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# Etiological Evaluation and Mortality of Patients with Renal Artery Stenosis: A Single-Center Experience

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## ABSTRACT

**Introduction:** Renal artery stenosis (RAS) is a clinical picture that is evaluated as a renovascular disorder and includes many diseases in its etiology. The primary purpose of the present study was to reveal the etiology of cases followed up in the nephrology outpatient clinic due to RAS; to describe their demographic, clinical, and radiological features; and investigate their treatment and prognosis. The second aim of the study was to investigate the relationship between isolated RAS cases that cannot be attributed to any etiological cause and Takayasu's arteritis.

**Methods:** Patients were included in retrospectively examining all patient files that were registered between January 1996 and 2018. Demographic data of the patients, date of diagnosis, initial physical examination findings, comorbid diseases, imaging findings, interventional and medical treatments, need for kidney replacement therapy, and time to hemodialysis/transplantation were recorded.

**Results:** Out of the 17427 (8800 M/8627 F) patients, a total of 134 (70 M/64 F) patients aged over 18 years with RAS were included in the study; 60 (55%) patients had atherosclerotic RAS, whereas 23 (21.1%) patients were diagnosed with vasculitis. In total, 16 patients (13.5%) died with a mean of 6±3.4 years after admission. It was found that advanced age, low GFR at diagnosis, and small kidneys are significant and poor prognostic factors.

**Conclusion:** A more systematic approach model can be developed in terms of applying "maximal medical treatment", which is our approach that we can currently describe as incomplete in cases of RAS with an early atherosclerotic process.

**Keywords:** Renal artery stenosis, atherosclerosis, Takayasu's arteritis, hypertension, prognosis

## Introduction

Renal artery stenosis (RAS) is a clinical picture that is evaluated as a renovascular disorder and includes many diseases in its etiology (1-3). RAS, which constitutes the group of renovascular diseases together with ischemic nephropathy and renovascular hypertension (HT), includes conditions in which more than 60% of the luminal diameter of the renal artery is affected (1-3).

The most common cause at the age of 40 years and below was Takayasu's arteritis (with 60.5%), while the primary etiology above the age of 40 years was atherosclerosis (with 94.7%) (3,4). Atherosclerotic RAS, the most common type, is seen especially in the elderly population and mainly occurs in patients with comorbid diseases (1-5). This population appears to have more left ventricular hypertrophy, ischemic heart disease, and renal failure (6). Atherosclerotic RAS usually involves the ostium and the middle 1/3, and it can also be seen at the level of the proximal renal artery, especially in normotensive patients aged 60 years or over (1-5).

Takayasu's arteritis, which can cause vascular involvement and may also involve the renal artery, appears as vasculitis that can result in HT, renal failure, and early death; particularly in the second or third decades, females are predominantly encountered (7). Fibromuscular dysplasia (FMD), on the other hand, is predominantly seen between the ages of 30 and 50 and exhibits a 3- to 4-fold female dominance. It is an idiopathic, non-inflammatory, and non-atherosclerotic process. It progresses bilaterally in 40% of cases, especially in the right renal artery. In conventional angiographic imaging, it is defined as "string-of-beads". Apart from the most common medial type, there are intimal and adventitial types; the medial type especially involves the distal 2/3 of the renal artery and is bilateral in 60% of cases (7,8).

RAS arises because of various etiologies, but prognostic studies supported by clinical and radiological data showing the etiologies followed from one center are limited. The primary purpose of the present study was to reveal the etiology of cases followed up in the nephrology outpatient

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clinic due to RAS; to describe their demographic, clinical, and radiological features; and investigate their treatment and prognosis. The second aim of the study was to investigate the relationship between isolated RAS cases that cannot be attributed to any etiological cause and Takayasu's arteritis.

## Methods

Patients who met the inclusion criteria were included in the study by retrospectively examining all patient files that were registered between January 1996 and January 2018 in the İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, Nephrology Outpatient Clinic.

