

# The Prevalence and Clinical Significance of Coronary Artery Calcification in Cardiac Catheterization

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## ABSTRACT

**Objective:** To determine the prevalence of coronary artery calcification, its pattern of distribution, relative frequency in each coronary artery and its association with coronary artery stenosis.

**Methods:** This is a retrospective study conducted in Queen Alia Heart Institute in Amman-Jordan in the period between 2012 and 2015. A total number of 1137 adult patients who had coronary angiography were reviewed looking for coronary calcification, its frequency according to gender, age and distribution. Calcification was diagnosed as radiopacities within the vessel wall seen during selective coronary angiogram.

**Results:** The total numbers of angiography reviewed were 1137. Coronary calcification was diagnosed in 111 patients, most of them were males, left anterior descending artery was the commonest artery involved, isolated calcification of right coronary artery and circumflex artery was rare, obstructive coronary artery disease was highly associated with coronary artery calcifications.

**Conclusion:** Coronary artery calcification is highly associated with coronary artery stenosis, it may be seen in any part of the coronary circulation, Left Anterior Descending was most commonly affected, it was usually seen in proximal segments and was found in 10% of population, with male gender being the majority.

**Key words:** Coronary angiography, calcific coronaries, Coronary artery disease, Mortality, PCI.

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## Introduction

Cardiovascular disease is considered to be the leading cause of mortality worldwide, causing more than 17 million deaths per year, thus, continuous efforts are needed to prevent cardiovascular disease in both developed and developing countries.<sup>(1)</sup> Age and gender are the most important risk factors for development of coronary calcification ranging from 14% in population younger than 40 year old, to more than 90% for men older than 70 years and more than 75% for women older than 70 years.<sup>(2,3)</sup> Other risk factors include

diastolic hypertension, obesity<sup>(4)</sup>, diabetes, glycemic control,<sup>(5)</sup> diet<sup>(6)</sup> and alcohol consumption.<sup>(7)</sup> In addition, coronary artery calcification is considered to be a risk marker for subclinical atherosclerosis,<sup>(8,9)</sup> a strong independent predictor of cardiovascular events and mortality<sup>(10,11)</sup>. And it has a clear association with the risk of development of heart failure independent of overt coronary artery disease.<sup>(12)</sup> Fluoroscopy in cardiac catheterization have frequently been used to detect coronary artery calcification(CAC)<sup>(13,14,15,16,17)</sup> as it can detect moderate to large calcification.<sup>(18)</sup> However, newer modalities

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are currently being used to detect this entity such as computed tomography(CT) scan, as it is less invasive and more accurate.<sup>(19,20,21)</sup>

## Methods

This is a descriptive, retrospective, non-randomized study conducted at Queen Alia Heart Institute in Amman – Jordan, started in January 2012 and ended in December 2015. The sample size was 1311 patients who underwent conventional coronary angiograph in that period of time for suspected coronary artery disease, as described by their symptoms, risk factors, or who experienced at least one cardiac event. Patients with congenital heart disease and paediatric age group were excluded from this study. The angiograms were reviewed for the presence of coronary artery calcification and was considered present once detected and recognized fluoroscopically during cardiac catheterization, it was identified as readily apparent radiopacities within the vascular wall noted before contrast injection. The frequency of coronary artery calcification was calculated among males and females. A specially designed form was used to record the relevant data: Gender, type of coronary calcification (diffuse or localized), affected coronaries and association with significant coronary artery disease (stenosis of more than 50% of lumen), in addition to treatment strategy.

