes, and analyzed the risk factors for preoperative acute pyelonephritis in pregnant women with renal colic during pregnancy. Delayed surgery does not affect clinical outcomes, but leads to longer hospital stay. Time from pain to hospitalization and the location of the stones are risk factors for preoperative acute pyelonephritis. Our research will have important significance in the clinic.

ARTICLE HIGHLIGHTS

Research background

Pregnancy with renal colic may cause pyelonephritis, decreased renal function, systemic infection and even shock in pregnant women, and cause premature birth and other adverse pregnancy outcomes.

Research motivation

When surgery is necessary, the relationship between timing of the operation and the outcome of the mother and child are not known.

Research objectives

To investigate the association between time to ureteral stent placement and clinical outcomes of patients with renal colic during pregnancy.

Research methods

In this retrospective study, pregnant women with renal colic who underwent surgery were studied. Maternal preoperative acute pyelonephritis (PANP), pregnancy outcome, and length of hospital stay (LOS) were compared between the two groups.

Research results

PANP was closely related to hospitalization costs, re-admission to hospital due to urinary tract infection after surgery and premature delivery. Multivariate analysis showed that stone location and time from pain to admission were related to PANP.

Research conclusions

Both early and delayed surgery are safe and effective for the treatment of renal colic during pregnancy. Early surgery may be superior to a delayed procedure due to shorter LOS. For pregnant patients with renal colic, delayed surgery within 48 h is not related to the clinical outcome of the mother and child. However, the time from pain to hospital admission was related to PANP.

Research perspectives

Delayed surgery does not affect clinical outcomes, but leads to longer hospital stay. Time from pain to hospitalization and location of the stones are risk factors for preoperative acute pyelonephritis. Our research will have important significance in the clinic.

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