The study protocol was approved by the Clinical Research Ethics Committee of İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine (approval number: 83088843-604.01.01-379993, date: 11.10.2017). This study was conducted in accordance with the 1975 Declaration of Helsinki, as revised in 2013. The form of consent was not obtained because the data were analyzed anonymously. The ethics committee waived the requirement for informed consent.

### Inclusion Criteria

- Age ≥18 years,

- Having been diagnosed with RAS using any of the defined imaging methods,

### Exclusion Criteria

- Age <18 years,

- Incomplete or inaccessible diagnosis and follow-up information,

- Previous kidney transplant before admission to the clinic,

- RAS involves only a segmental renal artery branch,

- Diagnosed with RAS before admission.

Demographic data of the patients (date of birth, gender), date of diagnosis, initial physical examination findings (blood pressure measured at the time of admission, fundus examination), comorbid diseases, imaging findings, interventional and medical treatments (antihypertensive and immunosuppressive drugs), need for kidney replacement therapy (hemodialysis and renal transplantation), and time to hemodialysis/transplantation were recorded. Although the patients were excluded from our hospital follow-up, the causes and dates of death were recorded using the national patient follow-up system and included in the analysis. The cause of death and date of death of the patients who came out of the hospital follow-up were obtained and recorded using the national patient follow-up system.

### Comorbidities

They were classified as HT, hyperlipidemia (HL), diabetes mellitus (DM), coronary artery disease (CAD), congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), cerebrovascular accident (CVA), and malignancies. Inflammatory comorbidities were grouped as vasculitides [Takayasu's arteritis, Behçet's syndrome, other vasculitides (defined as suspicious or undifferentiated)] and other inflammatory diseases (rheumatoid arthritis, ankylosing spondylitis, familial Mediterranean fever, gout, mixed connective tissue disease). All patients were diagnosed with Takayasu's arteritis by rheumatologists using the 1990 American College of Rheumatology criteria (9).

Resistant HT is defined as above-goal elevated blood pressure in patients despite concurrent use of three antihypertensive drug classes, commonly including a long-acting calcium channel blocker, a blocker of the renin-angiotensin system, and a diuretic. Antihypertensive drugs should be administered at maximum or maximally tolerated daily doses. It also includes patients whose blood pressure achieves target values on ≥4 antihypertensive agents (10).

### Laboratory

The laboratory results included urea, creatinine, sodium, potassium, uric acid, calcium phosphate, calcium × phosphate, parathormone, leukocyte, neutrophil, hemoglobin, platelet, C-reactive protein, and 1$^{st}$-hour sedimentation value. The 24-hourly urine findings included glomerular filtration rate (GFR), proteinuria, and albuminuria. The estimated GFR was calculated using the formulas of the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) or Modification of Diet in Renal Disease (MDRD) (11,12) in patients who could not collect 24-h urine.

### Imaging

Doppler ultrasonography (USG) findings were recorded using the following parameters:

If measured, the renal/aortic ratio separately for the right and left renal arteries: It was determined by proportioning the renal artery systolic flow velocity and the aortic systolic flow velocity. When the ratio between renal artery peak systolic velocity (PSV) and aortic PSV is >3.5, it indicates a 60% stenosis (13,14). Patients whose renal arteries could not be visualized with Doppler USG were categorized as unsuccessful.

In addition, computed tomographic (CT) angiography or magnetic resonance (MR) angiography results, if available, and conventional angiography results, if performed, were recorded.

Interventional procedures applied to the patients during the follow-up period were grouped under three headings: stent application, balloon angioplasty, and bypass.

### Statistical Analysis

The mean, standard deviation, and minimum and maximum values were used in the data analysis to generate statistics for the continuous structure. The frequency and percentage values were used to define categorical variables. The Kaplan-Meier method was used to estimate the overall survival curves. The log-rank test was used to determine differences according to risk factors. The statistical significance of the data was taken as $p<0.05$. SPSS 18.0 (SPSS Inc, USA) was used in the study.

## Results

### Demographic and Clinical Characteristics and Follow-Up

Out of the 17427 (8800M/8627F) patients registered at the İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, Clinic of Nephrology Outpatient between January 1996 and January 2018, a total of 134 (70 M/64 F) patients aged over 18 years with RAS were included in the study.

