

# Acute Renal Infarction: A Single-Center Experience

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## ABSTRACT

**Objective:** The aim of this study is to evaluate the clinical characteristics and short- and midterm renal functions in patients with acute renal infarction.

**Methods:** The medical records of the patients who were diagnosed with acute renal infarction by computed tomography in our clinic between 2012 and 2019 were retrospectively reviewed. Twenty-four patients who had follow-up data for at least 1 year were included in the study. Clinical, radiological, and laboratory findings of the patients at the time of admission and the results of serum creatinine level and glomerular filtration rate at first month and first year were recorded.

**Results:** The mean age of the patients was  $49.5 \pm 20.7$  years. In half of the cases, cardiac origin diseases were the underlying risk factor of acute renal infarction. Flank/abdominal pain was the most common presenting symptom. At admission, mean white blood cell count, serum lactate dehydrogenase, serum creatinine, and glomerular filtration rate values were  $12\,507 \pm 6367/\mu\text{L}$ ,  $437.4 \pm 261$  U/L,  $1.4 \pm 1.9$  mg/dL, and  $85.3 \pm 47.7$  mL/min/1.73 m<sup>2</sup>, respectively. Chronic kidney disease developed in 7 patients.

**Conclusions:** Acute renal infarction should be taken into consideration in patients with flank or abdominal pain and increased serum lactate dehydrogenase level. In addition, patients with acute renal infarction are at risk of developing chronic kidney disease.

**Keywords:** Glomerular filtration rate, infarction, kidney, kidney function tests

## INTRODUCTION

Acute renal infarction (ARI) is a condition that results from acute disruption of blood flow in the ipsilateral main renal artery or segmental branches. Cardioembolic diseases, injury of the renal artery, and hypercoagulation disorders are the most common etiologic factors of ARI.<sup>1</sup> Acute renal infarction is an uncommon condition which has an estimated incidence rate of 0.004%-0.007% among emergency department admissions.<sup>2,3</sup> Most patients with ARI presented with non-specific symptoms including flank pain, abdominal pain, nausea, and vomiting that mimic more common conditions such as urinary tract stone disease and acute abdominal diseases. Both rarity and presentation with non-specific symptoms often lead to delay in diagnosis that increase the risk of impairment in renal functions.<sup>4,5</sup> Today, contrast-enhanced computed tomography (CT) is the standard radiological tool for the diagnosis of ARI.<sup>2</sup>

In the current study, we aimed to share our experience of patients with ARI and to describe the characteristics, etiological factors, and short- and midterm renal functions of the patients with ARI.

## METHODS

The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the Ethics Committee of Ankara City Hospital (Date: August 25, 2021, Ethics Committee Ruling number: E1-21-1953). Written informed consent was obtained from all the patients. Following ethical committee approval, we retrospectively reviewed the medical records of the patients that were evaluated by our department between 2012 and 2019 for ARI diagnosed by contrast-enhanced CT. Our review revealed that 31 patients with ARI were evaluated by our department. Patients with missing data at presentation (n=2), lack of follow-up data (n=4), and unavailable CT images (n=1) were excluded. Following application of the exclusion criteria, 24 patients who were followed up for at least 1 year and the patients with available CT images at admission and laboratory data were included.

Demographic, clinical, radiological, and laboratory findings of the patients at the time of admission and the results of the kidney function tests including serum creatinine level and estimated

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glomerular filtration rate (eGFR) at the time of presentation, first month, and first year were recorded.

Infarcts were classified based on CT as focal (single wedge-shaped lesion), multifocal (more than 1 lesion), and global (uniformly >50% of the renal tissue was involved).<sup>6</sup> In addition, the volume of infarction/kidney volume was calculated for each patient based on CT findings. Estimated glomerular filtration rate was calculated by using the modification in diet and renal disease (MDRD) formula.<sup>7</sup> Chronic kidney disease (CKD) was defined as eGFR < 60 mL/min/1.73 m<sup>2</sup> over 3 months using the MDRD equation.<sup>8</sup>

To evaluate the infarct lesions and kidney function, Tc-99m dimercaptosuccinic acid (DMSA) scintigraphy was performed 3 months after admission. At the time of hospitalization, all patients were assessed by the cardiology department to start or regulate the anticoagulant/antiplatelet therapy.

