

## Original Article

# Evaluation of glomerular filtration rate decline in patients with renal colic

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**Abstract:** Purpose: The aim of current study was to evaluate glomerular filtration rate (GFR) decline in patients with renal colic. Materials and methods: This descriptive analytical study was conducted on patients with definitive diagnosis of renal colic in Alzahra hospital. Data including gender, age, and underlying disease were extracted from medical records. GFR and creatinine level were assessed before and 3 months after stone excretion. Hydronephrosis severity was assessed by ultrasound procedure. Results: In current study, 224 patients with renal colic and mean age 45.6±11.35 years old were selected. The mean GFR before and 3 months after urinary stone excretion were 45.89±18.84 and 61.13±22.10 ml/minute, respectively ( $P<0.01$ ). The mean creatinine at the beginning and 3 months after urinary stone excretion was 1.93±0.46 and 1.59±0.43 mg/dl, respectively ( $P<0.01$ ). The most frequency of patients with different hydronephrosis degrees was related to score 3 (n=92). There was significant difference between hydronephrosis severity in terms of GFR ( $P=0.000$ ). No significant difference was seen between the mean GFR at the beginning of the study and at 3 months after urinary stone excretion in terms of diabetes and hypertension ( $P>0.05$ ). Conclusion: We observed significant difference between hydronephrosis severity in terms of GFR. This indicated that the increase of hydronephrosis degree was associated with worse renal function. Moreover, urinary stone excretion led to the increase of GFR and the decrease of creatinine level. In addition, the mean GFR was not influenced by diabetes and hypertension.

**Keywords:** Creatinine, glomerular filtration rate, renal colic

## Introduction

Urolithiasis is a disease characterized by the presence of stones in the urinary or kidney tract. In Asia, about 1%-19.1% of individuals suffer from urolithiasis [1]. It is one of the main causes of renal colic [2]. On the other hand, renal colic is caused often by partial or complete ureteric obstruction due to ureteral stones in the vast majority of cases [3]. The movement of stone from renal collecting system influences the genitourinary tract and leads to intermittent or constant obstruction and ureteral hydronephrosis causing urine to back up into the kidney. Renal colic in about 5% of patients may be due to abnormalities of the urinary tract which is unrelated to stone disease including ureteropelvic junction obstruc-

tion [3]. In addition, renal colic is a common complaint in emergency room and is associated with acute flank pain [1, 3, 4]. This disease as the most uncomfortable form of pain requires fast diagnosis and treatment [3]. Diagnosis of renal colic is based on the combination of physical and history examination, imaging and laboratory findings [5]. Recent studies have shown that acute ureteral obstruction leads to reduces the glomerular filtration rate (GFR) of the affected kidney and enhances excretion of urine [5]. Another study reported that the GFR reduces within a few hours following acute occlusion. This decline of GFR may continue for weeks after relief of obstruction [6].

In addition, the main treatment of renal colic is analgesic therapy including opiates and NSAIDs

**Table 1.** Comparison of mean variables at the beginning and 3 months after study

Variables	Mean ± SD at the beginning of study	Mean ± SD 3 months after urinary stone excretion	P-value*
Creatinine (mg/dl)	1.93±0.46	1.59±0.43	0.000
GFR (ml/minute)	45.89±18.84	61.13±22.10	0.000

\*Paired sample T test, GFR: glomerular filtration rate.

[7]. NSAIDs in renal colic reduce production of metabolites of arachidonic acid, reducing pain which is caused by distension of the renal capsule. In addition, they lead to contract the efferent arterioles to the glomerulus, leading to reduction of hydrostatic pressure in the glomerulus [8].

Given that renal colic led to eventual loss of kidney function with irreversible damage and GFR measurement was the predictor of renal function [9], and kidney function tests such as GFR was not routinely evaluated in patients with renal colic, and few studies were conducted regarding the evaluation of GFR decline in patients with renal colic, the aim of current study was to evaluate GFR decline in patients with renal colic.

## Patients and methods

### Sampling and data selection

This descriptive analytical study was conducted on patients with definitive diagnosis of renal colic in Alzahra hospital, Isfahan, Iran in 2019. Data including gender, age, body mass index (BMI), underlying disease such as hypertension and diabetes mellitus were extracted from medical records. GFR was assessed via Cockcroft-Gault formula before and 3 months after stone excretion according as follows.

$$\text{GFR} = (140 - \text{age}) \times \text{weight/plasma Cr} \times 72 \text{ (men)}$$

$$\text{GFR} = 0.85 \times (140 - \text{age}) \times \text{weight/plasma Cr} \times 72 \text{ (Women).}$$

In addition, creatinine level was evaluated by enzymatic method (Pars azmoon kit) before and 3 months after stone excretion. The incidence and severity of hydronephrosis were assessed by ultrasound procedure. The severity (grading) of hydronephrosis is obtained by the Society of Fetal Urology (SFU) that grades of hydronephrosis are included grade 0 (no hydronephrosis or dilatation), grade 1 or mild (renal pelvis dilation, no calyces dilation, no

parenchymal atrophy), grade 2 or mild (dilation of renal pelvis and calyces without parenchymal atrophy), grade 3 or moderate (dilation of renal pelvis and calyces, flattening of papillae, mild cortical atrophy) and grade 4 or severe (severe dilation of renal pelvis and calyces, renal atrophy) [10].