Twenty-five (12 M/13 F) patients (18.6%) were excluded from the study because of the limited follow-up duration of one visit and lack of data. The files of the remaining 109 patients (58 M/51 F) were scanned retrospectively using a standardized study form (Figure 1).

The demographic and clinical characteristics of the patients are shown in Table 1. Patients were usually middle-aged (median: 55; range: 18 to 87 years), and male gender (53%) was more prominent.

The most common comorbidities accompanying RAS were HT (96.3%), followed by CAD (23.9%), DM (22.9%), CVA (8.3%), HL (4.6%), COPD (3.7%), CHF (3.6%), and malignancies (2.8%).

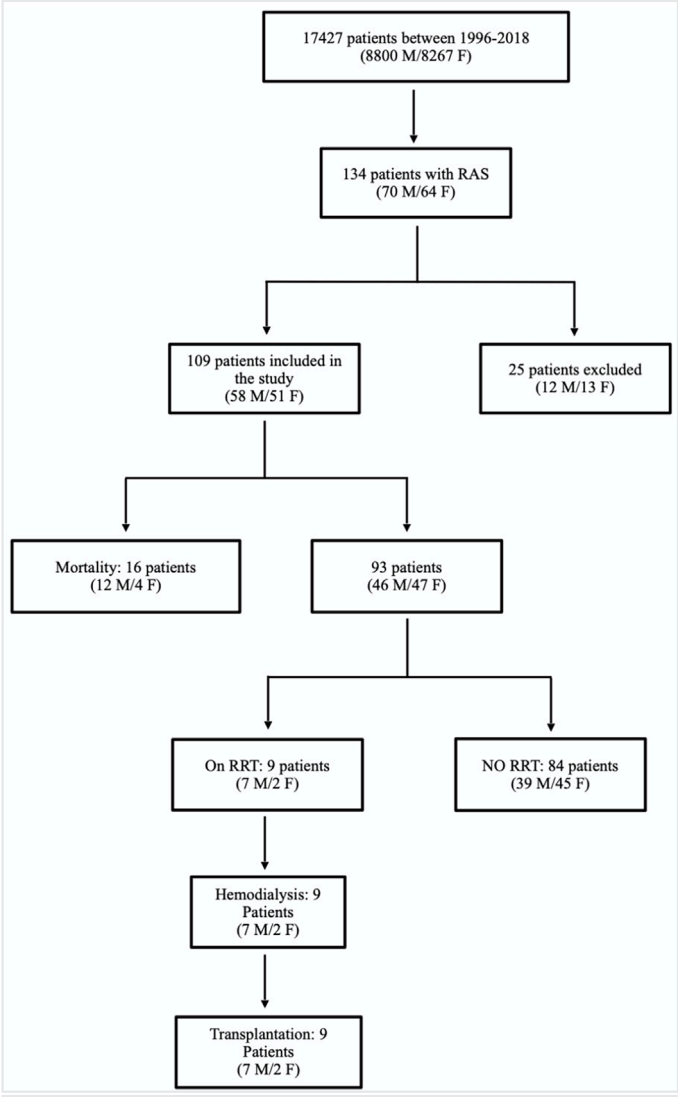


**Figure 1.** Patients' flow chart
M: Male, F: Female, RAS: Renal artery stenosis

While 60 (55%) patients were diagnosed with RAS due to atherosclerosis, 18 (16.6%) patients had a diagnosis of FMD.

Thirty-one (28.4%) patients with inflammatory disease were identified. It was observed that there were 23 patients (21.1%) in total with vasculitis. Fourteen patients (12.8%) were diagnosed with Takayasu arteritis. There were 2 patients with Behçet's disease (1.8%) and 7 patients (6.4%) with undifferentiated vasculitis. There were 8 patients under the title of other inflammatory disorders (6.4%). Of this patient group, 2 had rheumatoid arthritis (1.8%), 2 had ankylosing spondylitis (1.8%), 1 had familial Mediterranean fever (0.9%), 2 had crystal arthropathy (1.8%), and 1 had mixed connective tissue disease (0.9%).

