BRIEF REPORT

Fluoroscopic Detection of Coronary Artery Calcification may Predict Long-Term Mortality

La calcificación coronaria detectada por fluoroscopia es capaz de predecir la mortalidad a largo plazo

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ABSTRACT

Introduction: Coronary artery calcification is a marker of atherosclerosis. Fluoroscopy is a simple and accessible method to detect coronary artery calcification.
Objective: The aim of this study was to evaluate the value of fluoroscopic detection of coronary artery calcification as an independent predictor of all-cause mortality and long-term cardiovascular mortality.
Methods: A prospective cohort of subjects aged ≥45 years without documented cardiovascular disease underwent fluoroscopic examination to identify the presence of coronary artery calcification.
A Cox regression model was used to evaluate the independent effect of calcification as a predictor of long-term mortality.
Results: A total of 857 persons were included in the study. Follow-up was completed in 98.7% of cases with an average of 14.4 ± 4.3 years (range: 34 days to 20.8 years). Mean age was 61.3 ± 9.7 years, 88.9% had hypertension, 19.6% had high cholesterol levels, 1.8% had diabetes and 52.7% were men. Coronary artery calcification was detected in 264 patients (32%). The presence of coronary artery calcification was associated with age, male gender and high cholesterol levels.
All-cause long-term mortality was 28.3% and cardiovascular mortality was 14.9%.
The presence of coronary artery calcification was an independent predictor of all-cause mortality (HR 1.6, 95% CI 1.2-2.0; p = 0.002) and cardiovascular mortality (HR 2.5, 95% CI 1.6-3.9; p = 0.002). All-cause mortality without calcification was 1.35 per 100 patient-years and 3.39 per 100 patient-years with calcification [p (log rank test) < 0.0001].
Conclusion: Fluoroscopic detection of coronary artery calcification may predict long-term all-cause and cardiovascular mortality in a population without documented cardiovascular disease.

Key words: Coronary calcification – Mortality - Fluoroscopy

RESUMEN

Introducción: La calcificación coronaria es un marcador de aterosclerosis coronaria. La fluoroscopia es un método simple y accesible accesible para detectar la presencia de dicha calcificación.
Objetivo: Evaluar si la presencia de calcificación coronaria detectada por fluoroscopia es un predictor independiente de mortalidad global y cardiovascular a largo plazo.
Material y métodos: Se estudió una cohorte prospectiva de personas ≥ 45 años sin enfermedad cardiovascular conocida a las que se les realizó una fluoroscopia para identificar presencia de calcificación coronaria.
Se efectuó seguimiento a largo plazo y se estudió con un modelo de regresión de Cox el efecto independiente de la calcificación como predictor de muerte.
Resultados: Se incluyeron 857 individuos. El seguimiento se completó en el 98,7% de los casos con un promedio de 14,4 ± 4,3 años (rango: 34 días a 20,8 años). La edad promedio al ingreso fue de 61,3 ± 9,7 años, el 88,9% eran hipertensos, el 19,6% tenían colesterol elevado, el 1,8% eran diabéticos y el 52,7% eran hombres. Se detectó calcificación coronaria en 264 pacientes (32%). La presencia de calcificación coronaria se asoció con edad, sexo masculino y colesterol alto.
La mortalidad a largo plazo global fue del 28,3% y la cardiovascular fue del 14,9%.
La presencia de calcificación coronaria resultó ser un predictor independiente de mortalidad global (HR 1,6, IC 95% 1,2-2,0; p = 0,002) y cardiovascular (HR 2,5, IC 95% 1,6-3,9; p = 0,002). La mortalidad global sin calcificación fue de 1,35 cada 100 pacientes/año y con calcificación, de 3,39 cada 100 pacientes/año [p (log rank test) < 0,0001].
Conclusión: La calcificación coronaria detectada por fluoroscopia es capaz de predecir de manera independiente mortalidad global y cardiovascular en una población sin enfermedad cardiovascular conocida.

Palabras clave: Calcificación coronaria - Mortalidad - Fluoroscopia.

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INTRODUCTION

The presence of coronary artery calcification is a strong marker of coronary artery atherosclerosis. (1-3)

The identification of coronary artery calcification by flouroscopy has been used for a long time to detect coronary artery disease. (4, 5)

The application of this noninvasive and cheap method in clinical practice is very attractive, as it can be rapidly used and is based on the patient's anatomy.