**Statistical Analysis**

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) v. 25 for Windows (SPSS Inc. Chicago, Ill, USA). Continuous variables were presented as mean ± standard deviation (SD) with or without min-max, and dichotomous values were expressed as number and percentage. The Friedman test was used to compare the eGFR values at admission, first month, and first year. A value of *P* < .05 was considered to be statistically significant.

**RESULTS**

The mean age of the patients was 49.5 ± 20.7 (18-88) years. Of the 24 patients, 41.7% (n = 10) were female and 58.3% (n = 14) were male. In half of the cases, ARI is of cardiac origin including atrial fibrillation, valvular heart disease, or cardiac thrombus. However, 6 of them had not been diagnosed with any cardiac origin comorbidity until ARI occurred. No predisposing factors were found in 7 patients and classified as idiopathic. In 4 patients, focal ARI occurred following blunt trauma due to motor vehicle accident, and extravasation or perinephric hematoma was not detected in the CT scan. Hypertension was the most common comorbidity (29.2%). At admission, 10 patients were under anticoagulant/antiplatelet therapy. The other drugs that the patients had been using were antihypertensive

drugs (n=7), oral antidiabetics (n=6), beta-adrenergic blockers (n=3), antihyperlipidemic drugs (n=3), non-steroidal anti-inflammatory drugs (n=2), and proton pump inhibitors (n=3). Characteristics of the patients are summarized in Table 1.

Seventeen patients had flank and/or abdominal pain at the time of admission. Based on CT, detection rates of focal, multifocal, and global renal infarct were 50%, 20.8%, and 29.2%, respectively. In 2 patients with global infarct (1 had solitary kidney), endovascular procedures were suggested; however, the patients refused the intervention due to possible complications. Therefore, all patients were managed conservatively and received therapeutic doses of low-molecular-weight heparin (LMWH). After initial treatment with LMWH, warfarin was started in 2 patients and acetylsalicylic acid in 4 patients for maintenance therapy. Among the 7 patients with global infarct, 2 had impaired contribution to total renal function (18% and 23%). Five patients had non-functioning kidney findings at DMSA scintigraphy, 3 of whom underwent laparoscopic simple nephrectomy while 2 denied to undergo nephrectomy. Renal scintigraphy showed that 14 patients had

**Table 1.** Characteristics of the Patients with ARI

Age (years)	49.5 ± 20.7 (18-88)
Sex, n (%)	
Male	14 (58.3)
Female	10 (41.7)
Body mass index, (kg/m <sup>2</sup> )	26 ± 3.3 (20.9-33.1)
Smoking, n (%)	
Active smoker	13 (54.2)
Ex-smoker	4 (16.7)
Never smoked	7 (29.2)
Suspected cause of ARI, n (%)	
Cardiac	12 (50)
Renal injury/trauma	4 (16.7)
Idiopathic	7 (29.2)
Hypercoagulable status	1 (4.2)
Comorbidities, n (%)	
Hypertension	7 (29.2)
Diabetes mellitus	6 (25)
Cardiac	6 (25)
Other	5 (20.8)
None	7 (29.2)
Under anticoagulant/antiplatelet therapy, n (%)	10 (41.7)
Acetylsalicylic acid	6 (25)
Clopidogrel	2 (8.3)
Warfarin	2 (8.3)

ARI, acute renal infarction. Data are presented as mean ± standard deviation (min-max) or number (%).

**Main Points**

- Acute renal infarction (ARI) is a rare condition and patients with ARI are admitted to the hospital with non-specific complaints including flank or abdominal pain, nausea, and/or vomiting.
- The most common predisposing factor of ARI is cardiac origin diseases, namely atrial fibrillation, valvular heart disease, and cardiac thrombus.
- Contrast-enhanced computed tomography is the standard imaging tool for the diagnosis of ARI.
- Acute renal infarction is associated with impaired kidney function and may lead to chronic kidney disease.

**Table 2.** Clinical, Radiological, and Laboratory Findings at the Time of Presentation

Clinical presentation, n (%)	
Flank/abdominal pain	17 (70.8)
Nausea/vomiting	3 (12.5)
Fever	1 (4.2)
Other	3 (12.5)
Side of ARI on CT, n (%)	
Right	10 (41.7)
Left	10 (41.7)
Bilateral	4 (16.7)
Configuration of infarct on CT, n (%)	
Focal	12 (50)
Multifocal	5 (20.8)
Global	7 (29.2)
Infarction volume/kidney volume (%)	53.9 ± 31.8 (6.1–100)
Laboratory data (reference range)	
WBC (4500–11 000 /µL)	12 507 ± 6367 (5140–29 050) /µL
Serum LDH (0–248 U/L)	437.4 ± 261 (181–1210) U/L
Serum AST (0–50 U/L)	56.2 ± 61.6 (12–257) U/L
Serum ALT (0–50 U/L)	46.3 ± 41.2 (11–183) U/L

ARI, acute renal infarction; CT, computed tomography; WBC, white blood cell; LDH, lactate dehydrogenase; AST, aspartate aminotransferase; ALT, alanine aminotransferase.

