

# Usefulness of the Echocardiographic Calcium Score as Predictive Tool for Obstructive Coronary Artery Disease

## *Utilidad del score de calcio ecocardiográfico como herramienta predictiva de enfermedad coronaria obstructiva*

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### ABSTRACT

**Background:** The aim of this study was to evaluate the predictive value of the echocardiographic calcium score (ECS).

**Methods:** Ninety-six patients with coronary angiography indication were enrolled in the study: 20 with non-ST-segment elevation acute coronary syndrome, 15 with chronic angina, 31 with ST-segment elevation acute coronary syndrome and 30 asymptomatic patients. After echocardiography with ECS and correlation with coronary artery disease, patients were classified into 2 groups according to ECS  $\leq 1$  or ECS  $\geq 2$ .

**Results:** Among the total number of patients, 23 patients without lesions had ECS: 0.61 and 73 with lesions had ECS: 2.63. In patients presenting lesions, 16 had single lesion with ECS: 1.68 and 57 multiple lesions with ECS: 2.87. In the 23 patients without lesions, 20 had ECS  $\leq 1$  and 3 ECS  $\geq 2$ , and among the 73 patients with lesions, 13 had ECS  $\leq 1$  and 60 ECS  $\geq 2$ . Thus, ECS  $\geq 2$  presented a higher frequency of coronary artery disease vs. ECS  $\leq 1$  ( $p < 0.05$ ), with 82.2% sensitivity, 87% specificity, 95.2% positive predictive value and 60.6% negative predictive value. In single vs. multiple lesions, 9 out of 16 patients with single lesion had ECS  $\geq 2$  and 51 out of 57 patients with multiple lesions had ECS  $\geq 2$ , with 89.5% sensitivity and 43.8% specificity to identify multi-vessel disease, and 85% positive predictive value and 53.8% negative predictive value.

**Conclusions:** The ECS would have good positive predictive value to assess coronary artery disease.

**Keywords:** Echocardiography - Coronary Disease - Vascular Calcification/diagnostic imaging

### RESUMEN

**Introducción:** Evaluar el valor predictivo del score cálcico ecocardiográfico (SCE).

**Material y métodos:** Se evaluaron 96 pacientes con indicación de coronariografía (CCG). Síndrome coronario sin supra ST 20 pacientes. Angina crónica 15 pacientes Síndrome coronario con supra ST 31 pacientes. Asintomáticos 30 pacientes. Se efectuó ecocardiograma con SCE y correlación con coronariopatía. Dos grupos: pacientes con SCE  $\leq 1$  y SCE  $\geq 2$ .

**Resultados:** Sobre 96 pacientes, 23 sin lesiones con SCE 0,61, y 73 con lesión SCE 2,63. Entre aquellos con lesión, 16 lesión única SCE 1,68, 57 lesión múltiple SCE 2,87. De 23 sin lesiones 20 tuvieron SCE  $\leq 1$ , y 3 SCE  $\geq 2$ , y de 73 con lesiones 13 tuvieron SCE  $\leq 1$ , y 60 SCE  $\geq 2$ ; así, un SCE  $\geq 2$  presenta mayor frecuencia de coronariopatía vs. SCE  $\leq 1$  ( $p < 0,05$ ), sensibilidad 82,2%, especificidad 87%, valor predictivo positivo: 95,2%, y negativo 60,6%. En lesión única vs. múltiple 16 presentaron lesión única, 9 tenían SCE  $\geq 2$ , y 57 múltiple, 51 tenían SCE  $\geq 2$ , sensibilidad: 89,5% y especificidad: 43,8% para identificar múltiples vasos, valor predictivo positivo 85%, y negativo: 53,8%.

**Conclusiones:** El SCE tendría buen valor predictivo positivo para coronariopatía.

**Palabras clave:** Ecocardiografía - Enfermedad coronaria - Calcificación vascular/diagnóstico por imagen

### INTRODUCTION

Cardiac and aortic valve calcium is related to coronary artery disease and is suggested as a form of atherosclerosis. (1-4)

Different studies have established that aortic and mitral valve calcification detected by echocardiography can predict cardiovascular morbidity and mortality. (5-6)

The use of a score assessing aortic and mitral valve, papillary muscle and ascending aorta calcium is associated with coronary calcium evaluated by computed tomography and coronary artery disease by angiography. (7-8) The aim of this study was to evaluate the usefulness of the echocardiographic calcium score (ECS) as a predictive tool to assess obstructive coronary artery disease.

