Predictors of forniceal rupture in patients with obstructing ureteral calculi: Analysis of multicenter data

Yahya G. Ghazwani[1,2,3], Saeed M. Bin Hamri[1,2,3], Khalid A. Alrabeeah[1,2,3], Abdullah M. Alkhayal[1,2,3], Bader H. Alsaikhan[1,2,3], Turki Ahmed Alferayan[1,2,3], Omar Badr Alfraidi[1,2,3], Faisal Khalid Balaraj[1,2,3], Mohammad A. Alghafees[1,2,3], Abdullah A. Al Qurashi[2], Yasser A. Noureldin[1,2,3,4]

[1]Division of Urology, King Abdulaziz Medical City, [2]Department of Medicine, College of Medicine, King Saud Bin Abdulaziz University for Health Sciences, [3]King Abdullah International Medical Research Center, Riyadh, Saudi Arabia, [4]Department of Urology, Faculty of Medicine, Benha University, Benha, Egypt

Abstract

Background: Renal forniceal rupture (FR) is a unique complication of obstructive uropathy. This study aimed to identify the predictors of FR among patients presenting with renal colic due to obstructing ureteral calculi.

Materials and Methods: After obtaining ethics approval, electronic records of patients from three National Guard hospitals in Saudi Arabia were reviewed between 2016 and 2020 to identify patients who presented with renal colic and were diagnosed with FR due to obstructive ureteric stones (FR group). An equivalent number of consecutive patients presenting with renal colic due to obstructing ureteric stones without FR was selected as a control group (non-FR group). Patients were grouped according to age group (<30, 30–40, 41–50, and >50 years), body mass index (BMI) class, gender, comorbidities, grade of hydronephrosis, location of the stone in the ureter, size of the stone (<3 mm, 3–7 mm, and >7 mm), and stone former status. Baseline patients' and stone characteristics were compared, and a regression analysis was performed to identify predictors of FR.

Results: A total of 50 patients with FR were identified, and a control group of 50 patients without FR were selected. The baseline patients' and stone demographic characteristics in terms of age ($P = 0.42$), gender ($P = 0.275$), BMI ($P = 0.672$), comorbidity, grade of hydronephrosis ($P = 0.201$), and stone location ($P = 0.639$) were comparable between the FR group and the non-FR group. However, the stone size was statistically significant between both groups ($P = 0.014$). On multivariable analysis, it was found that the stone size was associated with a significantly higher increase in the incidence of FR (odds ratio [OR]: 6.5 [1.235–34.434]; $P = 0.027$). Furthermore, the age group between 30 and 40 years was potentially at a lower risk for FR (OR: 0.262 [0.069–0.999]; $P = 0.049$).

Conclusion: This multicenter study showed that the stone size 3–7 mm had a six-fold increase in the chance of FR, and the age group between 30 and 40 years is potentially at a lower risk for FR.

Keywords: Endourology, forniceal rupture, ureteric calculi

Access this article online	
Quick Response Code:	**Website:** www.urologyannals.com
	DOI: 10.4103/ua.ua_57_23

How to cite this article: Ghazwani YG, Hamri SM, Alrabeeah KA, Alkhayal AM, Alsaikhan BH, Alferayan TA, *et al*. Predictors of forniceal rupture in patients with obstructing ureteral calculi: Analysis of multicenter data. Urol Ann 2024;16:146-9.

INTRODUCTION

Urolithiasis is the most common cause of obstructive uropathy. It is a significant disease, especially in the Middle East, with the highest recorded incidence rates observed in the United Arab Emirates, Kuwait, and Saudi Arabia.[1] Renal forniceal rupture (FR) is a rare outcome of obstructive uropathy and is a urological emergency in most instances. The pathophysiology of this presentation generally lies with obstruction caused by ureteric stones and primarily occurs in upper or lower renal pole calyces. However, other causes, including malignant or benign extrinsic ureteric compression, have been highlighted as well.[2,3]

Preoperative diagnosis poses a significant challenge in patients with suspected FR due to blood loss and lack of urinary symptoms.[4] Radiological imaging methods, including kidney-ureter bladder X-ray, abdominal ultrasonography, and abdominal computed tomography (CT), are the most reliable methods to confirm FR and determine the etiology.[3] The corresponding prognosis substantially varies among patients depending on the underlying pathology, renal injury, and the place of rupture, with the presence of infection increasing the risk of complications.[5] If left untreated, patients with FR are at risk of infection of the urinoma, abscess formation, and sepsis.[6]