### Ethical statement

After obtaining written consent from patients, current study was approved by Isfahan University of Medical Sciences (IR.MUI.MED.REC.1399.977).

### Inclusion and exclusion criteria

Patients with single kidney, age range less than 18 years and history of open surgery, bariatric surgery, intestinal surgery, glomerulonephritis, high creatinine, congenital diseases, polycystic kidney disease, reflux disease, and sepsis were excluded from study. In addition, taking antibiotic and NSAIDs led to exclude of patients.

### Statistical analysis

Data were entered to SPSS, version 19. The quantitative data were shown based on mean and standard deviation and the qualitative variables were shown based on frequency and percentage. Independent T test, Fisher exact test, Chi-square test, and Paired Sample T test were used for analysis.  $P < 0.05$  was assumed significant.

## Results

Current study was conducted on 224 patients with definitive diagnosis of renal colic and mean age  $45.6 \pm 11.35$  years old. Among them, 122 patients (54.5%) were male and 102 (45.5%) female. Mean weight of patients was  $73.4 \pm 7.23$  kg.

**Table 1** shows comparison of mean creatinine and GFR at the beginning and 3 months after study.

As demonstrated in **Table 1**, significant difference was seen before and 3 months after uri-

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**Table 2.** The comparison of the mean GFR at the beginning and after the study in terms of diabetes and hypertension

Variables	Diabetes, hypertension	Number	Mean ± SD	P-value*
GFR at the beginning of study	Absence of diabetes	177	46.8±19.18	0.68
	Presence of diabetes	47	42.2±17.21	
GFR 3 months after study	Absence of diabetes	177	61.06±22.63	0.48
	Presence of diabetes	47	61.40±20.19	
GFR at the beginning of study	Absence of hypertension	180	47.48±18.69	0.24
	Presence of hypertension	44	39.37±18.24	
GFR 3 months after study	Absence of hypertension	180	62.34±22.40	0.123
	Presence of hypertension	44	56.21±20.3	

\*Independent T test, GFR: glomerular filtration rate.

**Table 3.** Comparison of frequency of GFR in terms of diabetes and hypertension

Variables		GFR		Total	P-value*
		GFR<60 mL/min	GFR≥60 mL/min		
Diabetes	No	154 (79)	41 (21)	195 (100)	0.593
	Yes	23 (79.3)	6 (20.7)	29 (100)	
	Total	177 (79)	47 (21)	224 (100)	
Hypertension	No	155 (79.5)	40 (20.5)	195 (100)	0.28
	Yes	25 (86.2)	4 (13.8)	29 (100)	
	Total	180 (80.4)	44 (19.6)	224 (100)	

\*Fisher exact test, GFR: glomerular filtration rate.

**Table 4.** Frequency of patients with different degree of hydronephrosis in terms of GFR after 3 months

GFR	Hydronephrosis				P-value*
	Grade 1	Grade 2	Grade 3	Grade 4	
GFR<60 mL/min	2	42 (21.5)	85 (43.6)	66 (33.8)	0.0000
GFR≥60 mL/min	2 (6.9)	19 (65.5)	7 (24.1)	1 (3.4)	
Total	4 (1.8)	61 (27.2)	92 (41.1)	67 (29.9)	

\*Chi-square test, GFR: glomerular filtration rate.

**Table 5.** Comparison of the mean hydronephrosis severity in terms of GFR

	GFR	Mean ± SD	Number	P-value*
Hydronephrosis severity	GFR<60 mL/min	3.10±0.76	195	0.000
	GFR≥60 mL/min	2.24±0.63	29	

\*Independent T test, GFR: glomerular filtration rate.

nary stone excretion regarding creatinine and GFR ( $P<0.01$ ).

The comparison of the mean GFR at the beginning and after the study in terms of diabetes and hypertension is shown in **Table 2**.

As demonstrated in **Table 2**, no significant difference was seen between the mean GFR at the beginning of the study in terms of diabetes and hypertension ( $P>0.05$ ). In addition, there was no difference between the mean GFR at 3 months after the study in terms of diabetes and hypertension ( $P>0.05$ ).

Comparison of frequency of GFR (less or equal and more than 60 mL/min) in terms of diabetes and hypertension is shown in **Table 3**.

As demonstrated in **Table 3**, no remarkable difference was observed between frequency of patients in two groups (GFR<60 mL/min and GFR≥60 mL/min) regarding diabetes and hypertension ( $P>0.05$ ).

Comparison of frequency of patients with different degree of hydronephrosis in terms of GFR is shown in **Table 4**.