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**METHODS**

Ninety-six patients with indication of coronary angiography (CA) were included from August 2017 to February 2018.

Patients were divided into 4 groups:

- Non-ST-segment elevation acute coronary syndrome (NSTEMACS): 20 patients.
- Stable chronic angina (SCA): 15 patients.
- ST-segment elevation acute coronary syndrome (STEMACS): 31 patients.
- Asymptomatic with positive perfusion test (Asymptomatic.): 30 patients.

After CA, each patient underwent echocardiography with ECS (Table 1). In STEACS, the echocardiogram was performed after the CA without knowing the coronary anatomy. A Mindray M7 ultrasound machine with 2-4 mHz transducer was used by a single operator.

Each aortic cusp was classified on a scale ranging from 0=NORMAL (leaflet thickness <2 mm and calcium absence), 1=MILD (leaflet thickness >2 mm and increased echogenicity), 2=MODERATE (leaflet thickness >4 mm and diffuse increase of echogenicity) and 3=SEVERE (leaflet thickness >6 mm and important echogenicity).

Once the coronary anatomy was known, ECS was correlated with coronary artery disease and number of vessels. Obstructive coronary artery disease was defined with lesions affecting 70% of the arterial lumen. Multi-vessel lesions were defined as lesions in two territories or >50% involvement of the main left coronary artery.

Continuous variables were expressed as means and categorical variables as absolute numbers or percentages. A multivariate logistic regression analysis was performed to evaluate the association between ECS and coronary artery disease.

Patients were divided into 2 groups according to the ECS:

- Patients with ECS ≤1.
- Patients with ECS ≥2.

**Exclusion criteria were:**

- Known coronary artery disease
- Previous cardiovascular surgery
- Aortic stenosis.
- Rheumatic disease
- Renal failure.

**Ethical Considerations**

An informed consent form allowing the use of clinical history data was reviewed by the institutional Ethics Committee in accordance with the 1975 declaration of Helsinki, its 1983 correction and 1989 revision, and signed by all participants.

**RESULTS**

**General population**

Twenty-three (23.9%) of the 96 patients included in the study had no coronary lesion with average ECS (aECS): 0.61; while 73 (76.1%) presented coronary lesions with aECS: 2.63. Among patients with coronary artery disease, 16 (21.9%) had a single lesion with aECS: 1.68 and 57 (78.1%) had multiple lesions with aECS: 2.87 (Figure 1).

As the population without coronary lesion had average ECS <1, patients were divided into those with ECS ≤1 (n=33; 34.4% of patients) and those with ECS ≥2 (n=63; 65.6%).

DEGREE	Papillary muscle calcification (*)	Mitral annulus calcification (mm) (**)	Aortic valve sclerosis (***)	Ascending aorta calcification
0	Absent	Absent	Absent	Absent
1	Present	Mild <5	Mild	Present
2		Moderate 5-10	Moderate	
3		Severe >10	Severe	

**Table 1.** Ecocardiographic calcium score

(\*) Papillary muscle calcification: defined as localized hyperechogenicity at the level of the head of one or both papillary muscles.  
 (\*\*) Mitral annulus calcification: defined as a hyperechogenic structure located in the atrioventricular junction, in relation to the posterior mitral leaflet.  
 (\*\*\*) Aortic valve calcification or sclerosis: defined as thickening of the aortic cusps and focal areas of greater echogenicity, in the absence of aortic stenosis (velocity through the aortic valve <2.5 m/s).



**Fig. 1**

Twenty out of the 23 patients without lesion (86.9%) had ECS  $\leq 1$  and 3 (13.3%) ECS  $\geq 2$ , and 13 out of the 73 patients with lesions (17.8%) had ECS  $\leq 1$  and 60 (82.2%) ECS  $\geq 2$ . These results established that having ECS  $\geq 2$  was associated with a higher frequency of coronary artery disease compared with ECS  $\leq 1$  ( $p < 0.05$ ).

