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Research Article

Prevalence and factors associated with left ventricular remodeling in renal artery stenosis

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Abstract

The objective of this study is to evaluate the prevalence, geometric patterns, and factors associated with left ventricular remodeling in patients with renal artery stenosis (RAS). Demographic, clinical, and echocardiographic data were assessed in 77 patients with RAS prior to endovascular stenting. The left ventricular mass index (LVMI) and relative wall thickness were calculated using American Society of Echocardiography (ASE) recommendations. Patients were classified based on LVMI and relative wall thickness into four ventricular remodeling patterns: normal geometry, concentric remodeling (CR), concentric hypertrophy (CH), and eccentric hypertrophy (EH). Logistic regression was done to investigate the determinants of the different ventricular remodeling patterns. Mean LVMI and relative wall thickness were 118 $\pm$ 40 g/m^2 and 0.45 $\pm$ 0.1. Left ventricular hypertrophy was observed in 65%. CH was the most prevalent geometric pattern of remodeling (normal, 16.9%; CR, 18.2%; CH, 40%; EH, 24.6%). Thirty (39%) patients had an abnormal LV systolic function (ejection fraction <55%), with 14 (46%) of them having eccentric hypertrophy. Independent predictor of EH was glomerular filtration rate (odds ratio [OR], 0.943; confidence interval [CI], 0.899–0.989; P = .01). Systolic elevation of blood pressure (OR, 1.030; CI, 1.003–1.058; P = .03) was associated with CH, and elevated diastolic blood pressure was associated with CR (OR, 0.927; CI, 0.867–0.992; P = .02). Patients with RAS have a high prevalence of left ventricular remodeling and LVH. Even though CH was the most prevalent pattern of left ventricular remodeling, EH was commonplace and was associated with renal dysfunction and heart failure. J Am Soc Hypertens 2014;8(4):254–261. © 2014 American Society of Hypertension. All rights reserved.

Keywords: Left ventricular remodeling; left ventricular hypertrophy; renal artery stenosis.

Introduction

Renal artery stenosis (RAS) is strongly associated with cardiovascular morbidity and mortality,[1–3] progression of renal insufficiency,[4,5] and pathogenesis and control of heart failure.[6] The risk of cardiovascular events from RAS appears to be independent of its association with hypertension, kidney disease, or atherosclerosis.[7,8] The pathophysiologic mechanisms that may explain this relationship are complex and include activation of the renin-angiotensin system,[9] sympathetic, and central nervous system,[10] endothelial dysfunction,[11] and the influence of vasoactive molecules.[12,13]

RAS is associated with changes in left ventricular (LV) structure and function.[14] Although a high incidence of LV hypertrophy (LVH) has been reported in RAS[7,14]; little is known about prevalence and pattern of LV remodeling in patients with RAS. In this study, we evaluated the epidemiology of LV morphological changes and factors associated with them.

The objectives of this study of patients with RAS are to determine 1) the prevalence of LV remodeling patterns, 2) identify factors that influence remodeling patterns, and 3) assess association of LV remodeling patterns with congestive heart failure.

Conflict of interest: None.

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Methods

Patient Selection

The study was conducted after approval from the institutional review board. All patients who underwent percutaneous transluminal renal angioplasty as per the recommendations of American College of Cardiology/ American Heart Association guidelines in the setting of significant unilateral or bilateral RAS and underwent preintervention echocardiography were included in the study.[15] Patients underwent digital subtraction or cine angiography to determine RAS. A significant RAS was defined as a ≥60% diameter stenosis with a translesional systolic pressure gradient of ≥20 mm Hg. Stenosis were quantified by using the digital caliper technique.[16] The exclusion criteria were: age <18 years, pregnancy, life expectancy <6 months, patients on dialysis, kidney transplant, stenosis not amenable to stent, allergy to study agents, unrelated renal disease, untreated aortic aneurysm, kidney size <8 cm. Patients who fulfilled the inclusion criteria and gave informed consent were considered eligible for the study.