The mean age of the patients diagnosed with Takayasu's arteritis was 29 (median: 27, range: 18-55).

### Initial Laboratory Findings

On-admission laboratory data of the patients are shown in Table 2.

The mean leukocyte count was 7976.3±2463.7/mm$^3$, platelet count 261385.6±80652.4/mm$^3$, hemoglobin 13.2±1.9 g/dL, serum urea 45.9±32.1 mg/dL, and creatinine was 1.5±1.1 mg/dL.

**Table 1. Demographic and clinical characteristics of all patients**

| Characteristics | All patients (n=109) |
|---|---|
| **Gender, n (%)** | |
| Female | 51 (47%) |
| Male | 58 (53%) |
| Age, years | 49±17 |
| Female | 50±17 |
| Male | 51±17 |
| **Comorbidities** | |
| Hypertension | 105 (96.3) |
| CAD | 26 (23.9) |
| DM | 25 (22.9) |
| CVA | 9 (8.3) |
| Hyperlipidemia | 5 (4.6) |
| CHF | 4 (3.7) |
| COPD | 4 (3.7) |
| Malignancy | 3 (2.8) |
| Inflammatory comorbidities | 31 (28.4) |
| - Vasculitis | 23 (21.1) |
| Takayasu | 14 (12.8) |
| Behcet's disease | 2 (1.8) |
| Vasculitis, other | 7 (6.4) |
| - Other inflammatory disorders | 8 (7.3) |
| Follow-up duration (years) | 4.74±3.8 |
| Mortality | 16 (14.6) |
| Overall survival (years) | 6±3.4 |

CAD: Coronary artery disease, DM: Diabetes mellitus, CVA: Cerebrovascular accident, CHF: Congestive heart failure, COPD: Chronic obstructive pulmonary disease.
Data are expressed as mean ± standard deviation for quantitative parameters and n (%) for nominal parameters

**Table 2. Laboratory findings of all patients**

| Parameters | All patients (n=109) |
|---|---|
| Urea (mg/dL) | 45.9±32.1 |
| Creatinine (mg/dL) | 1.5±1.1 |
| Na (mEq/L) | 140±3.2 |
| K (mEq/L) | 4.5±0.6 |
| Uric acid (mg/dL) | 6.1±1.9 |
| Ca (mg/dL) | 9.4±0.5 |
| P (mg/dL) | 3.6±0.7 |
| CaxP ($mg^2/dL^2$) | 33.5±6.5 |
| Parathormone (pg/mL) | 91.9±86.4 |
| WBC (/$mm^3$) | 7976.3±2463.7 |
| Neutrophil (/$mm^3$) | 5109.2±2042 |
| Hemoglobin (gr/dL) | 13.2±1.9 |
| Thrombocyte (/$mm^3$) | 261385.6±80652.4 |
| CRP (mg/L) | 13.1±35.2 |
| Sedimentation (mm/h) | 26.6±23.7 |
| GFR in 24-hours urine (mL/min/1.73 $m^2$) | 70.4±40.2 |
| Protein in 24-hours urine (mg/day) | 574.1±1026.1 |
| Albumin in 24-h urine (mg/day) | 288.2±813.7 |
| CKD-EPI eGFR (mL/min/1.73 $m^2$) | 67.7±33.6 |
| MDRD eGFR (mL/min/1.73 $m^2$) | 65.7±34.4 |

Data are expressed as mean ± standard deviation. Na: Sodium, K: Potassium, Ca: Calcium, P: Phosphate, CAxP: Calcium x phosphate, WBC: White blood cell, CRP: C-reactive protein, eGFR: Estimated glomerular filtration rate, CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, MDRD: Modification of Diet in Renal Disease

In the 24-h urine measurements, the mean GFR was 70.4±40.2 mL/min/1.73 $m^2$. The mean GFR was 67.7±33.6 mL/min/1.73 $m^2$ according to the CKD-EPI formula. It was calculated as 65.7±34.4 mL/min/1.73 $m^2$ using the MDRD formula. Most of the patients had a GFR value of 30 and had stage I, II, and III chronic kidney disease.