The ECS  $\geq 2$  presented 82.2% sensitivity and 87% specificity to identify coronary artery disease, with a positive predictive value of 95.2% and a negative predictive value of 60.6%.

Taking into account single and multiple coronary lesions, among 16 patients with single lesion (21.9%), 9 (56.2%) had ECS  $\geq 2$ , and among 57 patients with multiple lesions (78.1%), 51 (89.4%) had ECS  $\geq 2$ , resulting in 89.5% sensitivity and 43.8% specificity to identify multi-vessel coronary artery disease with a positive predictive value of 85% and a negative predictive value of 53.8%.

### Subpopulations

#### Non-ST-segment elevation acute coronary syndrome

Six (30%) out of 20 patients with NSTEMACS had no coronary lesion with aECS: 0.66 and 14 (70%) had coronary lesions with aECS: 2.42. Among patients with coronary lesions, 4 (28.6%) had a single lesion with aECS: 2 and 10 (71.4%) had multiple coronary lesions with aECS: 2.6.

When this population was divided according to the ECS, we observed that 5 out of the 6 patients without lesions (83.3%) had ECS  $\leq 1$  and 1 (16.7%) ECS  $\geq 2$ , and that 3 out of the 14 patients with lesions (21.4%) had ECS  $\leq 1$  and 11 (78.6%) ECS  $\geq 2$ , allowing to conclude that patients with ECS  $\geq 2$  had a higher frequency of coronary artery disease compared with the ECS  $\leq 1$  group ( $p < 0.01$ ).

The ECS  $\geq 2$  had a sensitivity of 78.6% and specificity of 83.3% to identify coronary artery disease with a positive predictive value of 91.7% and negative predictive value of 62.5%.

Considering single and multiple lesions, we observed that among the 4 patients presenting a single lesion, 2 had ECS  $\geq 2$  and 9 out the 10 patients with multiple lesions had ECS  $\geq 2$  resulting in 90% sensitivity and 50% specificity to identify multi-vessel coronary artery disease with a positive predictive value of 81.8% and a negative predictive value of 66.7%.

#### Stable chronic angina syndrome

Among 15 patients with SCA, 3 (20%) had no coronary lesions with aECS: 1.33 and 12 (80%) had coronary lesions with aECS: 3.08. Two out of the 12 patients with coronary lesions (16.7%) had a single lesion with aECS: 2 and 10 (83.3%) had multiple coronary lesions with aECS: 3.3.

When this population was divided according to the ECS, we observed that 2 out of 3 patients without lesions (66.7%) had ECS  $\leq 1$  and 1 (33.3%) ECS  $\geq 2$ , and in the 12 patients with lesions, none had ECS  $\leq 1$  and all had ECS  $\geq 2$ , allowing to establish that patients with

ECS  $\geq 2$  had a higher frequency of obstructive coronary artery disease compared with the ECS  $\leq 1$  group, although without statistical significance ( $P < 0.05$ ).

The ECS  $\geq 2$  had a sensitivity of 100% and a specificity of 66.7% to identify coronary artery disease, with a positive predictive value of 92.3% and a negative predictive value of 100%.

The comparison between single and multiple lesions showed that 2 patients presented a single lesion, both with ECS  $\geq 2$  and 10 multiple lesions, all with ECS  $\geq 2$ , resulting in sensitivity of 90.0% and specificity of 33.3% to identify multi-vessel coronary artery disease with a positive predictive value of 83.3% and a negative predictive value of 50%.

#### ST-segment elevation acute coronary syndrome

Among 31 patients with STEACS, 1 (3.22%) had no coronary lesion with aECS: 0, and the remaining 30 (96.78%) presented coronary lesions with aECS: 2.46. Among patients with coronary lesions, 5 (16.6%) had a single lesion with aECS: 1 and 25 (83.34%) multiple coronary lesions with aECS: 2.88.

