Noninvasively assessed pulsatility of ascending aortic pressure waveform is associated with the presence of coronary artery narrowing

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Abstract Several hemodynamic indices, measured invasively in the ascending aorta during routine angiography, are related to the presence and severity of coronary atherosclerosis. Radial artery tonometry, when combined with a validated transfer function, offers the possibility of noninvasive assessment of central arterial pressure. We aim to evaluate the association between noninvasive indices of aortic or radial pressure waveforms and the presence of a significant coronary stenosis. Patients who underwent elective coronary angiography were studied (110 men, 91 women, mean age 53 ± 0.9 years). Noninvasive measurement of their central hemodynamics was performed by analysis of the aortic pressure waveform derived from the radial artery. An increase in aortic fractional pulse pressure was associated with coronary artery narrowing or previous myocardial infarction. After multivariate adjustment, the odds ratio and confidence intervals (CI) of having a significant coronary aortic stenosis was 1.72 (95% CI, 1.1–2.7) and of previous myocardial infarction 1.6 (95% CI, 1.1–2.2). An increase in noninvasively assessed aortic fractional pulse pressure, but not of the peripheral index is significantly associated with the presence of coronary artery disease.

Key words Arterial stiffness · Aortic pulsatility · Fractional pulse pressure · Coronary artery disease

Introduction

Several hemodynamic indices, measured invasively in the ascending aorta during coronary angiography, are related to coronary atherosclerosis. Conversely, similar indices measured noninvasively in the brachial artery are not related to the presence and extent of coronary artery disease. Ascending aortic fractional pulse pressure (FPP), fractional diastolic pressure (FDP), or the pulsatility index (PI) are associated with the risk of a significant coronary lesion. Some of these variables are associated with the extent of coronary artery disease or predict restenosis after coronary angioplasty. Recently it has been shown that a central pressure waveform, characteristic of an ascending aorta, may be noninvasively reconstructed with validated transfer function from the analysis of a radial pulse wave. We aim to evaluate any possible association between noninvasive indices of aortic or radial pressure waveforms and the presence of a significant coronary stenosis or previous myocardial infarction.

Material and methods

Study population

A total of 201 patients in sinus rhythm (110 men, 91 women, mean age 53 ± 0.9 years) undergoing elective coronary angiography for the evaluation of stable coronary artery disease (CAD) were recruited. None of the patients suffered from cancer, renal insufficiency or overt heart failure. Hypertension was defined as a repeatedly elevated blood pressure exceeding 140 over 90 mmHg. The institutional ethics committee approved the study protocol. The patient’s characteristics are shown in Table 1.

Angiographic evaluation

Coronary angiography was performed by the Judkins method. The presence of coronary atherosclerosis was estimated by two independent observers, both blinded for laboratory data. A significant coronary artery stenosis was defined as the presence of narrowing of >50% of the lumen.
Noninvasive assessment of pressure waveform

Studies were carried out in the morning, alcohol and caffeine having been excluded for the previous 24 h. Long-acting nitrates were withheld for 24 h before the study. Recordings of the blood pressure and radial pressure waveform were performed on supine patients after 10 min rest.

The brachial blood pressure was recorded noninvasively with the use of an oscillometric method (Colin BPM 7000; Colin, Komaki, Japan). The measurement of the brachial blood pressure was used as a calibration value for radial tonometry. The radial pressure waveform was recorded noninvasively with a piezoelectric tonometer (Colin BPM 7000) attached to the subject’s wrist. The recorded analog signal was sent in real time to SphygmoCor Mx (AtCor Medical, West Ryde, NSW, Australia) for on-line reconstruction of a pressure waveform characteristic for an ascending aorta with the use of a validated transfer function. Pulse wave analysis was applied to assess the central systolic (SBPc), diastolic (DBPc), and mean blood pressures (MBP).

Aortic pulsatility was defined as the ratio of aortic pulse pressure to mean pressure and described as the central fractional pulse pressure (cFPP). Peripheral arterial pulsatility was defined as the ratio of brachial pulse pressure to mean pressure and described as the peripheral fractional pulse pressure (pFPP).

Statistical analysis

Results are expressed as mean ± SEM. Comparisons between groups were made using the Student t-test for unpaired observations. A logistic regression analysis was used to estimate an association between the presence of significant coronary stenosis (Model 1) or of a previous myocardial infarction (Model 2) and various covariates, which demonstrated a significant association with the outcome variable in univariate analysis. All analyses were performed using Statistica, version 7.0 (StatSoft, Tulsa, OK, USA).

Results

Hemodynamic and clinical characteristics of the population studied

The participants’ baseline characteristics are shown in Table 1. Based on coronary angiography, 57% of the studied population showed significant coronary artery stenosis. Thirty-eight percent of the patients had suffered a myocardial infarction in the past, 44% were hypertensive, and 22% suffered from diabetes.

Patients with significant coronary artery stenosis (Table 2) were older and had higher systolic aortic blood pressure and higher central FPP. Similar characteristics were observed in the population of patients who suffered from myocardial infarction in the past (Table 3).

In univariate analysis age, male sex, hypertension, diabetes, higher body mass index (BMI), and central (but not peripheral) FPP were all associated with the presence of significant coronary artery stenosis (Table 4). Central FPP was significantly associated with the presence of CAD in the multivariate model, odds ratio (OR) 1.7 (95% confi-