Data are presented as number (%) or mean ± standard deviation (min--max).

reduced tracer uptake at the site infarction while 3 patients with focal ARI had normal findings.

The mean white blood cell count and serum lactate dehydrogenase (LDH) value of the patients were 12507 ± 6367 /µL and 437.4 ± 261 U/L, respectively. The mean systolic blood pressure of the patients at admission was 147.3 ± 17.3 mmHg, and diastolic blood pressure was 94.2 ± 19.2 mmHg. The clinical, radiological, and laboratory findings of the patients at the time of admission are shown in Table 2.

The mean serum creatinine and eGFR values at admission were 1.4 ± 1.9 mg/dL and 85.3 ± 47.7 mL/min/1.73 m<sup>2</sup>, respectively. At the time of clinical presentation, 8 patients had higher serum

creatinine levels and 7 patients had <60 mL/min/1.73 m<sup>2</sup> eGFR value. In a 54-year-old male patient who had congenital solitary right kidney, global right ARI occurred. This patient required acute hemodialysis and was included in the chronic hemodialysis program. The kidney functions of the patients at admission, first month and first year are shown in Table 3.

**DISCUSSION**

Acute renal infarction mostly affects middle-aged population with a mean age of 60 years<sup>9-11</sup>; in our series, the mean age of the patients was 49.5 years. We believe that 4 patients who had renal trauma were younger (21-41 years); therefore, it might decrease the mean age of our population. Patients with ARI frequently have cardiac diseases including atrial fibrillation and ischemic or valvular heart diseases that increase the risk of thromboembolism.<sup>2</sup> Similar to the previous studies,<sup>2,10,12,13</sup> cardiac diseases were the most common suspected cause of ARI in our study. Renal trauma and renal vascular injury were the other causes of ARI. Kagaya et al.<sup>14</sup> reported that renal trauma was the underlying cause of ARI in 8% of the patients in their study. In another study that included 89 patients, renal vascular injury was the accused cause of ARI in 14.6% of the patients.<sup>10</sup> In our study, 4 of 24 patients had ARI due to renal injury/trauma. However, in some cases, predisposing factor of ARI is unknown. Faucon et al.<sup>15</sup> reported that the mechanism of ARI was idiopathic in 3.8% of 186 patients. However, another study reported that 47% of the patients had idiopathic ARI.<sup>13</sup> In our study, the rate of idiopathic ARI was 29.2%.

Most of the patients with ARI present with abdominal or flank pain. Ongun et al. reported that 56.5% of the patients presented with abdominal pain and 43.4% of the patients presented with flank pain.<sup>9</sup> In another study, it was reported that 72% of the patients presented with flank pain.<sup>11</sup> In our study, 70.8% of the patients had flank or abdominal pain at the time of admission. However, these signs are not specific to ARI, and the diagnosis of ARI needs to be proved by imaging tools. Although earlier studies reported that angiography and isotope scans were the main diagnostic techniques, contrast-enhanced CT has been the gold standard diagnostic tool for ARI with increased use since the 1990s.<sup>12</sup> According to the CT configuration, ARI is classified as focal, multifocal, or global. In a study by Suzer et al. CT features of ARI were evaluated in 37 patients. The authors reported that focal, multifocal, and global infarcts were observed in 23 (62.2%), 5 (13.5%), and 9 (24.3%) patients, respectively.<sup>6</sup> In our series, focal infarcts were the most common type of ARI with 50% of incidence.

**Table 3.** Summary of Renal Functions During 1-Year Follow-Up

Variables	At Presentation Time	At First Month	At First Year	P
Serum creatinine (mg/dL)	1.4 ± 1.9	1.4 ± 1.2	1.5 ± 1.5	.54
eGFR (mL/min)	85.3 ± 47.7	74.6 ± 46.8	82.9 ± 48.2	.54
Patients with increased serum creatinine (>1.2 mg/dL), n (%)	8/24 (33.3)	11/24 (45.8)	8/24 (33.3)	
Patients with decreased eGFR (<60 mL/min), n (%)	7/24 (29.2)	11/24 (45.8)	7/24 (29.2)	

eGFR: estimated glomerular filtration rate.

