Superior assessment of CVD death by MACD index compared with the Framingham score is highly associated with predisposition to diabetes

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Introduction

It has been shown that aortic calcification is a major risk factor for cardiovascular disease (CVD) related deaths. We investigated the relation between mortality and aspects of number, size, morphology, and distribution of calcified plaques in the lumbar aorta of postmenopausal women between 48 to 76 years.
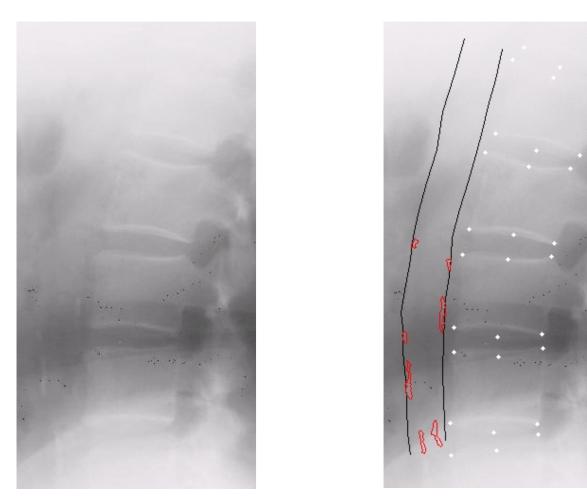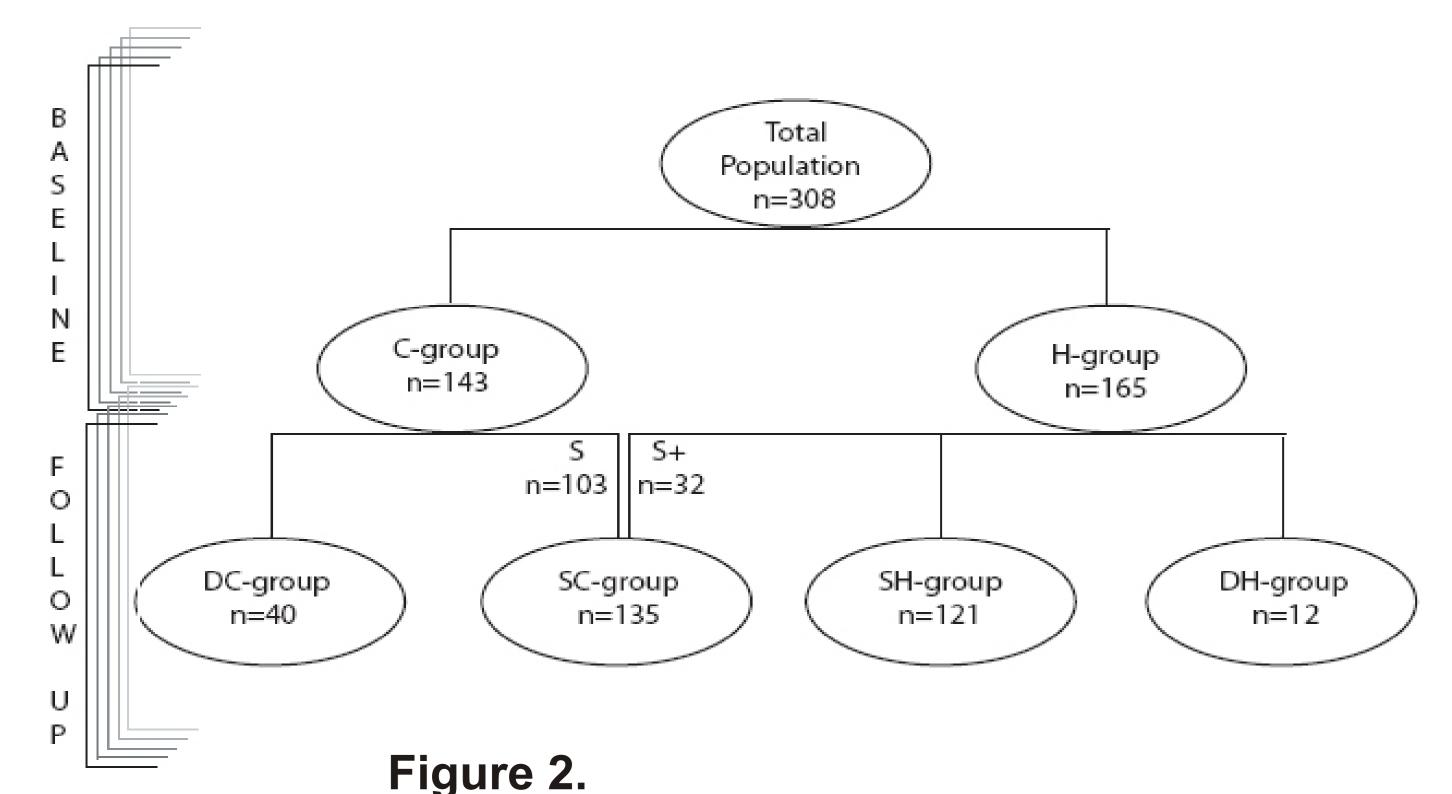

