Abstract

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A Comparison of Pulse Pressure, Arterial Stiffness, and Endothelial Function for the Diagnosis and Prognostic Risk of Coronary Heart Disease

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Background

Pulse pressure, an index of arterial stiffness, correlates with the presence of cardiovascular disease and predicts subsequent cardiovascular event risk (see next figure).

Several techniques for directly measuring arterial stiffness have recently been developed.

Brachial artery flow-mediated vasodilation, an index of endothelial function, also correlates with the presence and subsequent event risk of cardiovascular disease.

Vaccarino V, et al. JACC 2000;36:130

Increase in 10-Year Cardiovascular Risk per 10 mmHg Increase in Blood Pressure in 2152 Elderly Patients

- Pulse Pressure: 1.22
- Systolic Pressure: 1.14
- Mean Pressure 1.10
- Diastolic Pressure 0.96

Hypothesis

The direct measurement of arterial stiffness should improve the diagnostic and prognostic value of pulse pressure.

Specific Aims

To compare pulse pressure, brachial artery stiffness, and brachial artery flow-mediated vasodilation as diagnostic indexes for the presence of cardiovascular disease.

To compare pulse pressure and brachial artery stiffness as indexes predictive of Framingham Heart Disease Study risk.

Methods

Diagnostic Study: Measurement of pulse pressure and brachial artery stiffness by computerized oscillometry (Cardiovision®) in 100 consecutive study subjects [26 known CVD (16 CAD, 5 PVD, 5 cerebrovascular disease) and 74 assumed normals] undergoing analysis in a research vascular biology laboratory, of whom the first 30 also had measurement of brachial artery flow-mediated vasodilation.

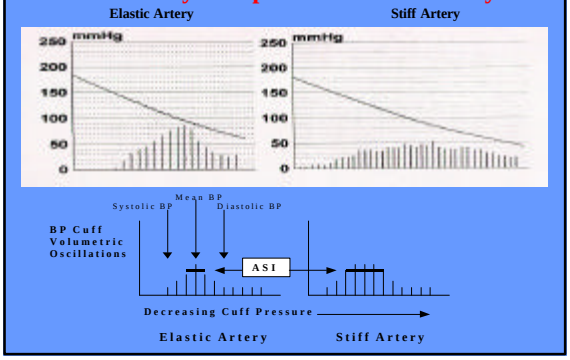
Prognostic study: Measurement of pulse pressure and brachial artery stiffness by computerized oscillometry (CardioVision®), and 10-year Framingham Coronary Heart Disease Study risk (CardioVision®) in 688 ACC Annual Scientific Sessions attendees undergoing a risk factor screen, inclusive of lipid analysis.

Methods (continued)

Blood pressure, pulse pressure, and brachial artery stiffness were measured by an automated blood pressure cuff (CardioVision®, International Medical Device Partners, Inc., Las Vegas, NV) which uses computerized oscillometry. This approach calculates an Arterial Stiffness Index (ASI) equal to 10 times the width of the oscillometric curve at 90% of the peak height. This approach is based on the observation that elastic arteries generate sharply peaked curves, whereas stiff arteries generate rounded peaks (see next figure). With input of total and HDL-cholesterol levels, the CardioVision® device also generates the 10-year Framingham Coronary Heart Disease Study risk score (see subsequent figure).

Brachial artery flow-mediated vasodilation was measured by 11 MHz ultrasound as the % change in arterial diameter 1 minute after a 5 minute upper arm occlusion (see subsequent figure).

Measurement of Blood Pressure and Arterial Stiffness by Computerized Oscillometry



Wilson et al. Circulation 1998;97:1837

Framingham Heart Study

10-Year Coronary Event Risk for Men (M) and Women (F)