As demonstrated in **Table 4**, the most frequency of patients with different hydronephrosis

degrees was related to score 3. Moreover, significant difference was seen between frequency of patients with different severity of hydronephrosis in terms of GFR ( $P<0.01$ ). Comparison of the mean hydronephrosis severity in terms of GFR is shown in **Table 5**.

As demonstrated in **Table 5**, there was significant difference between the severity of hydronephrosis in terms of GFR ( $P=0.000$ ).

### Discussion

Hydronephrosis is caused due to anatomic or functional processes that interrupt the flow of urine and this interruption happens anywhere in urinary tract of kidneys or urethral meatus. This increase in ureteral pressure can lead to change the function of glomerular filtration, tubular and renal blood flow [9, 10]. Wang et al., reported that there was significant association between degree of renal injury and hydronephrosis process [11]. In current study, we observed significant difference between hydronephrosis severity in terms of GFR. This finding indicated that the increase of GFR is associated with the decrease of severity of hydronephrosis. Wang et al., assessed the effect of hydronephrosis on GFR in patients with renal injury and reported that the increase of hydronephrosis degree is associated with worse renal function [11]. Hassanzadeh et al., assessed reversibility of GFR after surgery of obstructive uropathy and reported that total  $GFR > 25 \text{ ml/minute}/1.73 \text{ m}^2$  is associated with the functional recovery of damaged kidney following the surgery [12]. The findings of these studies were consistent with our study. Therefore, according to these findings, the decrease of hydronephrosis degree is associated with the functional recovery.

Moreover, the mean GFR before and 3 months after urinary stone excretion were  $45.89 \pm 18.84$  and  $61.13 \pm 22.10$ , respectively. Therefore, significant difference was observed before and after study regarding GFR. Klahr et al., reported a progressive fall in GFR following ureteral obstruction due to reduction of single nephron GFR and number of filtering nephrons [13]. Kazama et al., assessed unilateral ureteral obstruction caused by urolithiasis in patient with acute kidney injury and observed significant fall of GFR from the baseline level approximately 61.2 to 47.3  $\text{mL/min}/1.73 \text{ m}^2$  [5]. Hassanzadeh et al., also reported that urinary tract obstruction is associated with various consequences including reduced glomerular filtration rate, and renal plasma flow [12]. Robert et al., assessed GFR before and after ureteral obstruction and observed recovery of GFR after

ureteral obstruction (at eight weeks) [14]. The finding of this study was consistent with our study. Other studies evaluated GFR before and 72 hours after releasing the obstruction and observed the increase of GFR. It seems that after removing the obstruction, the change of renin-angiotensin system and vasoconstrictors leads to increase of GFR [15, 16]. The findings of these studies were also consistent with our study. Rose et al., assessed recovery of renal function after urinary tract obstruction and observed that measurement of GFR following relief of obstruction estimate the degree of recovery.

Moreover, in current study, significant difference was seen before and 3 months after urinary stone excretion regarding creatinine level. Chen et al., assessed creatinine level before and after ureteral obstruction and reported that the creatinine level at 3 days after the operation reduced than those before the operation [17]. However, there was no remarkable difference at 3 days and 6 months after operation regarding creatinine level. Hassanzadeh et al., also demonstrated the reduced level of creatinine in 69.0% of the patients after surgery. Although serum level of creatinine was not a precise evidence of the renal function status and it is dependent to muscle mass and activity, it may be distorted in patients with obstructive uropathy [12]. Kazama et al., assessed unilateral ureteral obstruction caused by urolithiasis in patient with acute kidney injury and observed an increase of serum creatinine level from the baseline level approximately 0.96 to 0.98  $\text{mg/dL}$ . The finding of this study indicated that ureteral obstruction was associated with the increase of serum creatinine level.

In addition, diabetic nephropathy is the leading cause of end-stage renal disease in patients [18]; however, we did not observe any relation between the mean GFR with diabetes and hypertension. Naderpour et al., reported no significant relation between GFR and systolic blood pressure [19]. They believed that this is related to the narrow range of blood pressure among participants and these populations had normal blood pressure levels. But Samigham et al., demonstrated a significant association between history of hypertension and  $GFR < 60$  [20]. James et al., reported that lower GFR was associated with higher risks of acute kidney

injury in patients with and without diabetes or hypertension [21]. Weil et al., assessed GFR in 269 individuals and observed that HbA1c, and fasting blood sugar (FBS) were significantly associated with GFR [22]. Bjornstad et al., demonstrated that GFR decline is associated with renal hyperfiltration in 646 diabetes with type 1 [23]. Therefore, it seems that several factors including duration of diabetes and hypertension, the level of FBS, HbA1c and hypertension may affect GFR. According to controversy findings in this regard, further studies should be conducted in this regard.

### Conclusion

According to results of current study we observed significant difference between hydronephrosis severity in terms of GFR. This indicated that the increase of hydronephrosis degree is associated with worse renal function. Moreover, urinary stone excretion led to the increase of GFR and the decrease of creatinine level. In addition, the mean GFR was not influenced by diabetes and hypertension.

### Disclosure of conflict of interest

None.

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