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The effect of hypertension on renal functions in patients with acute coronary syndrome

Umut Uyan

Department of Cardiology, Ödemiş State Hospital, İzmir, Turkey

ABSTRACT

Objectives: In patients with acute coronary syndrome, age, ejection fraction, diabetes, hypertension, and chronic kidney disease (CKD) are regarded as independent risk factors for the development of acute kidney disease (ACD). This research evaluated the glomerular filtration rates (GFR) of acute coronary syndrome patient groups who were hypertensive and those who were not.

Methods: This retrospective analysis comprised 764 patients with acute coronary syndrome who had applied to our institution before coronary angiography. There were two groups created from these patients. In the first group, there were 383 hypertensive patients; in the second group, there were 381 non-hypertensive patients. To assess how well these patients' kidneys were functioning, GFR was determined and compared.

Results: The mean age of the two groups did not significantly differ from one another ($p = 0.053$). The standard lipid measures of total cholesterol, triglyceride, low-density lipoprotein-cholesterol, and high-density lipoprotein-cholesterol levels did not differ substantially between the two groups. The two groups had no discernible difference regarding high-sensitivity C-reactive protein, N-terminal fragment brain natriuretic peptides, creatinine, and thrombocyte levels. Systolic and diastolic blood pressure, as well as diabetes mellitus, were all considerably higher in the hypertensive patients' group $p < 0.001$). The GFR in hypertensive patients was substantially lower (64.83 ± 19.76 vs. 70.71 ± 19.19, $p < 0.001$)

Conclusions: Our research revealed a strong link between hypertension and diminished renal function. This leads us to believe that hypertension may be a separate risk factor for the decline in renal function in acute coronary syndrome patients.

Keywords: Acute coronary syndrome, renal failure, glomerular filtration rate, hypertension

Hypertension occurs in a significant proportion of patients with renal failure due to the reduction of water and sodium excretion in the kidney and the activation of the renin-angiotensin-aldosterone system. Although hypertension increases the frequency of cardiovascular and cerebrovascular events, it may cause renal failure by increasing the progression of kidney disease by causing hyalinization and sclerosis in the afferent arteriole wall. This study aims to examine the effect of hypertension on renal functions in patients hospitalized for acute coronary syndrome [1, 2].

The kidney and the heart coordinate numerous physiological events, including volume balance in the vascular bed, blood pressure, and peripheral tissue per-

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Address for correspondence: *Umut Uyan, MD., Ödemiş State Hospital, Department of Cardiology, Zafer Mah., Ortaç Sok., No:10, Ödemiş, İzmir, Turkey. E-mail: drumutuyan@hotmail.com, Phone: +90 232 544 51 13*

fusion. Thus, dysfunction in the kidney or heart results in the deterioration of the other organ's performance [1]. Important pathophysiological mechanisms underlying this connection include hemodynamic alterations, endothelial dysfunction, oxidative stress, immunological activation, inflammatory process, and activation of the renin-angiotensin-aldosterone and sympathetic nervous systems [2].

Even though approximately 30% of patients with advanced renal failure have hypertensive kidney disease, this rate is believed to be even lower because hypertension is not considered a factor in the development of renal failure. In patients with essential hypertension, the presence of concurrent kidney disease, diabetes, and cardiac ischemia increases the risk of developing kidney failure owing to hypertension. Renal dysfunction in hypertensive patients is a kidney injury that begins or worsens due to uncontrolled systemic blood pressure [3]. The deterioration of kidney function at the same or lower blood pressure levels is defined as the sensitivity to hypertensive kidney injury.

Glomerular filtration rate (GFR) is the most critical indication of kidney function in patients with both standard and impaired renal function [4]. GFR is the total amount of plasma filtered from glomeruli per unit of time in a nephron capable of maintaining its operations. Although a GFR value of 90 or more is considered normal for healthy individuals, this number might vary with age, body mass index, ethnicity, gender, and certain drugs and diets. GFR has a circadian rhythm, with nighttime values 10% lower than daytime [5]. The GFR decreases before the onset of kidney failure symptoms, and there is a clear correlation between the GFR decline and the development of CKD.

The GFR values of hypertensive and non-hypertensive patients with acute coronary syndrome (ACS) were compared in this study.