Figure 1.
The left side shows a lumbar x-ray with calcifications in the lower region. The image on the right illustrates the annotated vertebrae, aorta and calcified deposits.

From outlines of calcified plaques in lumbar x-rays several aortic calcification markers - including number, morphology and distribution - were quantified and combined into the morphological atherosclerotic calcification distribution (MACD) index.

All derived markers were compared to the SCORE card, the Framingham score and the Aortic Calcification Severity score (AC24).

Demographics:

Figure 2.
The separation of the whole population according to calcification status at baseline and follow-up.

Results

The AC24 vs. MACD:

For a given amount of calcified tissue, the markers are influenced differently by variations in calcification morpho-logy and distribution.
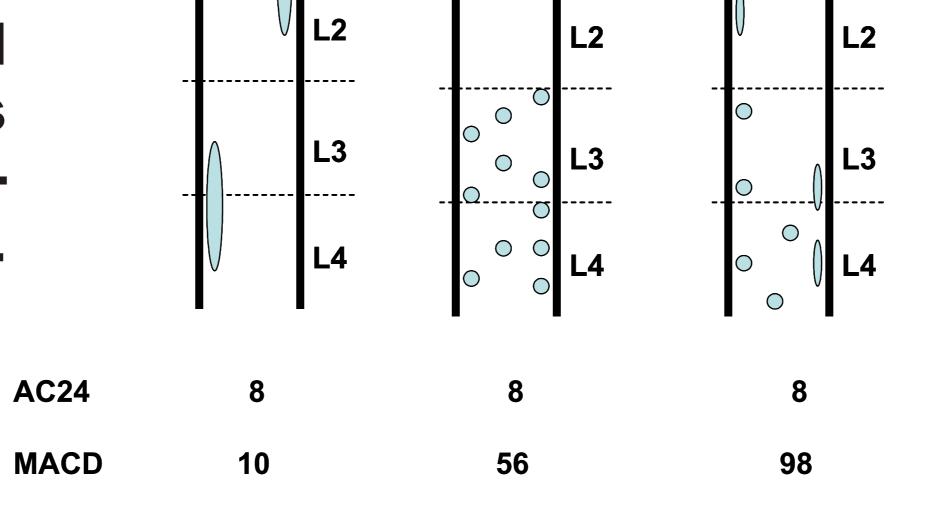

Figure 3.
The changes in MACD for equal AC24.

AC24	8	8	8
MACD	10	56	98

Correlations to biological parameters:

The baseline MACD provides the strongest and significant correlation with the blood glucose levels, triglycerides and LDL-C/HDL-C ratio, whereas the AC24 score does not correlate significantly to those. Both MACD and AC24 correlated positively with some of the traditional risk factors such as ApoB/ApoA, LDL/HDL ratio and negatively with HDL cholesterol. The MACD index calculated at follow-up still correlated glucose levels and also borderline to the LDL/HDL ratio.

	MACD Group C	AC24 Group C	FU-MACD Group SC	FU-AC24 Group SC
Age	-	-	-	-
Triglyceride	0.35***	0.13	0.09	-0.05
BMI	0.05	-0.07	-0.07	-0.06
Systolic BP	0.11	0.16(*)	0.01	0.11
Diastolic BP	-0.07	0.01	-0.05	0.08
Total-C	0.07	0.03	-0.06	-0.08
Glucose	0.30***	0.05	0.18*	0.19*
LDL-C	0.13	0.11	0.02	-0.12
HDL-C	-0.19*	-0.17*	-0.13	0.04
LDL-C/HDL-C	0.23**	0.18*	0.16(*)	-0.08
Apo B/Apo A	0.29***	0.23**	0.15	-0.03

Figure 4.
Correlations of different biological risk factors with age adjusted MACD and AC24. (* p < 0.05; ** p < 0.01; *** p < 0.001; (*) borderline)
Cross-sectional correlation performed on baseline biochemistry and baseline X-rays.
Cross-sectional correlation performed on follow-up biochemistry and follow-up X-rays.