AGE	M	F
30-34:	-1	-9
35-39:	0	-4
40-44:	1	0
45-49:	2	3
50-54:	3	6
55-59:	4	7
60-64:	5	8
65-69:	6	8
70-74:	7	8

T-CHOL	M	F
<160:	-3	-2
160-199:	0	0
200-239:	1	1
240-279:	2	1
>280:	3	3

----or----

LDL-C	M	F
<100:	-3	-2
100-129:	0	0
130-159:	0	0
160-190:	1	2
>190:	2	2

BP	M	F
<120/<80:	0	-3
120-9/80-4:	0	0
130-9/85-9:	1	0
140-59/90-9:	2	2
>160:	3	3

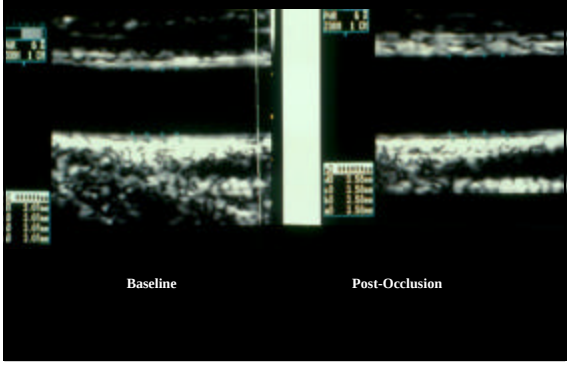
HDL-C	M	F
<35:	2	5
35-44:	1	2
45-49:	0	1
50-59:	0	0
>60	-1	-3

SMOKER	
NO:	0
YES (M):	2
YES (F):	2

DIABETES	
NO:	0
YES (M):	2
YES (F):	4

Total Points:	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	>17
%Risk (M):	2	2	3	4	4	5	7	8	10	13	17	21	26	32	38	46	54	→		
%Risk (F):	1	2	2	2	3	3	4	5	6	7	8	9	11	12	14	16	20	22	25	30

Brachial Artery Flow-Mediated Vasodilation



Results: Diagnostic Study

	N	PP (mmHg)	ASI (mmHg)	FMD (%Δ)
Normals without risk factors:	9	48±10	47±20	12±4
Normals with risk factors:	7	69±24	107±110	11±9
CVD with/without risk factors:	14	67±16*	168±78*	10±6

		PP>60 mmHg	ASI>80	Abn ASI or PP
Sensitivity:	26	61%	69%	69%
Specificity:	74	92%	96%	91%
Predictive Accuracy	100		89%	

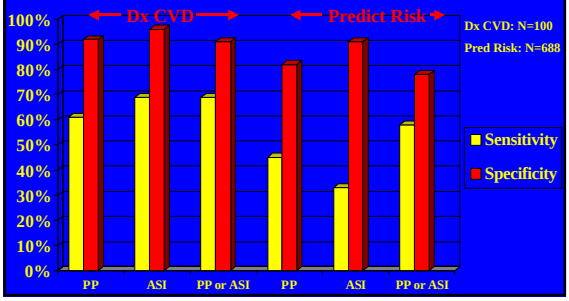
P<0.05 c/w normals

Results: Prognostic Study

688 screenees, 393 men, 295 women, ages 21-78 years
85 screenees with 10-year Framingham CHD risk ≥10%
(78 men, 7 women)
603 screenees with 10-year Framingham CHD risk <10%
(315 men, 288 women)

	PP>60mmHg	ASI>80	Abn PP or ASI
Sensitivity:	45%	33%	58%
Specificity:	82%	91%	78%

Sensitivity and Specificity of Pulse Pressure (PP≥60 mmHg) and Arterial Stiffness Index (ASI≥80) Measured by Computerized Oscillometery to Diagnose CVD and Predict ≥10% Framingham 10-Year CHD Risk



Study Limitations

Diagnostic Study: Subjects had either established CVD or were assumed normals. The absence of CVD was not verified in the normals.

CVD and normal subjects differed in risk factor burden.

Prognostic Study: Risk was predicted by the Framingham score rather than by prospective trial.

Conclusions

As measured by computerized oscillometry, the screening parameters pulse pressure (≥60 mmHg) and brachial artery stiffness (≥80) reasonably predict both the presence of CVD and increased long-term CHD risk.

Brachial artery flow-mediated vasodilation did not predict the presence of CVD.

Brachial artery stiffness has moderate sensitivity for the presence of CVD and modest sensitivity for CHD risk, but high specificity for both.

Conclusions (continued)

Brachial artery stiffness adds 8% sensitivity to pulse pressure as a diagnostic criterion at a cost of 1% specificity.

Brachial artery stiffness adds 13% sensitivity to pulse pressure as a risk predictive criterion at a cost of 4% specificity.