METHODS

Seven hundred sixty-four patients with ACS who applied to our outpatient clinic between July 2020 and December 2022 were included in this retrospective study. Before coronary angiography, these patients were assessed. Of the 900 patients included in the

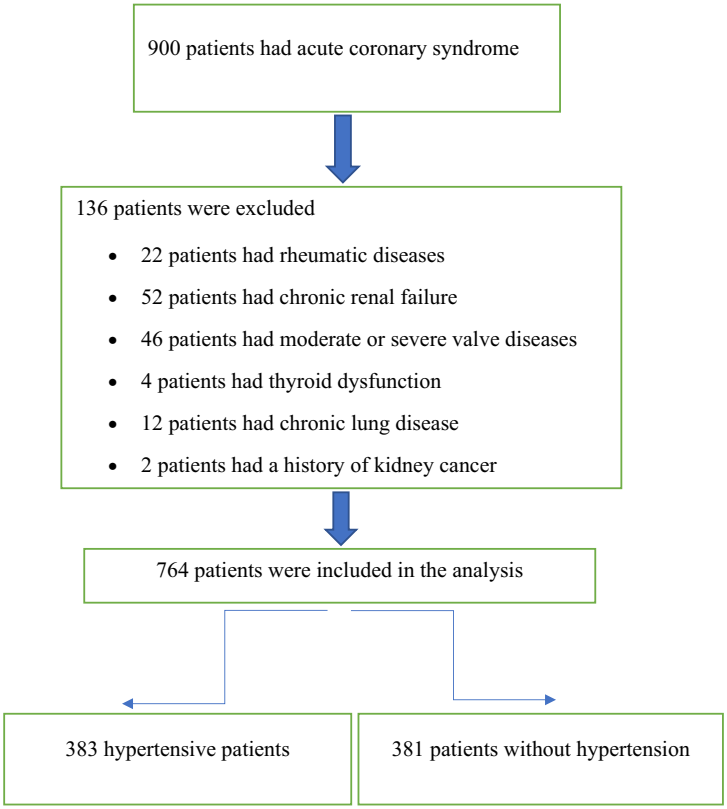

Fig. 1. Study flow chart

study, 136 were excluded due to exclusion criteria. There were 383 hypertensive patients and 381 patients without hypertension (Fig. 1). Patients with rheumatic diseases (rheumatoid arthritis, systemic lupus erythematosus, ankylosing spondylitis, etc.), secondary hypertension, electrolyte disorders, cardiac rhythm disorders, chronic renal failure, moderate or severe valve diseases, thyroid dysfunction, chronic lung disease, a history of cancer, and those taking antiarrhythmic, a tricyclic antidepressant, cortisone, antihistamine, and antipsychotic medications were excluded from the study. Systemic disorders were excluded by checking the histories of all patients, completing physical examinations, and examining laboratory tests.

According to World Health Organization (WHO) criteria, the patients included in the study were diagnosed with acute coronary syndrome. According to WHO guidelines, the diagnosis of acute coronary syndrome is made by the presence of ischemic chest pain, ischemic alterations in serial electrocardiograms (ECG), and at least two substantial elevations in blood cardiac markers. All patients with suspected ACS were monitored and followed using ECGs with 12 leads. The type and beginning time of the pain were questioned. The patients who participated in the study had their information (history, history, risk factors, physical examination, ECG findings, laboratory, time of admission to the hospital, and time of treatment) recorded. Patients who arrived with chest pain and were believed to have ACS were given whole blood and biochemistry tests (liver function tests, kidney function tests, cardiac markers, troponin, ck mb). Patients having ST elevation on the admission ECG with supporting clinical or laboratory findings were classified as STEMI. In contrast, those without ST elevation were classified as NSTEMI or unstable angina pectoris based on the presence or absence of myocardial injury. Patients without ST elevation but with elevated biochemical markers on the admission ECG were classified as non-ST-elevation myocardial infarction (NSTEMI); otherwise, they were classified as unstable angina pectoris [6].

According to the guidelines of the American Heart Association/American Society of Cardiology (ACC/AHA) and the European Society of Cardiology, the treatment of the patients was started (ESC). Antihypertensive medication or a history of high blood pressure (systolic blood pressure 140 mmHg or diastolic blood pressure 90 mmHg) were the criteria for the diagnosis of hypertension. Based on previous insulin or antidiabetic medication use or the discovery of increased blood glucose (fasting plasma glucose 126 mg/dL), a diabetes mellitus diagnosis was made [7]. For the diagnosis of dyslipidemia, previous use of antihyperlipidemic medicines or measurements above the values suggested for patient categories in a newly released guideline is based on [8]. The Chronic Kidney Disease Epidemiology Collaboration's (CKD-EPI) formula was used to calculate GFR values.

Statistical Analysis

SPSS 21.0 was utilized for statistical analysis (Statistical Package for Social Science Inc., Chicago, Illinois, USA). The homogeneity and normality of the distribution were evaluated using the Kolmogorov-Smirnov test. Mean and standard deviation was utilized for variables with a normal distribution, whereas number (n) and percentage (%) were used for categorical variables. The median (minimum-maximum) was used to illustrate the descriptive statistics of the variables that were not normally distributed. Pearson's chi-squared or Fisher's exact test was used to compare the categorical variables. Student-T test was used to compare parametric variables in non-categorical variables, while the Mann-Whitney U test was used to compare non-parametric variables. A p-value of 0.05 was judged statistically significant.