However, the current literature concerning the clinical practice and collective treatment of FR is limited. Surgical treatment with ureteral stent placement is the most common intervention alongside conservative treatment in the absence of infection, kidney failure, and other risk factors. This management approach has been successfully implemented with few complications and readmissions.[7]

The availability of literature related to FR is lacking and primarily consists of case reports and case series. This article, therefore, aimed to provide a descriptive overview and identify the predictors of FR from three of the largest endourology centers in the region.

MATERIALS AND METHODS

This retrospective cohort study included all patients who presented with renal colic and were diagnosed with FR due to obstructing ureteral calculi in three hospitals of the National Guard Health Affairs in Saudi Arabia, including King Abdulaziz Medical City in Riyadh, Jeddah, and Al Ahsa. This study was conducted after obtaining ethics approval from King Abdullah International Medical Research Center (RYD-20-419812-1389695) and included a review of electronic charts of the target patients between January 2016 and December 2020. Enhanced and nonenhanced CT abdomen and pelvis were used to identify FR. Moreover, axial diameter was used to determine the stone size. An equivalent number of consecutive patients presenting with renal colic due to obstructing ureteric stones without FR was selected as a control group (non-FR group).

Variables were grouped as follows: the variables were grouped according to the age group (<30, 30–40, 41–50, and >50), body mass index (BMI) class (<18.5, 18.5–24.9, 25.0–29.9, 30.0–34.9, 35.0–39.9, and >40 kg/m²), gender (male and female), comorbidities in terms of hypertension (HTN) and diabetes mellitus (DM), and presence of urinary tract infection, grade of hydronephrosis (mild, moderate, and severe), location of the stone (ureterovesical junction, distal, mid ureteric, proximal ureteric, and ureteropelvic junction), size of the stone (<3 mm, 3–7 mm, >7 mm), and stone former status (stone former and nonstone former). The glomerular filtration rate (GFR) was collected as well. All patients' and stone characteristics were compared between both groups, and a regression analysis was performed to identify predictors of FR.

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 23.0 (IBM Corporation, NY, USA). Frequency and percentage were used to display the categorical variables. A multivariate logistic regression analysis was used to identify the independent factors associated with FR. The confidence interval was set at 95% and $P < 0.05$ was considered statistically significant.

RESULTS

In total, 50 FR patients were compared to a control group of 50 non-FR patients with ureteric obstructing stones. More than 80% of FR patients ($n = 40$) were above 40 years old, whereas in the non-FR group, 56% were younger than 40 years old ($P = 0.42$), 40% ($n = 20$) of FR group had a BMI of 18.5–29.9 versus 36% in non-FR group ($P = 0.672$), and 80% ($n = 40$) of FR group were male gender versus 88% in non-FR group ($P = 0.275$). Only 20% of the FR group had DM versus 16% in the non-FR group ($P = 0.603$). HTN in the FR group was 24% versus 12% in the non-FR group ($P = 0.118$). 80% of the FR group had GFR >90 versus 92% in the non-FR group ($P = 0.367$). The grade of hydronephrosis in the FR group was mostly mild 76% versus 45 90% in the non-FR group ($P = 0.201$). Other demographic data are presented in Table 1. Our data showed that 40%

of FR patients had obstruction at the vesicoureteric junction versus 40% in the non-FR group (*P* = 0.639). Therefore, there was no statistically significant difference between the FR group and the non-FR group in terms of age (*P* = 0.42), gender (*P* = 0.275), BMI (*P* = 0.672), comorbidity, grade of hydronephrosis (*P* = 0.201), and stone location (*P* = 0.639). However, the stone size was statistically significant between both groups, where 84% had 3–7 mm stone in the FR group versus 64% in the non-FR group (*P* = 0.014). More details are presented in Table 1.

