ELSEVIER

Archives of Medical Research 47 (2016) 200–206

Archives of Medical Research

ORIGINAL ARTICLE

Relationship Between Echocardiographically Evaluated Aortic Stiffness and Prolidase Activity in Aortic Tissue of Patients with Critical Coronary Artery Disease

Aydemir Koçarslan,[a] Sezen Koçarslan,[b] Mehmet Salih Aydın,[c] İbrahim Halil Altıparmak,[d] Deniz Demir,[e] Hatice Sezen,[f] Hasan Hüsnü Yüce,[g] and Mustafa Göz[c]

[a]*Department of Cardiovascular Surgery,* [b]*Department of Pathology, Kahramanmaraş Sütçü İmam University Faculty of Medicine, Kahramanmaraş, Turkey*
[c]*Department of Cardiovascular Surgery,* [d]*Department of Cardiology, Harran University Faculty of Medicine, Şanliurfa, Turkey*
[e]*Department of Cardiovascular Surgery, Bursa Treaning and Research Hospital, Bursa, Turkey*
[f]*Department of Biochemistry,* [g]*Department of Anaesthesiology and Reanimation, Harran University Faculty of Medicine, Şanliurfa, Turkey*

Received for publication March 15, 2016; accepted June 28, 2016 (ARCMED-D-16-00164).

Background and Aims. The aim of this study was to determine the relationship between echocardiographically evaluated aortic stiffness and prolidase activity in aortic tissue of patients with critical coronary occlusion.

Methods. Thirty six patients with coronary artery disease (CAD) scheduled for CABG and 30 control patients with no CAD proven angiographically were enrolled in this study. Plasma prolidase activities were quantified spectrophotometrically. During performance of the proximal anastomoses in the study group, a piece of aortic tissue was taken by punch and tissue prolidase activity was quantified spectrophotometrically and also evaluated pathologically by prolidase immunostaining. Eventually, the correlation of plasma prolidase activity, aortic tissue prolidase activity and aortic prolidase immunohistochemical staining with aortic stiffness was studied.

Results. The correlation of aortic stiffness with aortic tissue prolidase activity (r_s = 0.364; p = 0.029) and aortic prolidase immunohistochemical staining (r_s = 0.354; p = 0.034) was significant in the study group. However, the correlation of plasma prolidase activity with aortic stiffness was not statistically significant (r_s = 0.083; p = 0.292). Linear regression analysis showed that the aortic stiffness β index was significantly associated with aortic tissue prolidase activity (β = 0.354; p = 0.034) and statin usage (β = −0.334; 0.047) in the study group. Regression analysis revealed that ATPA and statin use were predictors of aortic stiffness, and API+ was found to be the predictor for ATPA (β = 0.449; p = 0.006).

Conclusion. Aortic tissue prolidase activity was more significant than plasma prolidase activity and aortic tissue prolidase immunohistochemical staining in the relationship with aortic stiffness in the critical CAD group. © 2016 IMSS. Published by Elsevier Inc.

Key Words: Aortic stiffness, Blood prolidase, Tissue prolidase, Immunohistochemistry, Coronary artery disease.

Introduction

Prolidase is a manganese-dependent exopeptidase that is important in collagen turnover, matrix remodelling and cell growth. It is the main regulatory enzyme in the metabolism of proline and hydroxyproline (1). Prolidase activity has been demonstrated in plasma and many organs containing

Address reprint requests to: Aydemir Koçarslan, Assistant Professor, Department of Cardiovascular Surgery, Kahramanmaraş Sütçü İmam University School of Medicine, Avsar Kampüsü, Kahramanmaras, 46100, Turkey; Phone: +90344 280 34 34; E-mail: drakocarslan@gmail.com or sezay98@gmail.com

0188-4409/$ - see front matter.
http://dx.doi.org/10.1016/j.arcmed.2016.06.009

proline, hydroxyproline and collagen. Specifically, the brain, heart, liver, kidney and muscles have a high level of prolidase activity (2–4). Serum prolidase levels have been evaluated in many diseases and found to be high in fibrotic liver disease, metabolic syndrome, hypertension, coronary artery disease (CAD) and valve disease (5–9). However, serum prolidase acitivity has been found to be low in cardiomyopathy, aortic aneurysm and chronic obstructive pulmonary disease (10–12).