When patients were divided according to the ECS, we observed that 1 patient without lesion had ECS  $\leq 1$  and 8 out of 30 patients with lesions (26.6%) had ECS  $\leq 1$  and 22 (73.4%) ECS  $\geq 2$ , which determined that patients with ECS  $\geq 2$  presented a higher frequency of coronary artery disease compared with ECS  $\leq 1$  although without statistical significance ( $p: 0.29$ ).

The ECS  $\geq 2$  had a sensitivity of 73.3% and a specificity of 100% to identify coronary artery disease with a positive predictive value of 100% and a negative predictive value of 11.1%.

Taking into account single and multiple lesions, we observed that 1 out of 5 patients presenting a single lesion had ECS  $\geq 2$  and 21 out of 25 with multiple lesions had ECS  $\geq 2$ , resulting in 84% sensitivity and 80% specificity to identify multi-vessel coronary artery disease with a positive predictive value of 95.5% and a negative predictive value of 50%.

#### Asymptomatic

Thirteen out of 30 asymptomatic patients (43.3%) had no coronary lesion with aECS: 0.46 and 17 (56.7%) had coronary lesions with aECS: 2.7. Among patients with coronary lesions 5 (29.4%) had a single lesion with aECS: 2 and 12 (70.6%) had multiple lesions with aECS: 3.83.

When patients were divided according to the ECS, we observed that the 13 patients without lesions had ECS  $\leq 1$  and in the 17 patients with lesions, 2 (11.8%) had ECS  $\leq 1$  and 15 (88.2%) ECS  $\geq 2$ , allowing to conclude that patients with ECS  $\geq 2$  had a higher frequency of coronary artery disease compared with ECS  $\leq 1$  ( $p < 0.01$ ).

The ECS  $\geq 2$  had 88.2% sensitivity and 100% specificity to identify obstructive coronary disease with a positive predictive value of 100% and a negative predictive value of 86.7%.

When comparing single and multiple lesions, we observed that 4 out of 5 patients with single lesion had ECS  $\geq 2$  and among 12 with multiple lesions, 11 had ECS  $\geq 2$ , resulting in 91.7% sensitivity and 20% specificity to identify multi-vessel coronary artery disease with a positive predictive value of 73.3% and a negative predictive value of 50%.

## DISCUSSION

It is known from previous publications that in patients over 65 years of age the presence of calcium in the mitral annulus is related with calcium deposits in the aortic cusps and coronary arteries as a manifestation of silent atherosclerosis, since it is uncommon to find calcium in these sites in individuals with normal cholesterol values. (1-3)

The presence of cardiac and aortic calcium has been related to coronary artery disease and cardiovascular events. A study describes the association of risk factors such as age, obesity, hypertension and plasma homocysteine levels with calcific thickening of the aortic leaflets. (4)

In our study we found significant difference between those with or without obstructive coronary artery disease, regardless of the form of presentation. This difference varies when we compare patients without coronary lesion according to the syndrome that caused the indication of CA, where the score is lower in asymptomatic populations compared with patients with chronic angina in whom age and risk factors are higher. The same happens if we compare patients with STEACS and NSTEMACS where the pathogenesis of one or the other syndrome is different.

It is known that mitral annulus and aortic calcification can predict cardiovascular morbidity and mortality and even stroke risk. (5-6)

Although the gold standard for assessing a calcium score is computed tomography (CT), the use of the ECS has been associated with coronary calcium evaluated by CT scan and obstructive coronary disease diagnosed by CA. (7-10)

## Limitations

This was a single center study without a control group, with a small number of patients and the echocardiographic study was performed by a single operator.

## CONCLUSIONS

The ECS with a cut-off point  $\geq 2$  provided significant information with good sensitivity and positive predictive value for patients with obstructive coronary ar-

tery disease and multi-vessel lesion.

Analyzed by syndrome subgroups and attending to physiopathogenic differences and risk factors, we found variations in the degree of statistical significance, sensitivity, specificity and predictive values.

The ECS could be considered a valid method with good positive predictive value to suspect obstructive coronary artery disease and is a useful, available, economical and risk-free tool.

## Conflicts of interest

None declared.

(See authors' conflicts of interest forms on the website/ Supplementary material).

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