RESULTS

Two patient groups with acute coronary syndrome were included in the study. The mean age of 381 non-hypertensive patients was 62.57 ± 10.30 years. The mean age of 383 hypertensive patients was 64.06 ± 10.93 years. The two groups had no significant difference regarding mean age ($p = 0.053$). Clinical and laboratory data for both groups are presented in Tables 1 and 2.

The total cholesterol, glucose, triglycerides, LDL, and HDL cholesterol levels were not significantly different between the two groups. Once again, the two groups had no discernible change in the ranks of hs-CRP, NT-pro-BNP, creatinine, or platelets.

Hypertensive patients had considerably higher

Table 1. Comparison of demographic characteristics of the study population

	Hypertensive Group (n = 383)	Control Group (n =381)	*p* value
Age (years)	64.06 ± 10.93	62.57± 10.30	0.053
Male gender, n (%)	224 (58.5)	307 (80.6)	**< 0.001**
Diabetes, n (%)	105 (27.4)	99 (26)	0.386
Hyperlipidemia, n (%)	150 (39.2)	131(34.4)	0.229
Smoking, n (%)	113 (29.5)	186 (48.8)	**< 0.001**
Systolic blood pressure (mm Hg)	140.21 ± 28.52	118.76 ± 18.17	**< 0.001**
Diastolic blood pressure (mm Hg)	82.59 ± 15.81	73.33 ± 11.49	**< 0.001**
Left ventricular ejection fraction (%)	48.26 + 9.57	45.88 + 11.03	**0.002**

systolic and diastolic blood pressure ($p < 0.001$). In non-hypertensive patients, smoking prevalence was significantly higher ($p < 0.001$). When echocardiography findings were compared throughout patient groups, hypertensive patients had a significantly higher mean ejection fraction ($p = 0.002$). GFR in hypertensive patients was substantially lower (70.71 ± 19.19 vs. 64.83 ± 19.76, $p < 0.001$) than non- hypertensive patients.

Table 2. Comparison of laboratory and echocardiographic values of the study population.

	Hypertensive Group (n = 383)	Control group (n = 381)	*p* value
Creatinine (mg/dL)	1.12 + 0.34	1.10 + 0.28	0.534
Fasting glucose (mg/dL)	139.63 ± 86.30	138.61 ± 71.37	0.482
Total cholesterol (mg/dL)	190.66 ± 54.36	190.22 ± 56.79	0.914
Fasting LDL cholesterol (mg/dL)	117.72 ± 41.77	120.40 ± 44.53	0.396
Fasting HDL cholesterol (mg/dL)	40.48 ± 10.89	40.08 ± 11.43	0.620
Fasting triglyceride (mg/dL)	169.86 ± 113.23	160.37 ± 146.39	0.321
Na (mmol/L)	138.30 ± 2.14	138.70 ± 2.43	0.394
K (mmol/L)	4.31 ±0 .36	4.32 ± 0.37	0.240
Ca (mg/dL)	9.66 ± 0.44	9.80 ± 0.43	0.064
Mg (mg/dL)	2.03 ± 0.24	2.04 ± 0.18	0.874
TSH (mIU/mL)	1.64 ± 0.82	1.68 ± 0.66	0.620
Hemoglobin (g/dL)	14.66 ± 1.87	14.17 ± 1.72	0.724
Leukocyte count (×103/mL)	10.95 ± 3.44	11.19 ± 3.75	0.112
Platelet count(×103/dL)	241.12 ± 78.43	232.49 ± 67.74	0.104
GFR (mL/min.)	64.83 ± 19.76	70.71 ± 19.19	< 0.001
NT-pro-BNP (pg/mL)	1677.23 ± 4067.21	1442.19 ± 4738.88	0.470
hs-CRP (mg/dL)	5.35 ± 4.37	4.92 ± 4.51	0.199

LDL-C = low-density lipoprotein-cholesterol, HDL-C = high-density lipoprotein-cholesterol, hs-CRP = high sensitivity C-reactive protein, NT-pro-BNP = N-terminal fragment brain natriuretic peptides, GFR = Glomerular filtration rate.

DISCUSSION

This study compared GFR values between hypertensive and non-hypertensive patients with acute coronary syndrome. As a result of our research, a significant relationship was found between hypertension and impaired renal function. Regardless of the etiology of kidney disease, there is disagreement about whether hypertension is the primary cause of kidney function loss. It is widely accepted that uncontrolled hypertension accelerates the onset of renal failure, becoming more common as it progresses.