## Results

The incidence of CAC among patients who were reviewed in this study was 9.8% (111 patient) , males were the majority 70.3% Table I .CAC occurred most commonly in isolated left anterior descending artery (LAD) (31%) , followed by two vessel calcification (22.5%), right coronary artery(RCA) calcification was seen in 8.1%. Isolated left main (LM) or circumflex artery(CX) calcification were equal at 5.4%, where as all vessel calcification occurred in 9%. Table II. Calcification of proximal segment in coronaries was the commonest (69.3%), followed by diffuse pattern of calcification (24,3%), calcification of distal bed was rare as it was seen in 5.4% of angiographs reviewed. Table III The prevalence of CAC in patients who were more than 70 year old was 30%, it was less in younger age groups. For example, it was 17% in patients who are between 60 and 70 year old and 11% in patients who were between 50 and 60 year old, the percentage drops to 3% in patients between 40 and 50 year old, whereas we failed to detect calcification in people younger than age of 40 years. Table IV. In patients with calcific coronaries, the incidence of obstructive coronary artery disease (CAD) was 83.7%. it was almost equal in both males (84.6%) and females (81.8%). Table V and Table VI. Regarding treatment strategies, Aorto-coronary bypass surgery (ACB) was chosen in one third of patients, medical treatment in 29%, whereas 37.8% of patients with CAC underwent percutaneous coronary intervention (PCI) Table VII.

**Table I:** Frequency of CAC and according to gender.

Total	No. of patients with CAC	Male	Female
1137	111	78	33
%	9.8%	70.3	29.6%

CAC: coronary artery calcification

**Table II:** Distribution of coronary artery calcification according to the involved vessel.

	RCA alone	LAD alone	Cx. alone	LM alone	Two vessels involved	All vessel calcification	Total
No.	9	55	6	6	25	10	111
%	8.1%	49.5%	5.4%	5.4%	22.5%	9%	100%

RCA: right coronary artery.

LAD: left anterior descending artery.

Cx: circumflex artery.

LM: left main coronary

**Table III:** The pattern of calcification in the involved coronary.

	Total	Diffuse CAC	Proximal CAC	Distal CAC
No. of patients	111	27	77	7
%	100%	24.3%	69.3%	6.3%

CAC: coronary artery calcification

**Table IV:** Distribution of CAC among age groups.

Age group	20-30 years	30-40 years	40-50 years	50-60 years	60-70 years	More than 70 years
No. of patients	64	139	331	301	196	106
No. of patents with CAC	0	0	10	35	34	32
Percentage	0%	0%	3%	11%	17%	30%

CAC: coronary artery calcification

**Table V:** Frequency of CAD in patients with CAC.

	CAC with associated CAD	CAC without CAD	Total
No. of patients	93	18	111
%	83.7%	16.2%	100%

CAD: coronary artery disease.

CAC: coronary artery calcification

**Table VI:** Distribution of patients with calcific coronaries according to sex and the presence of CAD.

Gender	CAD in patients with CAC	Non-occlusive coronaries in patients with CAC	Total
Male	66 (84.6%)	12 (15.3%)	78 (70.3%)
Female	27 (81.8%)	6 (18.2%)	33 (29.6%)

CAC: coronary artery calcification

CAD: coronary artery disease

**Table VII:** treatment strategy for patients with CAC.

	Surgical	Medical	PCI
No. of patients	37	32	42
%	33.3%	28.8%	37.8%

PCI: Percutaneous coronary intervention

## Discussion

Calcific coronary artery disease has been previously studied in a large number of patients, and association with coronary artery disease has been well established.<sup>(22)</sup> Our study demonstrated that the prevalence of calcific coronaries is 9.8% which is less than the rate mentioned in other studies such as the one performed by Lieber and Jorgens<sup>(23)</sup> where they used fluoroscopy to detect CAC in 23.8% and the one performed by Tampas and Soule,<sup>(24)</sup> they were able to detect calcification in 15%. We believe that the incidence of CAC should be higher than the percentage reported in our study, unlike other studies, we only

included symptomatic individuals with chest pain subjected to diagnostic coronary angiograms, hence, this might explain our lower percentage. The Left anterior descending artery has the highest rate of calcification in our study (49.5%), in agreement with results reported in other studies,<sup>(22,23,25)</sup> while isolated LM or CX artery were rare with a percentage of 5.4% , furthermore, these studies reported that calcifications in the proximal segment were more than distal beds,<sup>(22)</sup> these results are similar to ours as demonstrated in Table III. Age and gender are considered powerful risk factors for developing coronary artery