Table 1: Demographic characteristics of the participants

Variables	FR group, *n* (%)	Non-FR group, *n* (%)	*P*
Age (year)			
<30	6 (12)	8 (16)	0.42
30–40	4 (8)	14 (28)	
41–50	12 (24)	10 (20)	
>50	28 (50)	18 (36)	
BMI (kg/m^2)			
<18.5	0	4 (8)	0.672
18.5–24.9	20 (40)	18 (36)	
25–29.9	10 (20)	18 (36)	
30–34.9	18 (36)	6 (12)	
>35	2 (4)	4 (8)	
Gender			
Male	40 (80)	44 (88)	0.275
Female	10 (20)	6 (12)	
Diabetic			
Yes	10 (20)	8 (16)	0.603
No	40 (80)	42 (84)	
Hypertensive			
Yes	12 (24)	6 (12)	0.118
No	38 (76)	44 (88)	
GFR			
>90	40 (80)	46 (92)	0.367
89–60	10 (20)	2 (4)	
59–45	0	0	
44–30	0	0	
29–15	0	0	
<15	0	2 (4)	
UTI			
Yes	6 (12)	8 (16)	0.564
No	44 (88)	42 (84)	
Grade of hydronephrosis			
Mild	38 (76)	45 (90)	0.201
Moderate	8 (16)	4 (8)	
Severe	4 (8)	1 (2)	
Location of stone			
UVJ	20 (40)	20 (40)	0.639
Distal	10 (20)	14 (28)	
Mid	4 (8)	2 (4)	
Proximal	12 (24)	8 (16)	
UPJ	4 (8)	6 (12)	
Size of stone (mm)			
<3	6 (12)	6 (12)	0.014
3–7	42 (84)	32 (64)	
>7	2 (4)	12 (24)	
Stone former			
Yes	12 (24)	18 (36)	0.19
No	38 (76)	32 (64)	

FR: Forniceal rupture, BMI: Body mass index, GFR: Glomerular filtration rate, UTI: Urinary tract infection, UVJ: Ureterovesical junction, UPJ: Ureteropelvic junction

Moreover, 24%, (*n* = 12) of the FR group were stone formers versus 36% in the non-FR group (*P* = 0.19). This is depicted in Table 1.

Multivariate analysis was done to report the predictors of FR. Patients who were in the age group of 30–40 years old were potentially at a lower risk for developing FR than their peers (odds ratio [OR]: 0.262 [0.069–0.999); *P* = 0.049). Stone sizes 3–7 mm had significantly higher opportunity of developing FR compared with other stone sizes (OR: 6.5 [1.235–34.434]; *P* = 0.027). More details on the multivariate analysis are found in Table 2.

DISCUSSION

The majority of FR is linked to ureteral stones that are blocking the ureters. Other related etiologies of urinary obstruction, such as renal pelvic cancer, ureteropelvic junction obstruction, bladder outlet obstruction, trauma, and iatrogenic causes, have also been discussed. The need for an urgent intervention may increase if the radiologist or emergency medicine doctor notices FR on a CT scan. Although uncommon and concerning, there is little research on the evaluation of FR and the risk factors that might predict the occurrence of FR. This is a retrospective analysis of multi-institute data on patients suffering from renal colic and was diagnosed with ureteric obstructing stone-induced renal FR. The current study aimed to identify the predictors of FR in this group of patients. In this study, data showed that more than 80% of FR patients were above 40 years old, whereas in the non-FR group, it was only 56%, which concords with a previously published article by Setia *et al*. suggesting that age and changes to renal parenchyma increase the susceptibility of developing FR.[1,8] However, there was no significant difference between the FR and non-FR groups in terms of male and female gender, it was noticed that a higher percentage of FR patients were male gender, which contradicts Setia *et al*. findings where it was divided between male and female. This can be attributed to the pain tolerance and female patients seeking medical advice sooner than male patients which can increase the risk of FR.[8,9] Moreover, there was no significant difference between both groups in terms of the HTN and DM, which contradicts Setia *et al*. findings where DM and HTN were associated with a higher risk of FR. We hypothesize that since the age effect was quite established for FR the incidence of DM and HTN in those age groups is higher which is why the multivariate analysis had no significance in the study.[8] Regarding the stone characteristics and the associated abnormalities, 76% of the patients suffered from mild hydronephrosis in the FR group compared with 90% in the non-FR group, which