Demographic and Clinical Data

All patients included in the study underwent detailed review of their demographic and clinical data. The patients were evaluated for their existing comorbidities as per the standard disease definitions. Systemic hypertension was defined as blood pressure ≥140/90 mm Hg or the patient being on an anti-hypertensive medication.[17] Renal function was stratified on the basis of estimated glomerular filtration rate (GFR), calculated by the Cockcroft-Gault formula[17] corrected for body surface area.[18] Coronary artery disease was defined as per the recommendations of American Heart Association.[19] Congestive heart failure (CHF) was defined as a clinical diagnosis with symptoms and signs consistent with the Framingham criteria for CHF.[20]

Echocardiographic Data

All patients included in the study underwent a two-dimensional Doppler and M-mode echocardiogram. All echocardiographic measurements were performed according to the American Society of Echocardiography (ASE) guidelines.[21] Measurements included LV end-diastolic diameter (LVIDd), septal wall thickness in end-diastole (SWTd), and LV posterior wall in end-diastole (PWTd). LV mass (LVM) was determined using the ASE recommended formula for chamber quantification: $LVM = 0.8 \times (1.04[(LVIDd + PWTd + SWTd)^3 - (LVIDd)^3]) + 0.6$ and was indexed for body surface area to calculate LVM index (LVMI).[21] LVH was determined using the criteria of Devereux et al, and was defined as >115 g/m^2 for men and >95 g/m^2 for women, which is based on epidemiological data that has been adapted by ASE.[22] Relative wall thickness (RWT) was calculated using the formula: $RWT = ([2 \times PWTd]/LVIDd)$, and was used to distinguish between concentric hypertrophy (RWT >0.42), eccentric hypertrophy (RWT <0.42),[21,23] and concentric remodeling (CR). LV ejection fraction (LVEF) was calculated based on modified Simpsons rule as per ASE guidelines.[21]

The patients were categorized into four remodeling patterns based on LVMI and RWT: normal geometry (normal LVMI and normal RWT), concentric remodeling (normal LVMI and increased RWT), eccentric hypertrophy (increased LVMI and normal RWT), and concentric hypertrophy (increased LVMI and RWT). The patients were further divided into two groups based on the presence and absence of CHF. The LV remodeling patterns in these two groups were also evaluated.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation, and qualitative data was expressed as percentage. Differences between groups were evaluated by unpaired *t*-tests or analysis of variance, as appropriate. Statistical significance was defined as $P < .05$. The effects of baseline clinical, biochemical, and echocardiographic parameters were assessed on LVMI and LV geometry. Logistic regression analysis was applied to identify the independent determinants of different geometric patterns of LV remodeling. In the regression model, the independent predictors used were age, body mass index (BMI), renal function, blood pressure, prior comorbidities, and use of medications that affect remodeling. We did not include race as our patient population was mainly Caucasian. Statistical analysis was performed using SPSS Version 20.0 (IBM SPSS for Windows, Armonk, NY).

Results

Demographic and Clinical Data

Seventy-seven (34 men, 43 women) patients with RAS who underwent endovascular stent implantation at the University of Toledo Medical Center between July 1993 and November 2001 and fulfilled the inclusion criteria were included in the analysis. Their mean age was 70 ± 10 years, systolic blood pressure was 164 ± 24 mmHg, diastolic blood pressure was 78 ± 14 mmHg, and GFR was 50 ± 22 ml/min/1.73 m^2. Diabetes was present in 24 (31%) patients; hypertension in 67 (87%) patients. In terms of cardiovascular diseases, 66 (86%) patients had coronary artery disease, 45 (58%) patients had peripheral vascular disease, and 26 (34%) patients were found to have CHF. A total of 49 (64%) patients were on angiotensin converting enzyme (ACE) inhibitor or an angiotensin