	FU-MACD Group SC	FU-AC24 Group SC	FU-MACD Group S	FU-AC24 Group S
Age	-	-	-	-
Triglyceride	0.13	0.03	0.15	0.01
BMI	-0.05	-0.05	-0.01	-0.02
Systolic BP	0.18*	0.27**	0.17	0.22*
Diastolic BP	-0.02	0.04	-0.05	-0.02
Total-C	0.17(*)	0.04	0.20*	0.02
Glucose	0.05	0.09	0.04	0.06
LDL-C	0.24**	0.11	0.29**	0.12
HDL-C	-0.05	-0.07	-0.09	-0.11
Apo B/Apo A	0.26**	0.13	0.31**	0.15
LDL/HDL	0.19*	0.15	0.24*	0.17

Figure 5.
Correlation of age adjusted follow up-MACD and AC24 to baseline biological risk factors.
(* p < 0.05; ** p < 0.01; *** p < 0.001; (*) borderline)

FU-MACD correlates well with blood lipids, showing significant correlation to ApoB/ApoA, LDL-cholesterol, the LDL/HDL ratio, and borderline with total cholesterol, whereas AC24 did not correlate with any of the lipid parameters. Both FU-MACD and FU-AC24 correlate with a traditional risk factor - systolic blood pressure.
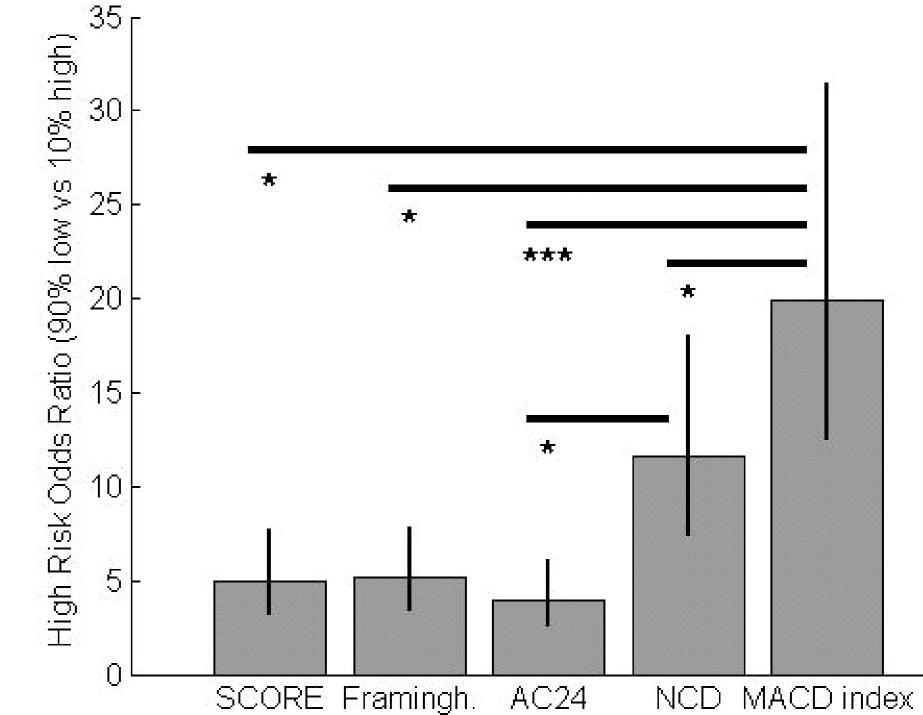
Conclusions

Figure 6.
The differences in odds ratios for the different markers.
(* p<0.05, ** p<0.01, *** p<0.001)

This results in a superior identification of CVD related death with an OR of 20. This increased biological information of the MACD index correlated strongly to glucose levels suggesting that an assessment of this method entails information of pre-diabetic status that is an important risk factor of plaque development and subsequent death.