Data are presented as mean ± standard deviation or number (%).

Serum LDH is a marker of cell necrosis,<sup>4</sup> and elevated LDH level is the most common laboratory finding in patients with ARI.<sup>12</sup> Several studies showed that elevated LDH level was observed over 70% of the patients.<sup>3,4,9,11,12</sup> Our results were comparable with the literature, and elevated LDH level was recorded in 17 of 24 patients (70.8%) at presentation.

The treatment options for ARI are medical treatment including anticoagulants, antiplatelets, and thrombolytics, endovascular procedures, and open surgery. However, the optimal treatment for ARI is not clear due to the lack of comparative studies among these treatment modalities.<sup>16,17</sup> Previous studies reported that vast majority of the patients with ARI were treated with anticoagulant/antiplatelet drugs.<sup>5,10,11,18</sup> In a study by Fontán et al. only 4 patients underwent fibrinolysis with urokinase. The authors reported that 3 of them were successfully treated while 1 of them suffered upper gastrointestinal bleeding due to the treatment.<sup>18</sup> Yang et al. reported that 2 patients were given thrombolytic treatment for uncontrolled abdominal pain.<sup>10</sup> Endovascular radiologic procedures are the other and uncommonly used treatment options for ARI. Mesiano et al. reported that none of their patients underwent endovascular procedures.<sup>11</sup> A recent study reported that percutaneous angioplasty was performed in only 7% of the patients.<sup>19</sup> In our study, all patients were initially treated with LMWH, and long-term oral anticoagulant/antiplatelet therapy was started in 6 patients.

Acute renal infarction is a rare entity<sup>2,3</sup>; however, it is a clinically important condition as it may cause impairment in renal function. In a study by Huang et al. the mean serum creatinine level of 20 patients with ARI at presentation was  $1.3 \pm 0.3$  mg/dL. The authors reported that during hospitalization 4 patients had mildly elevated serum creatinine levels ( $>1.5$  mg/dL), and in 3 patients, no improvement was observed during more than 1-year follow-up.<sup>3</sup> In another study, it was found that 40.4% of the patients had impaired kidney function at admission.<sup>4</sup> In 2014, Bae et al. retrospectively reviewed 100 patients with ARI. The authors of the study stated that 30 patients had acute kidney injury and 7 of them progressed to CKD.<sup>5</sup> Ongun et al.<sup>9</sup> reported that 5 of 23 patients had impaired renal function at 1 month and 1-year follow-up. In another study with 89 patients with ARI, impaired kidney function rate was found as 27.4%.<sup>10</sup> A multicenter study by Eren et al. included 121 patients with ARI. In this study, the mean serum creatinine and eGFR values at the time of admission were  $1.5 \pm 0.1$  mg/dL and  $68 \pm 3$  mL/min, respectively. The authors of the study stated that CKD development rate was 28.9% during an average follow-up of 14 months and 4 patients required chronic dialysis.<sup>13</sup> According to our results, the mean serum creatinine value was  $1.4 \pm 1.9$  mg/dL, and at 1-year follow-up, CKD developed in 7 patients (29.2%) which was similar to previous studies. In addition, our results suggested that mean serum creatinine and eGFR levels at presentation were not statistically different compared to the levels at first month and first year.

In the current study, we aimed to present our experience with ARI and to evaluate the short- and midterm kidney functions in

patients with ARI. However, our study has some important limitations. First, we used the database and medical records of the patients; therefore, there are missing patients and clinical data including proteinuria and hematuria. Second, renal function values of the patients before ARI were unavailable.

## CONCLUSION

ARI is a rare condition and presents with non-specific symptoms; however, it is associated with deteriorated renal function in short- and midterm follow-up periods. Therefore, ARI should be taken into consideration in patients with flank or abdominal pain and increased serum LDH level. In addition, according to our results, serum creatinine and eGFR levels at presentation may be suggestive for midterm renal functions.

**Ethics Committee Approval:** Ethical committee approval was received from the Ethics Committee of Ankara City Hospital (Date: August 25, 2021, Ethics Committee Ruling number: E1-21-1953).

**Informed Consent:** Written informed consent was obtained from all participants who participated in this study.

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