Section: Urology

Original Research Article

UNDERSTANDING THE INTERPLAY OF SURGICAL FACTORS AND PATIENT VARIABLES IN SEPSIS DEVELOPMENT FOLLOWING RIRS FOR RENAL STONES

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Received : 25/09/2024
Received in revised form : 12/11/2024
Accepted : 27/11/2024

Keywords:
Sepsis; pyelonephritis; ureteral calculi; chronic disease; surgical factors; retrograde intrarenal surgery; diabetes; hypertension.

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DOI: 10.47009/jamp.2024.6.6.42

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (6); 217-221

Abstract

Background: Retrograde intrarenal surgery (RIRS) is a minimally invasive procedure that is commonly performed for the management of renal stones. Despite its high stone-free rate, sepsis remains a significant postoperative complication with an incidence of up to 15%. Identifying risk factors associated with sepsis is crucial for optimizing patient outcomes. The objective is to evaluate patient-related (age, sex, comorbidities, stone characteristics, and preoperative infection management) and surgical factors (operative time and preoperative DJ stenting) contributing to the development of sepsis following RIRS. **Materials and Methods:** This retrospective analytical study was conducted at the Government Royapettah Hospital over 12 months. Data were collected from 51 patients who had undergone RIRS for renal stones. Preoperative infections were managed using targeted antibiotics. Clinical, laboratory, and stone-related variables were analyzed using SPSS and statistical significance was determined ($p < 0.05$). **Result:** The incidence rate of sepsis was 15.7%. Positive preoperative urine culture was significantly associated with sepsis (50% vs. 2.3%; $p < 0.0001$). The stone size, location, and density were not significantly correlated with sepsis. Surgical factors, such as prolonged operative time (>71 min) and preoperative DJ stenting, were more common in the sepsis group, but the difference was not significant. Comorbidities including diabetes and hypertension were not significantly associated with sepsis. **Conclusion:** Positive preoperative urine culture is a critical risk factor for post-RIRS sepsis, underscoring the importance of rigorous infection management. While other variables showed no significant associations, infection control and individualized perioperative strategies are vital for reducing sepsis risk and improving outcomes.

INTRODUCTION

The global incidence of urolithiasis has been steadily increasing, currently estimated at approximately 10%, with prevalence rates ranging from 1% to 20%.[1] Regionally, the prevalence varies between 5% and 9% in Europe, 8% to 13% in the United States, and 1% to 5% in Asia.[2] Patients with symptomatic ureteral or renal stones are often initially treated with pain management, medical expulsive therapy, and serial imaging to monitor stone position and evaluate hydronephrosis. However, persistent issues such as pain, nausea, or renal dysfunction necessitate definitive stone treatment.[3] The three primary treatment options for managing stones in the upper urinary tract include shock wave lithotripsy, percutaneous nephrolithotomy, and retrograde intrarenal surgery (RIRS).[4]

Retrograde intrarenal surgery (RIRS) has emerged as a minimally invasive technique for managing renal stones,[5] employing a holmium laser and flexible ureteroscope to achieve high stone-free rates with relatively low morbidity. However, RIRS is not without risks, and the overall complication rate following ureteroscopy, including RIRS, ranges from 9% to 25%.[5,6] RIRS has limitations, including a restricted visual field, the high cost of flexible scopes and lithotripters with significant maintenance expenses, and a steep learning curve for surgeons. However, these challenges have limited their widespread adoption. However, RIRS is generally regarded as a safe procedure, with a low complication rate. Common complications include fever,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

hematuria, and infection, which are typically classified as low-grade according to the modified Clavien system. Severe complications are rare but can include obstruction from Steinstrasse and urosepsis.[7]

Several efforts have been undertaken to minimize perioperative complications associated with RIRS, but only a limited number of studies have focused specifically on postoperative febrile urinary tract infections (UTIs). Although infrequent, the progression of UTIs can result in life-threatening conditions, such as sepsis.[7] Sepsis, which results from urosepsis and is the most severe complication, with an estimated incidence of up to 5%. Given the life-threatening nature of sepsis, identifying preoperative and postoperative risk factors is crucial to improving outcomes.[8]

This study aimed to evaluate patient-related factors (age, sex, comorbidities, stone characteristics, and preoperative treatment for positive urine culture) and surgical factors (operative time and preoperative DJ stenting) that contribute to sepsis following RIRS in patients with nephrolithiasis.