### Initial Examination Findings

The mean arterial blood pressure was 145±26 mmHg at the first visit, and the mean diastolic blood pressure was 87±18 mmHg. Fundus examination results were available for 76 patients (69.7%). Grade 1-2 hypertensive retinopathy was found in 33 (30.2%) patients, grade 3-4 hypertensive retinopathy in 2 (1.8%), and diabetic retinopathy in 6 (5.5%). The remaining 35 pa-tients (32.1%) had normal fundus results.

### Imaging Results

A total of 109 patients were diagnosed with RAS using at least one imaging method. Among these methods, the most commonly used were Doppler USG (n=92) (84.4%) and conventional angiography (n=70) (64.2%). These were followed by MR angiography (n=29) (26.6%) and CT angiography (n=23) (21.1%). Fourteen patients were diagnosed using MR angiography (n=4), CT angiography (n=5), or conventional angiography (n=5), when Doppler USG was unsuccessful. All four imaging modalities were used in two patients. The total number of patients with bilateral RAS detected by any imaging method was 40 (36.7%).

The rate of detecting stenosis in the right renal artery in Doppler USG was more prominent [right renal artery in 43 (39.4%) patients, left renal artery in 33 (30.3%) patients]. Doppler USG findings of the patients are shown in Table 3.

### Interventional Procedures

We found that 33 (30.3%) renal stenting was the most frequently applied interventional procedure. In 11 patients, a stent was inserted into the right renal artery (10.1%) and in 15 (13.8%) patients into the left renal artery. Seven (6.4%) patients underwent bilateral stenting. Eight (7.3%) patients underwent balloon angioplasty in the right renal artery. Eleven patients (10.1%) underwent balloon angioplasty in the left renal artery; 4 (3.7%) patients underwent bilateral balloon angioplasty. Five patients (4.6%) underwent a bypass.

Interventional treatment was performed in 5 of 14 patients with Takayasu's arteritis: Balloon angioplasty was performed in 3 patients, bypass in 1 patient after balloon angioplasty, and a unilateral stent was performed in 1 patient.

### Renal Replacement Therapy

Hemodialysis was initiated in 9 patients (8.3%). The mean time between admission and hemodialysis was 37.7±33.7 months in the total population. Transplantation was performed in 4 patients (3.7%). The mean time to transplantation was 96.2±62.5 months.

### Following Status

The mean follow-up period was 4.74±3.8 years. Among the survivors, 40 (36.7%) patients used alpha receptor blockers, 36 (33%) angiotensin-converting enzyme inhibitors (ACEI), 17 (15.6%) diuretics, 17 (15.6%) calcium channel blockers, and 5 (4.6%) nitrite-based antihypertensives. The number of patients who met the definition of resistant HT in the survivor group was 12 (11%) in total. Six of the resistant HT patients were controlled after interventional therapy, two after both interventional therapy and immunosuppressive therapy, and two only after immunosuppressive therapy (Table 4).

All patients with Takayasu's arteritis received immunosuppressive therapy, 1 patient underwent hemodialysis and then renal transplantation, and no death was observed in any patient.

**Table 3. Doppler USG findings of the patients**

| Parameters | n=76 (%) |
|---|---|
| Renal/aortic ratio <3.5, right, n (%) | 57 (52.3) |
| Renal/aortic ratio ≥3.5, right, n (%) | 32 (29.3) |
| Renal/aortic ratio <3.5, left, n (%) | 51 (46.7) |
| Renal/aortic ratio ≥3.5, left, n (%) | 39 (35.7) |
| Undetectable renal artery, right, n (%) | 3 (2.8) |
| Undetectable renal artery, left, n (%) | 2 (1.8) |
| Size of kidney, (mm) | 103.6±17.6 |
| Size of kidney, (mm) | 100.5±19.7 |