In our group, we have been working with this method for many years, with good sensitivity and specificity to detect obstructive coronary artery disease. (6, 7)

Some studies showed that fluoroscopy of the coronary arteries can predict an increase in all-cause mortality and cardiovascular mortality; yet, the follow-up period of these studies was not long. (8, 9)

Numerous studies have demonstrated that the coronary artery calcification score measured by multislice computed tomography can predict all-cause and cardiovascular mortality. (10-12)

We hypothesize that flouroscopic detection of coronary artery calcification may predict long-term mortality.

METHODS

Study population

The study included asymptomatic subjects aged 45 years or more, with at least one risk factor for the development of atherosclerosis and without documented cardiovascular disease.

A risk factor registry was created from a questionnaire based on the information provided by the patients and by the referring physicians.

Hypertension, dyslipidemia and diabetes were defined by the presence of the diagnosis and/or diet or pharmacological treatment for the corresponding condition.

Study design

This prospective observational cohort study was conducted at the Clínica Coronel Suárez.

The incidence of mortality and its cause were recorded during follow-up.

All the patients signed an informed consent form approved by the Teaching and Research Committee of the Clínica Coronel Suárez, following the Declaration of Helsinki recommendations.

Coronary artery fluoroscopy

A 9 inch image intensifier with a closed-circuit television system was used. The technique was performed using 1.5 to 2.5 milliamperes and between 80 to 100 kilovolts according to the morphology of the subject examined.

The examination was considered positive for calcification if one or more dense"shadows"of calcium intensity in the region of the coronary arteries, moved synchronously with the cardiac contraction.

Definitions

Cardiovascular mortality was defined as death with no documented non-cardiovascular cause (e.g., cancer, trauma, infection). Uncertain causes of death are supposed to be due to cardiovascular causes.

Statistical analysis

Discrete variables were expressed as percentages and continuous variables as mean ± standard deviation for normal distribution or median with their corresponding 25-75 interquartile range for non-Gaussian variables. The results were compared using the chi-square test with Yates correction or Fisher's exact test for discrete variables. Continuous variables were compared using Student's t test for unpaired data or Wilcoxon rank sum test, as applicable.

Contingency tables were constructed to analyze predictors of all-cause mortality and cardiovascular mortality. For each variable, hazard ratios and their corresponding confidence intervals were determined. The independent effect of coronary artery calcification on the risk of death, adjusted for possible confounders, was investigated with a Cox proportional-hazards regression model. All the variables with a p value < 0.10 in univariate analysis and those which might exert a confounder effect in the relation between mortality and the presence of calcification were included. The log rank test was calculated to compare survival according to the presence of calcification.

A two-tailed p value < 0.05 was considered statistically significant. The analyses were performed using the Intercooled Stata 8 (Stata Corporation) software package.

RESULTS

Between July 1992 and May 2000, 857 consecutive subjects were included in the study. Mean age was 61.3 ± 9.7 years, 52.7% were men, 88.9% had hypertension, 1.5% diabetes and 19.6% dyslipidemia.

There were no gender-related differences in age (61.9 ± 9.5 years in women and 60.8 ± 9.5 years in men; $p = 0.09$), but the prevalence of hypertension was greater in women (93.8% vs. 84.5% in men; $p < 0.0001$). Diabetes and dyslipidemia were less prevalent in women compared to men (0.5% vs. 13.1%; $p = 0.008$ and 13.1% vs. 25.4%; $p < 0.0001$, respectively).

The population was analyzed in two groups according to fluoroscopy findings: 274 (32%) with coronary artery calcification and 583 (68%) without calcification.

The comparison of baseline characteristics for both groups is shown in Table 1. Compared to subjects without coronary artery calcification, subjects with coronary artery calcification were significantly older men had a greater prevalence of diabetes and dyslipidemia and lower prevalence of hypertension.

Average follow-up was 14.4 ± 4.3 years (range: 34 days to 20.8 years) and was completed in 98.7% of the population.

During that period there were 239 all-cause deaths (28.3%), 126 (14.9%) due to cardiovascular disease and 113 (13.4%) to non-cardiovascular causes. All these events were significantly more frequent in patients with coronary artery calcification (Figure 1).

Overall mortality in patients with coronary artery calcification was 3.39 per 100 patient-years, and 1.35 per 100 patient-years in those without calcification (Figure 2).

In the multivariate analysis, age, male sex and the presence of coronary artery calcification detected by fluoroscopy were identified as predictors of all-cause mortality and cardiovascular mortality.

DISCUSSION

The presence of calcium detected by computed tomography scan has proved to be a useful method to predict increased risk in asymptomatic subjects.

Thus, the coronary artery calcium score has been incorporated in the scientific society guidelines. (13, 14)

The score measured by multislice computed tomography scan has an additional prognostic value with respect to traditional coronary risk factors.