MATERIALS AND METHODS

This retrospective analytical study was conducted at the Government Royapettah Hospital over 12 months from October 2023 to October 2024. Data were collected from 51 patients admitted to the Urology Ward for renal calculi management. This study was approved by the Institutional Ethics Committee before initiation, and informed consent was obtained from all patients.

Inclusion Criteria

Patients aged 18–75 years who underwent RIRS for renal calculi during the study period were included in the study.

Exclusion Criteria

Patients who had kidney stones on computed tomography, but in whom the stones were not detected during surgery, resulting in termination of the operation, or who had matrix stones, the pediatric age group, and those who underwent surgery for residual calculus were excluded.

Data, including clinical characteristics, laboratory test results, and stone characteristics, were retrospectively obtained from medical records using a standardized pro forma. Patients were categorized into postoperative sepsis-occurrence and sepsis non-occurrence groups. Sepsis was defined according to the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) and included cases with suspected infections and at least two systemic inflammatory response syndrome (SIRS) criteria.

Surgical details: RIRS was performed using an OTU-Wi flexible fiberoptic ureteroscope with 200- and 272-µm holmium optical fibers. A Spinx 30 W holmium laser system was utilized in all procedures. Patients with positive preoperative urine cultures received appropriate antibiotics for at least one week before surgery.

Sepsis was diagnosed based on suspected postoperative infection and the presence of at least two criteria according to the definition of Systemic Inflammatory Response Syndrome (SIRS). These criteria included: (1) body temperature >38°C or <36°C; (2) heart rate >90 beats per minute; (3) respiratory rate >20 breaths per minute or arterial carbon dioxide tension ($PaCO_2$) <32 mmHg (4.2 kPa); and (4) white blood cell (WBC) count >12,000/mm³ or <4,000/mm³ or an immature neutrophil proportion >10%.

Statistical analysis: Data were recorded and analyzed using the SPSS software. Categorical variables are expressed as frequencies and percentages, and within-group comparisons were performed using the chi-square test. P-values were calculated to determine the significance of the findings. A p-value of ≤0.05 is commonly regarded as the threshold for statistical significance.

RESULTS

Patient Demographics and Clinical Characteristics

The study included 51 patients, with the majority (35.3%) being aged 41–50 years. Male patients comprised 66.7% of the cohort, while females accounted for 33.3% of the cohort. Most patients (90.2%) had a negative preoperative urine culture and 9.8% had a positive culture. Among comorbidities, diabetes mellitus (27.5%) was the most common, followed by systemic hypertension (19.6%), while 58.8% of the patients had no comorbid conditions.

Stone and Operative Details

The stones were almost evenly distributed between the left (51.0%) and right (49%) kidneys. The stone size was predominantly between 10.1–15 mm (31.4%) and 15.1–20 mm (31.4%), with 64.7% of stones having a density of 1001–1500 Hounsfield units (HU). Lower-pole stones were most common (51%), followed by interpolar stones (37.3%). Preoperative DJ stenting was performed in 64.7% of the cases.

Surgical and Postoperative Outcomes

Most surgeries lasted 61–70 min (51%); sepsis was observed in 15.7% of the patients, while 84.3% did not. No mortality was reported, and residual stones were present in 21.6% of the patients [Table 1].

Demographic Factors, Surgical Factors and Outcomes

Patients aged 41–50 years had a higher incidence of sepsis (62.5%). There was no significant difference in the occurrence of sepsis according to sex. A positive preoperative urine culture was significantly associated with sepsis (50% in the sepsis group, $p < 0.0001$). Patients without comorbidities had a higher sepsis rate (75%) than those with conditions, such as diabetes or hypertension, with no significant difference ($p = 0.560$). Larger stones (>20.1 mm) were more common in the sepsis group (37.5%), but

ISSN (O): 2687-5365; ISSN (P): 2753-6556

the difference was not significant (p = 0.41). A longer operative time (>71 min) was associated with a higher sepsis rate (12.5%), but the difference was not significant (p = 0.509). Preoperative DJ stenting was observed in 75% of sepsis cases; however, this association was not significant (p = 0.507). Residual stones were observed in 25% of sepsis cases compared to 20.9% of non-septic cases (p = 0.787) [Table 2].