Data are expressed as mean ± standard deviation for quantitative parameters and n (%) for nominal parameters. USG: Ultrasonography

| Table 4. Patients with resistant hypertension | |
|---|---|
| Resistant hypertension, n (%) | 12 (11) |
| Controlled resistant hypertension after interventional therapy | 6 (5.5) |
| Resistant hypertension with inflammatory comorbidities | 5 (4.6) |
| Resistant hypertension with inflammatory comorbidities treated with interventional therapy and immunosuppressive | 3 (2.8) |
| Resistant hypertension with inflammatory comorbidities treated with immunosuppressive agents | 2 (1.8) |
| Controlled resistant hypertension with inflammatory comorbidities treated with interventional therapy and/or immunosuppressive therapy | 4 (3.7) |

Among the survivors, 5 patients (4.6%) had ischemic CVA, 1 patient (0.9%) had hemorrhagic CVA, and 5 patients (4.6%) had myocardial infarction and required coronary arterial intervention.

### Mortality

In total, 16 patients (13.5%) died with a mean of 6±3.4 years after admission. Six deaths were due to myocardial infarction, 4 due to CVA, and two due to sepsis in the males. Two of the females died due to a CVA and 2 due to myocardial infarction.

The 5-year survival estimate was 82% (M: 78%, F: 87%), whereas the 15-year survival rate was 68% (M: 59%, F: 87%). In the first 7.5 years following admission, mortality was similar between males and females, after which it increased significantly in males. Figure 2 shows the Kaplan-Meier survival curves a and b. All patients were shown in Figure 2a., comparison of gender subgroups was shown in Figure 2b.

We found that advanced age, low GFR at the time of diagnosis, and small kidneys are significant, poor prognostic factors ($p<0.01$, for all).