calcification. Males were found to have more calcifications than females in a ratio of about 7:3, other studies supported these findings<sup>(26,27)</sup> with a male prevalence of 66.5%. With regards to age, our study shows that the prevalence of CAC increases with age, but the ratio we calculated in each age group was less than the ratio mentioned in the literature.<sup>(2,3)</sup> This may be explained by lower incidence of CAC in our study. It is important to mention that a non-calcific vessel does not indicate the absence of CAD and the presence of calcification does not mean that obstructive CAD is present, however, the association remains very strong.<sup>(28)</sup> In fact, our study shows that the prevalence of CAD in calcific coronaries is high and almost equal in both males and females (more than 80% for each) Table V and VI. Our study also demonstrated that calcification tends to influence treatment option, where cardiologists tend to opt a medical or surgical option over performing PCI when encountering calcification in coronaries, as more complications may be predicted during the PCI procedure.<sup>(29)</sup> Although studies have indicated that patients with high burden of calcification are at higher risk for clinical events more than patients with less or no calcification, they fail to relate the calcified segment with plaque rupture,<sup>(30)</sup> so it is still unknown if these segments are responsible for these events or if these events are just due to a diseased vessel. Moreover, coronary calcification may give an estimate about disease burden more than conventional angiography, which describes luminal stenosis,<sup>(31)</sup> this is important in clinical practice because minor plaques are of great clinical significance as most hard cardiac events (death and acute myocardial infarction) are caused by them, even in asymptomatic patients,<sup>(32)</sup> this can be explained by the high number of these plaques in comparison with obstructive ones, in fact patients with acute MI tend to have lesions with less than 50% stenosis in the culprit artery by angiograph in more than 70%.<sup>(33)</sup> Thus, Investigations which are designed to test physiological demand and supply in the myocardium such as treadmill fail to recognise these patients due to the lack of high grade stenosis in their arteries. In recent era, and with the increasing

number of literature emphasising the significance of this entity, CAC was included in the Coronary Artery Risk development in Young Adults,<sup>(34)</sup> in subgroups of The Atherosclerosis Risk Communities Study, and The Cardiovascular Health Study.<sup>(35)</sup> Currently, coronary artery calcification can be diagnosed by many modalities, fluoroscopy has been used in many studies<sup>(13-17)</sup> in over 2670 patients, with a sensitivity ranged from 40% to 79% and a specificity of 52% to 95%. Friedrich and Colleagues<sup>(36)</sup> conducted a study to examine the accuracy of intravascular ultrasound (IVUS) in detecting different histologic types of calcium pattern in human coronary artery atherosclerotic lesions; they were able to detect histological extent of in-situ calcification with 90% sensitivity and 100% specificity. IVUS was compared to angiography in the diagnosis of CAC by Minz *et al*,<sup>(37)</sup> he concluded that IVUS have higher sensitivity in detecting coronary calcification at the site of larger lesions. Coronary Artery Calcium Score detected by 64-slice coronary CT angiograph is currently widely being used to detect calcium and provide prognostic information about cardiac events,<sup>(19,20)</sup> being less expensive, less invasive and supported by many evidence based reports.<sup>(19,21,38)</sup> Due to these data, many reports have emerged supporting the use of coronary calcification in addition to other risk factors of CAD to evaluate patients with intermediate risk group,<sup>(39,40)</sup> trying to identify patients who need intensive medical treatment and follow up in order to provide primary prevention and decrease mortality and morbidity associated with CAD.

## Conclusion

Coronary artery calcification is highly associated with coronary artery stenosis, it may be seen in any part of the coronary circulation, Left Anterior Descending was most commonly affected, it was usually seen in proximal segments and was found in 10% of population, with male gender being the majority.

## Limitations of study

There are several limitations to this study, calcification in coronaries was under reported

especially in the normal or nearly normal coronaries, patient number of 1137 is relatively small compared with other studies, moreover, findings can be influenced by operator skills and number of views obtained, finally younger age group and racial differences may result in ratios that is different than what others mentioned.

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