Table 1: Distribution of patient and stone characteristics.

		Number of Patients	Percentage
Age group (years)	<30	3	5.9%
	31-40	13	25.5%
	41-50	18	35.3%
	51-60	15	29.4%
	>61	2	3.9%
Sex	Female	17	33.3%
	Male	34	66.7%
Preop urine culture	Negative	46	90.2%
	Positive	5	9.8%
Comorbidities	SHTN	10	19.6%
	DLP	1	2.0%
	DM	14	27.5%
	CAD	2	3.9%
	Hypothyroid	3	5.9%
	Ba	1	2.0%
	Nil	30	58.8%
Stone laterality	Left	26	51.0%
	Right	25	49.0%
Stone size (mm)	<10	9	17.6%
	10.1-15	16	31.4%
	15.1-20	16	31.4%
	>20.1	10	19.6%
Stone (HU)	<1000	14	27.5%
	1001-1500	33	64.7%
	>1501	4	7.8%
Stone location	IP	19	37.3%
	LP	26	51.0%
	PUJ	1	2.0%
	RP	9	17.6%
	UP	5	9.8%
Sepsis	No	43	84.3%
	Yes	8	15.7%
Mortality	No	51	100.0%
Operative time (min)	<50	7	13.7%
	51-60	15	29.4%
	61-70	26	51.0%
	>71	3	5.9%
Preop DJ stenting	No	18	35.3%
	Yes	33	64.7%
Residual	No	40	78.4%
	Yes	11	21.6%

Table 2: Comparison of surgical characteristics and postoperative complications

Variable		Sepsis		P-value
		No	Yes	
Age group (years)	<30	3 (7.0%)	0 (0.0%)	0.461
	31-40	12 (27.9%)	1 (12.5%)	
	41-50	13 (30.2%)	5 (62.5%)	
	51-60	13 (30.2%)	2 (25.0%)	
	>61	2 (4.7%)	0 (0.0%)	
Sex	Female	14 (32.6%)	3 (37.5%)	0.785
	Male	29 (67.4%)	5 (62.5%)	
Preop urine culture	Negative	42 (97.7%)	4 (50.0%)	<0.0001
	Positive	1 (2.3%)	4 (50.0%)	
Comorbidities	DLP	1 (2.3%)	0 (0.0%)	0.560
	DM	13 (30.2%)	1 (12.5%)	
	Hypothyroid	2 (4.7%)	1 (12.5%)	
	SHTN	10 (23.3%)	0 (0.0%)	
	BA	1 (2.3%)	0 (0.0%)	
	CAD	2 (4.7%)	0 (0.0%)	
	Nil	24 (55.8%)	6 (75.0%)	
Stone laterality	Left	23 (53.5%)	3 (37.5%)	0.406
	Right	20 (46.5%)	5 (62.5%)	

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Stone size (mm)	<10	8 (18.6%)	1 (12.5%)	0.410
	10.1-15	13 (30.2%)	3 (37.5%)	
	15.1-20	15 (34.9%)	1 (12.5%)	
	>20.1	7 (16.3%)	3 (37.5%)	
Stone (HU)	<1000	12 (27.9%)	2 (25.0%)	0.631
	1001-1500	27 (62.8%)	6 (75.0%)	
	>1501	4 (9.3%)	0 (0.0%)	
Stone location	IP	14 (32.6%)	5 (62.5%)	0.391
	LP	23 (53.5%)	3 (37.5%)	
	PUJ	1 (2.3%)	0 (0.0%)	
	RP	7 (16.3%)	2 (25.0%)	
	UP	2 (4.7%)	2 (25.0%)	
Mortality	No	43 (100.0%)	8 (100.0%)	n/a
Operative time (min)	<50	7 (16.3%)	0 (0.0%)	0.509
	51-60	13 (30.2%)	2 (25.0%)	
	61-70	21 (48.8%)	5 (62.5%)	
	>71	2 (4.7%)	1 (12.5%)	
Preop DJ stenting	No	16 (37.2%)	2 (25.0%)	0.507
	Yes	27 (62.8%)	6 (75.0%)	
Residual	No	34 (79.1%)	6 (75.0%)	0.787
	Yes	9 (20.9%)	2 (25.0%)	