Aortic stiffness reflects the mechanical tension and elasticity of the aortic wall (13). Aortic stiffness may be easily measured with echocardiography (14). Studies of aortic stiffness have shown that hypertension, diabetes mellitus (DM), atherosclerosis, smoking and aging increase aortic stiffness (14). Aortic stiffness is associated with increased cardiovascular mortality and morbidity in hypertensive patients (14,15). Degenerative stiffness of the aortic wall is referred to as arteriosclerosis (13). There are many theories associated with the development of aortic stiffness; aortic fibrosis formation due to arteriosclerosis risk factors is one of these factors (16). It has been shown that the level of serum prolidase activity increases in accordance with turnover of the extracellular matrix in the presence of atherosclerosis in patients with CAD (8). Our aim in this study was to investigate the relationship of aortic stiffness with plasma prolidase activity (PPA), aortic tissue prolidase activity (ATPA) and aortic prolidase immunohistochemical staining (API+) in patients with critical coronary stenosis.

Materials and Methods

Patient Selection

The study population included 36 consecutive patients with CAD and 30 consecutive control cases with angiographically proven normal coronary arteries. Control group was evaluated only for plasma prolidase activity. Detailed information about co-morbidities, medications used, surgical history, left ventricle ejection fraction (LVEF) and number of anastomoses performed were recorded.

The study protocol was carried out in accordance with the principles of the Declaration of Helsinki and approved by the ethics committee of our hospital. Informed consent for participation in this study was obtained from all individuals. Exclusion criteria were hypertension, heart failure, malignant tumor, arrhythmias, renal insufficiency, chronic respiratory insufficiency, rheumatoid arthritis, cirrhosis, and valvular heart disease.

Blood Pressure Measurement

Blood pressure measurements were performed in the supine position with a cuff sphygmomanometer prior to echocardiographic examination. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured according to the first and fifth Korotkoff sound. Body surface areas were determined as square meters by calculation.

Echocardiography

All measurements were performed by the same cardiologist using echocardiography 1 day before surgery or from coronary angiography. M-mode and 2-D images of all patients and spectral and color flow Doppler records performed in frequency with a 2.5-MHz transducer were taken with a GE Vivid S6 echocardiography device. After routine echocardiographic examination and with patients in mild supine position, the 2-D guided M mode recordings of the ascending aorta were taken. The aortic diameter was recorded by M-mode echocardiogram at a level of 3 cm above the aortic valve.

Aortic diameter in systole and diastole between the inner edges of the front and rear walls was calculated based on distances. The systolic diameter of the aorta (AoS) was measured when the aortic valve was in the full open position. When the diastolic diameter of the aorta (AoD) synchronized with the QRS peak in the ECG, recordings were measured. In addition to these parameters, left ventricular end-systolic diameter and left ventricular end-diastolic diameter were measured, and LVEF was calculated for all patients. Aortic function parameters were calculated using the following formula as previously described by Lacombe et al. and Stefanidis et al. (17,18).

$$\textit{Aortic strain } AS(\%) = 100 \times (\mathrm{AoS} - \mathrm{AoD})/\mathrm{AoD}$$

$\mathrm{PP} = \mathrm{SBP} - \mathrm{DBP}$ (PP, pulse pressure; SBP, systolic blood pressure; DBP, diastolic blood pressure)

$$\textit{Aortic distensibility } AD\left(cm^2 \cdot dyn^{-1}\right) = 2 \times (\mathrm{AoS} - \mathrm{AoD}) / \mathrm{PP} \times \mathrm{AoD}$$

$$\textit{Aortic stiffness index } \beta = \ln(\mathrm{SBP}/\mathrm{DBP})/(\mathrm{AoS} - \mathrm{AoD}) / \mathrm{AoD}(\text{pure number})$$

Like BP measurements, the aortic stiffness index was calculated on three occasions and the average value of these measurements was used as the reference aortic stiffness index (17,18).

Blood Sample Collection

The study group blood samples were obtained before the day of surgery after a 12-h fast. The control group blood samples were obtained prior to angiography from a femoral arterial catheter after 12 h fasting. Blood samples were placed into heparinized tubes. Plasma was separated from cells by centrifugation at 4000 × g for 10 min and stored at −80°C.