Table 2: Multivariate analysis for predictors of forniceal rupture

Predictors of FR	*B*-coefficient	SE	Wald-χ^2	OR	95% CI for OR		*P*
					Lower bound	Upper bound	
Age <30 years	-	-	-	-	-	-	-
Age 30–40 years	−1.339	0.683	3.849	0.262	0.069	0.999	0.049
Age 41–50 years	−0.503	0.540	0.868	0.605	0.210	1.743	0.352
Age >50 years	−0.961	0.643	2.232	0.382	0.108	1.350	0.135
Stone size <3 mm	-	-	-	-	-	-	-
Stone size 3–7 mm	1.875	0.849	4.880	6.522	1.235	34.434	0.027
Stone size >7 mm	1.812	1.019	3.165	6.124	0.832	45.105	0.075

FR: Forniceal rupture, OR: Odds ratio, CI: Confidence interval, SE: Standard error

was not congruent with the study by Setia *et al*. where the degree of hydronephrosis was significantly associated with FR with moderate hydronephrosis being the most significant ($P = 0.02$).[8] In the present study, 40% of the FR group had stone obstruction in the ureterovesical junction (UVJ) with a similar percentage in the non-FR group with 40%, and this was similar to multiple studies which showed UVJ as the most common site of stone impaction.[8,9] Our study reported a mean stone size of 4.8 mm, which agrees with other researches.[8,9]

Multivariate analysis showed that patients aged 30–40 years were less likely to develop FR compared to other age groups. Interestingly, a previously published multivariate analysis did not find any correlation between age and the development of FR.[8] However, the age was assessed as a continuous variable without age groups, and this might explain the different findings in our study. Moreover, the current study showed that the stone size of 3–7 mm was a strong predictor of FR with a cumulative effect of more than 6 times. This could be explained by the fact that most cases of acute ureteral obstruction are caused by this the stone size group.

To the best of our knowledge, this retrospective study is the first multi-institute effort to report data that predicts the development of FR and the data of FR patients. This study is crucial as it provides urologists with valuable data to improve their decision-making in dealing with such patients.

This study contains few limitations that must be addressed. First, the retrospective nature of the research and the probability of a presence of bias. We highly recommend that future studies of similar objectives be conducted more controlled to avoid the biases that may be present. Second, the sample size of our study is relatively low to withdraw highly valid conclusions. However, the number of FR patients is pretty unique in this study compared with the available literature. Finally, the current study did

not report the proper management and outcomes in the treatment of FR patients.

CONCLUSION

This multicenter study showed that the stone size 3–7 mm had a six-fold increase in the chance of FR, and the age group between 30 and 40 years is potentially at a lower risk for FR. The data present in this study could be utilized by urologists to better identify FR patients and to help prevent such dangerous complications by considering the predictors of this condition.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Robertson WG. Stone formation in the Middle Eastern Gulf states: A review. Arab J Urol 2012;10:265-72.
2. Gershman B, Kulkarni N, Sahani DV, Eisner BH. Causes of renal forniceal rupture. BJU Int 2011;108:1909-11.
3. Ercil H, Tümer E, Senturk A, Alma E, Ünal U, Deniz M, *et al*. Etiology and treatment of renal forniceal rupture: A single center experience. J Urol Surg 2018;5:68-72.
4. Stone MB, Secko MA. Spontaneous rupture of the renal pelvis due to an obstructing ureteral calculus diagnosed by point-of-care ultrasound. Crit Ultrasound J 2010;1:133-4.
5. Balcells FS, de Torres Mateos JA, Mas AG, Lopes FG. Physiopathology of spontaneous extravasation of urine in the upper urinary tract. Apropos of 24 cases. J Urol Nephrol (Paris) 1976;82:385-95.
6. Al-Mujalhem AG, Aziz MS, Sultan MF, Al-Maghraby AM, Al-Shazly MA. Spontaneous forniceal rupture: Can it be treated conservatively? Urol Ann 2017;9:41-4.
7. Morgan TN, Bandari J, Shahait M, Averch T. Renal forniceal rupture: Is conservative management safe? Urology 2017;109:51-4.
8. Setia SA, Massie PL, Epsten MJ, Sharma A, Fogg L, Cherullo EE, *et al*. Renal forniceal rupture in the setting of obstructing ureteral stones: An analysis of stone characterization and urologic intervention pattern. J Endourol 2020;34:373-8.
9. Bartley EJ, Fillingim RB. Sex differences in pain: A brief review of clinical and experimental findings. Br J Anaesth 2013;111:52-8.