DISCUSSION

This study evaluated the interplay between surgical factors and patient variables in determining sepsis risk post-RIRS, contributing valuable insights into optimizing outcomes in renal stone management. We have observed that the overall incidence of sepsis was 15.7%, aligning with reported rates of 0.2% to 17.8% by a recent systematic review and meta-analysis.[3] However, Zisman et al. reported a lower sepsis rate of 3.1% post-RIRS, with higher rates of kidney stones, which were reduced with dual antibiotic prophylaxis.[9]

Among the evaluated variables, a significant association was found between a positive preoperative urine culture and the occurrence of sepsis, highlighting the critical role of infection control before surgery. Patients with positive urine cultures had a 50% incidence of sepsis compared to only 2.3% among those with negative cultures, underlining the importance of targeted preoperative antibiotic therapy. Previous studies have identified that a positive preoperative urine culture is linked to postoperative sepsis and infectious complications.[9-13] Blackmur et al,[14] highlighted its significance in non-pre-stented patients, while Bai et al,[10] found multidrug-resistant (MDR) cultures strongly associated with post-RIRS urosepsis.

Although larger stones (>20.1 mm) were more common in the sepsis group, this association was not significant. Similarly, other stone characteristics, such as density and location, were not significantly different between the sepsis and non-sepsis groups. A study of 332 patients with ureteral stones (9.2–10.3 mm) found larger stones to be an independent risk factor for sepsis after RIRS, while stone location and side were not significant.[15] Another study of 1493 patients found infection stones to increase the risk of postoperative fever (4.9%) and sepsis (0.5%).[13] This suggests that stone size may influence surgical complexity and may not independently predict sepsis risk.

Surgical factors including operative time and preoperative DJ stenting were also examined. Although prolonged operative time (>71 min) was associated with a slightly higher rate of sepsis (12.5%), this did not reach statistical significance. Preoperative DJ stenting, performed in 64.7% of the cases, showed a higher prevalence in the sepsis group, but without a significant correlation. This indicates that surgical factors, although important in patient management, may not independently determine the risk of sepsis without the presence of other contributing factors, such as preoperative infection.

Sugihara et al,[16] found a positive link between longer operative times and severe adverse events, including sepsis, supported by other studies identifying it as an independent risk factor for post-RIRS sepsis.[10,17,18] Ogreden et al,[19] reported an increased infection risk with double-J stents after RIRS in patients with ureteral stones and perirenal fat stranding.

Interestingly, comorbidities such as diabetes and hypertension, which are often implicated in poor surgical outcomes, were not significantly associated with sepsis in this cohort. Most patients with sepsis had no recorded comorbidities, suggesting that other factors such as immune response and infection control may play a more prominent role in this context. Risk factors for urosepsis include older age, diabetes mellitus, immunosuppression, and prior urological treatment.[20–22] Del Giudice et al. highlight that female gender and a history of urinary tract infection (UTI) pose the highest risk for developing sepsis, surpassing other comorbidities such as diabetes, hypertension, and obesity.[23]

CONCLUSION

Positive preoperative urine culture has emerged as the most significant predictor of sepsis following RIRS, emphasizing the need for meticulous infection screening and management before surgery. Although factors such as stone size, operative time, and

ISSN (O): 2687-5365; ISSN (P): 2753-6556

preoperative DJ stenting did not show significant associations, their potential contribution to surgical complexity and patient outcomes cannot be overlooked. This study underscores the importance of infection control and highlights the need for further research to better understand the interplay of surgical and patient factors in post-RIRS sepsis development. Comprehensive preoperative evaluation and tailored perioperative strategies are essential to minimize postoperative complications and optimize outcomes in patients undergoing RIRS for nephrolithiasis.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556