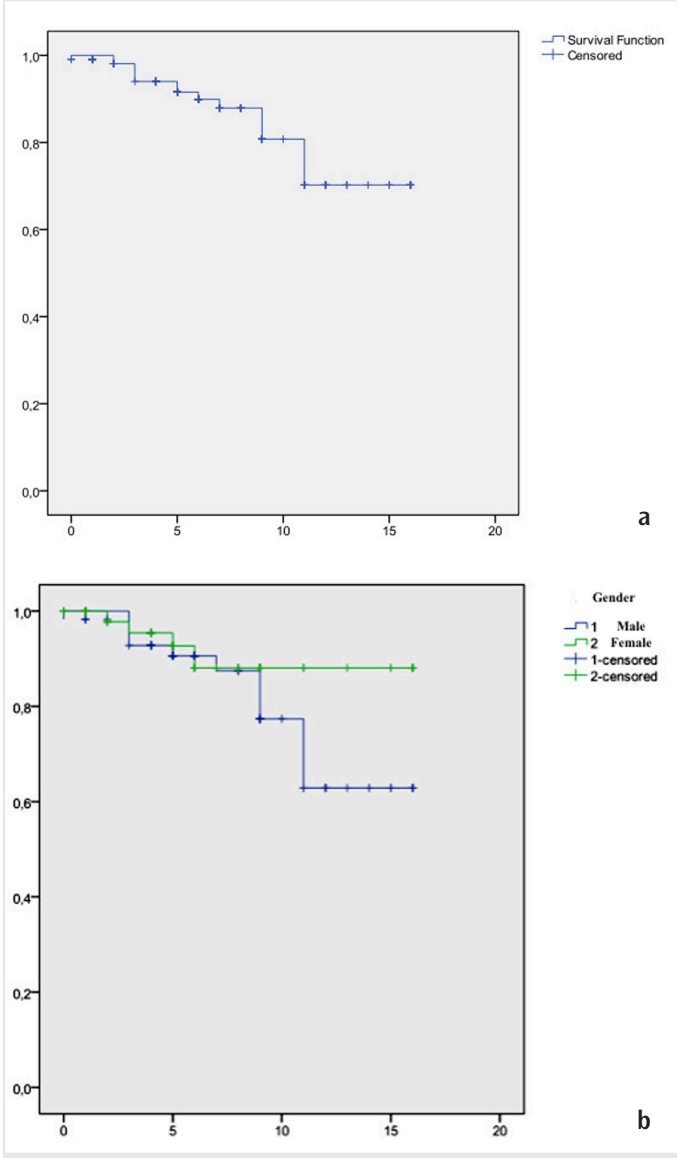


**Figure 2.** (a) Kaplan-Meier curves: All patients, (b) Kaplan-Meier curves: Comparison of gender subgroups

## Discussion

RAS is a clinical picture that is evaluated as a renovascular disease, but many diseases are involved in its etiology. Although there are many studies examining the causes in the etiology, it should be noted that there is limited information about the follow-up of patients diagnosed with RAS, the treatments applied during the follow-up period, and the mortality of the patients. In our study, 60 (55%) patients had atherosclerotic RAS, whereas 23 (21.1%) patients were diagnosed with vasculitis. In total, 16 patients (13.5%) died with a mean of 6±3.4 years after admission. In the first 7.5 years following admission, mortality was similar between gender subgroups, after which it increased significantly in males. It was found that advanced age, low GFR at diagnosis, and small kidneys are significant and poor prognostic factors.

In our study, the mean age of patients was 49±17 years old, male gender (53%) was more prominent. The most common accompanying comorbidity was HT, whereas the most common cause of RAS was atherosclerosis. The J-RAS study from Japan (15) was a prospective, multi-center study with 168 patients to assess the clinical outcome of RAS for up to 1-year-old patients with atherosclerotic RAS. The mean patient age was 72.7±8.5 years old, 82.6% of patients (123/149), and the most common accompanying clinical characteristic was HT (81.2%). Looking at the literature data, atherosclerosis is the primary cause and accounts for >90% of all cases with RAS, and FMD is the second most common cause (13,14,16). In our study, the second most common cause was vasculitides in 23 patients (21.1%) and, in parallel with the literature (13,14,17), Takayasu's arteritis constitutes an essential part of it.

Among the methods that can be used for RAS imaging, treatment, or diagnosis, plasma renin activity, the captopril challenge test, bilateral renal vein renin measurement, captopril renography, color Doppler USG, CT, or MR angiography could be used. Conventional angiography has emerged as the gold standard method (18). In our study, the most frequently used imaging method was Doppler USG. While conventional angiography followed Doppler USG, other non-invasive imaging methods were less preferred. In the J-RAS study (15), the most frequently used method was 100% conventional angiography. In the literature,

compared with the gold standard method, the sensitivities of Doppler USG, CT angiography, and MR angiography were 84 to 92%, 59 to 96%, and 90 to 100%; while the specificities were 64 to 99%, 82 to 99%, and 76 to 94%, respectively (19). In a study conducted in 2017, MR angiography using contrast material and non-contrast MR angiography were compared with conventional angiography as a reference. Non-contrast MR angiography is better, especially in application and motion artefacts, and it is safer in the patient group with a low filtration rate (18). In addition, false-positive MR angiography and false high measurement of the stenosis grade are also highlighted. In our study and the major studies from the literature (15,19,20), MR and CT angiography are in the back row.

Interventional therapy is one of the most important discussion topics in the current literature. Particularly with resistant HT (under a minimum of 3 antihypertensive drugs used at the maximum dose), progressive renal failure [progressive increase in serum creatinine, progressive decrease in GFR under ACEI or angiotensin receptor blockade (ARB)], or acute coronary syndrome independent of pulmonary edema, "revascularization" is recommended in patients with refractory CHF and bilateral RAS (21-23). In our study, a total of 33 patients underwent stenting (30.3%), 23 (21.1%) underwent balloon angioplasty, and 5 (4.6%) underwent a bypass. In the J-RAS study (15), 126 patients (84.6%) underwent interventional treatment for a single lesion, and 23 patients (15.4%) were treated for bilateral RAS. While the positive effect of renal arterial stenting on renal functions was shown to be inappropriate for patient selection in this study, in two other major studies, CORAL (20) and ASTRAL (21), no clinical benefit was demonstrated.