For the 2012 Consensus Statement on Cardiovascular Prevention of the Argentine Society of Cardiology, the use of the coronary artery calcium score for risk assessment in the general population constitutes a Class IIa recommendation with level of evidence B in patients with intermediate clinical risk. (15)

Most follow-up studies using computed tomography scans have been performed in 64-multidetector row equipments during short periods of time.

A study performed in hypertensive subjects using dual slice computed tomography scan and follow-up period similar to ours showed results that could be compared with the high coronary calcium scores found here. (16)

The high cost of the study and the lack of availability for certain populations are limits to the applicability of the method in our country.

Fluoroscopy with image intensifier is surely a less sensitive method than computed tomography, but has very low cost and is available in almost any medical facility. (17)

Previous studies have found that the presence of coronary artery calcification detected by fluoroscopy increases the risk of coronary events at one year. (8)

Another study performed in asymptomatic subjects with a 55-month follow-up demonstrated a greater incidence of coronary mortality and nonfatal myocardial infarction. (9)

In our study, fluoroscopy proved to be a method capable of detecting significant increase in all-cause mortality and cardiovascular mortality in a population without documented cardiovascular disease.

Hypothetically, we may think that fluoroscopic detection of calcium may be similar to the presence of a high coronary calcium score in the computed tomography scan.

Study limitations

The study was conducted in a single center and the evaluation of coronary artery calcium was done by a single operator (R.L.B.).

We do not have information about subsequent treatments received by the patients.

Table 1. Baseline characteristics of the population

	With coronary artery calcification (n = 274)	Without coronary artery calcification (n = 583)	p
Age, mean ± SD	65.8 ± 9.4	59.2 ± 9.1	< 0.0001
Malegender, %	64.9	47.0	< 0.0001
Hypertension, %	85.0	90.7	0.013
Diabetes, %	2.9	1.2	0.07
Dyslipidemia, %	29.6	14.9	< 0.0001

SD: Standard deviation.

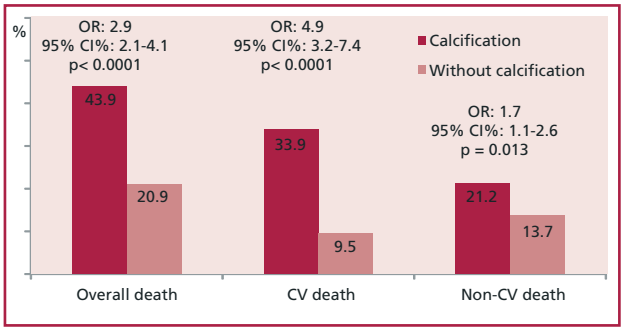

Fig. 1. Events according to coronary calcification;univariate analysis.CV: Cardiovascular. CI: Confidenceinterval. OR: Odds ratio

Table 2. Multivariate analysis of event predictors

	OR	95% CI	p
All-cause mortality			
Age (peryear)	1.1	1.1-1.1	< 0.0001
Male gender	1.8	1.4-2.3	< 0.0001
Coronary artery calcification	1.6	1.2-2.0	0.002
Cardiovascular mortality			
Age (peryear)	1.1	1.1-1.2	< 0.0001
Male gender	2.2	1.4-3.5	0.001
Coronary artery calcification	2.5	1.6-3.9	0.002

OR: Odds ratio. CI: Confidence interval.

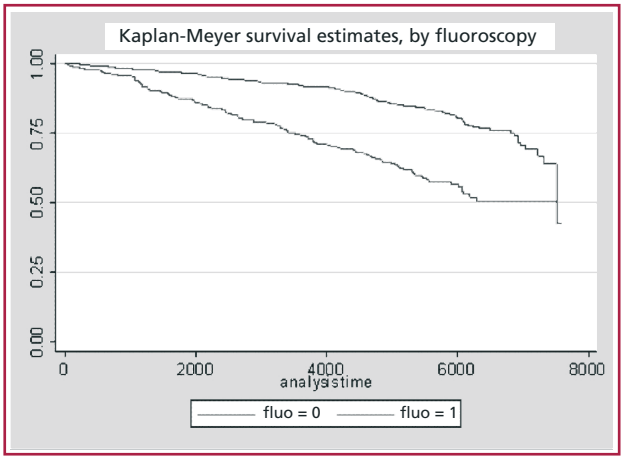

Fig. 2. All-cause mortality, according to fluoroscopic detection or not of coronary calcification (p log rank test < 0.0001).

CONCLUSION

Fluoroscopic detection of coronary artery calcification may predict long-term mortality.

Conflicts of interest

None declared.

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