Narrowing of preglomerular arteries and arterioles, as well as enlarged glomerular ischemia caused by decreased glomerular blood flow, are the two main factors that cause renal failure caused by high systemic blood pressure. Another factor is the development of direct hypertensive kidney damage caused by increased systemic blood pressure on the glomeruli. Gradual renal failure begins to develop due to the deterioration of the glomerular structure brought about by the increase in glomerular perfusion [9].

The vascular bed experiences the first physiological changes as the systemic blood pressure rises. The filtration rate increases and the glomerular filtration rate remains constant as the total renal blood flow decreases. The supply vessels constrict to accomplish this, but the uptake narrows less. Selective afferent artery narrowing increases blood flow to some nephrons while maintaining a constant glomerular filtration rate. This type of renal vasoconstriction responds to antihypertensive drugs. The renal vascular response seen in uncomplicated essential hypertension is the narrowing of the afferent arteriolar.

Degenerative changes result in endothelial edema, vascular smooth muscle hypertrophy, enlargement of the internal elastic lamina (due to accumulation of periodic acid-Schiff positive material), focal spasm of the afferent arteriole, and endothelial spasm. The afferent arteriole narrows due to hyalinization caused by focal lumen narrowing. The glomeruli may partially obscure these documented focal vascular changes. This suggests that uncomplicated essential hypertension does not cause significant nephron loss, and the resulting renal failure is unlikely to occur [10].

In the presence of hypertension, vasoconstriction occurs in the preglomerular vascular structure at the border of autoregulation, while the glomerular capillary pressure remains constant. In conclusion, the limits of renal autoregulation and the amount of blood pressure increase affect the renal microvascular system. One mechanism that protects against kidney damage is the widening of renal autoregulation thresholds in systemic hypertension. Severe glomerular damage from hypertensive kidney disease occurs when these autoregulation thresholds are exceeded. Near the upper border of systemic arterial hypertension, remodeling, the thickening of resistant arteries, and rarely glomerular damage are seen. In hypertensive individuals, glomerular injury in the autoregulation range causes prolonged localized glomerular ischemia [11]. The majority of cardiovascular illnesses continue to be the leading cause of morbidity and mortality in CKD patients, according to data from substantial prospective investigations. Even in patients with moderately severe coronary heart disease, it has been reported that decreased renal function increases vascular stiffness [12, 13] The development of vascular damage in atherosclerotic ACS depends on inflammation and oxidative stress [14].

On the other hand, novel risk factors like endothelial dysfunction, hyperphosphatemia, and hyperparathyroidism are highly prevalent and appear to play a more significant role in vascular disease in ACS and end-stage renal disease (ESRD) patients, compared with healthy subjects, in addition to traditional risk factors like diabetes mellitus, hypertension, hyperlipidemia, and advanced age [15, 16].

Renal function and stable ACS have been linked in some studies. According to Goodman *et al*. [17], ACS is typical in young adult patients with ESRD. According to Gradaus *et al*. [18], patients with ESRD experience a faster progression of atherosclerotic ACS than patients with normal renal function.

Studies have shown that the incidence of impaired renal function in patients with acute coronary syndrome ranges from 9 to 19% [19-22]. Poor renal function is an independent risk factor for increased morbidity and mortality in acute coronary syndrome [19, 20].

Many studies have evaluated risk factors for the development of acute kidney disease in patients with ACS, and age, ejection fraction, diabetes, hypertension, and chronic kidney disease are considered inde-

pendent risk factors [21-26].

In our study, the frequency of hypertension and diabetes was higher in the group with acute coronary syndrome with low GFR. Our findings show that lower eGFR values are linked to severe hypertension in patients with acute coronary syndrome. The standard CHD risk factors have no bearing on this connection.

Limitations

The fact that our study was done at a single facility with a small number of patients is its most significant drawback. More blood samples could be obtained from the patients included in our study. Radiological examinations could be used to evaluate kidney functions.

CONCLUSION

The results of our study suggest that hypertension may be an independent risk factor for impaired renal function in patients with acute coronary syndrome. There is a need for extensive randomized controlled studies on this subject.

Authors' Contribution

Study Conception: UU; Study Design: UU; Supervision: UU; Funding: N/A; Materials: N/A; Data Collection and/or Processing: UU; Statistical Analysis and/or Data Interpretation: UU; Literature Review: UU; Manuscript Preparation: UU and Critical Review: UU.

Ethics Committee Approval:

Health Sciences University Tepecik Training and Research Hospital, Non-Interventional Research Ethics Committee Ethics Committee, date: 15.06.2022. Issue no: 2022/06-23

Conflict of interest

The author disclosed no conflict of interest during the preparation or publication of this manuscript.

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