Permanent renal replacement therapy was 0.6% in the J-RAS (14), 0.7% in CORAL (20), and percentage in the ASTRAL (21) study, whereas it was 8.3% (9/109) of all patient groups in our study. Transplantation was performed in 4 patients (3.7%). The mean time to transplantation was 96.2±62.5 months. In our study, among the survivors, the most commonly used antihypertensive therapies were alpha-receptor blockers [40 patients (36.7%)] and ACEI [36 patients (33%)]. Calcium channel blockers and ARB were the most frequently used agents in other major studies related to RAS (15,20,21,24). Another important feature of our study was the resistant HT-related results. Six resistant HT patients were controlled after interventional therapy, two after both interventional and immunosuppressive therapy, and two only after immunosuppressive therapy. This result has not been previously defined in terms of inflammatory pathologies, renal artery involvement, and antihypertensive effect. While the most important causes of mortality in our study were cardiovascular and cerebrovascular events, in these studies (15,20,21,24), they were renal and cardiovascular events.

The CORAL study (20) provided prognostic information on RAS and its course. Nine hundred forty-seven patients were followed up for a mean of 43 months, with cardiovascular or renal events as the primary endpoint. A low baseline urinary albumin-creatinine ratio is a good prognostic feature, especially in the follow-up of HT and treatment response after stenting. Basal blood pressure and severity were not associated with post-stent response. In our study, advanced age, low GFR at the time of diagnosis, and small kidneys were found to be significant and poor prognostic factors.

In a study by Chen et al. (17), it was revealed that patients with Takayasu's arteritis with renal artery involvement were younger than those without renal involvement. In a study of 246 patients with renal artery involvement due to Takayasu's arthritis (25), the primary endpoints were chronic renal failure, refractory HT (blood pressure above 140/90 mmHg under 2 different maximum doses of antihypertensive used), and death. Of the 246 Takayasu patients included in that study, 62 had renal artery involvement, and 11 had undergone renal artery intervention; it was observed that these patients were aged 35 or below and predominantly male. In the same study, bilateral arterial involvement was riskier in terms of cardiovascular complications, such as CHF, than unilateral involvement (25). In a Chinese cohort (26), 567 patients with Takayasu were included, and RAS was confirmed in 172/567 (30.3%) patients. Revascularization was performed in 46 of 172 (26.7%) patients. Although this study showed that revascularization is beneficial in patients with Takayasu-associated RAS and uncontrolled or worsening renal function, the prognosis appears to be poorer for patients with renal insufficiency at presentation, bilateral artery involvement, and severe stenosis (26). In our study, interventional treatment was performed in 5 of 14 patients; all patients received immunosuppressive therapy. There was no mortal course in patients with Takayasu.

### Study Limitations

There are several limitations to our study. First, our patient population was limited compared with other studies. Data collection was challenging because of the difficulty of accessing past records. In particular, it was impossible to access the imaging methods' data completely retrospectively. Another important feature was that it contained only single-center data.

## Conclusion

The most common cause of RAS in our study was atherosclerosis. A total of 23 (21.1%) patients were diagnosed with vasculitis. Mortality was 13.5%, with 16 patients with a mean of 6±3.4 years after admission. Advanced age, low GFR at the time of diagnosis, and small kidneys are significant prognostic factors for mortality. In future study plans, RAS could be screened for with appropriate imaging methods to be selected in patients followed up with HT, and inflammatory etiologies in these cases can be investigated. In addition, a more systematic approach model can be developed in terms of applying "maximal medical treatment", which is our approach that we can currently describe as incomplete in cases of RAS with an early atherosclerotic process.

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**Ethics Committee Approval:** The study protocol was approved by the Clinical Research Ethics Committee of İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine (approval number: 83088843-604.01.01-379993, date: 11.10.2017).

**Informed Consent:** Retrospective study.

**Authorship Contributions:** Concept - İ.S., S.T., N.S.; Design - İ.S., S.T., N.S.; Data Collection or Processing - İ.S.; Analysis or Interpretation - İ.S.; Literature Search - İ.S.; Writing - İ.S.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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