Prevalence and morphology of coronary artery ectasia using multislice computed tomography coronary angiography

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Submitted by:

Rabab Galal Abdel Wahab, MB.B.CH.

Supervised by:

Prof. Soliman Ghareeb, MD.

Professor of Cardiology

Faculty of Medicine - Cairo University

Dr. Amr El Faramawy, MD.

Lecturer of Cardiology

Faculty of Medicine - Cairo University

Dr. Mohamed Ali Salem, MD.

Lecturer of Radiodiagnosis

Faculty of Medicine - Cairo University

Faculty of Medicine

Cairo University

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Abstract

Prevalence and Morphology of Coronary Artery Ectasia using Multislice Computed Tomography Coronary Angiography

Rabab Galal A. Wahab[1], MB.B.CH, Amr El Faramawy[1], MD, Azza Farrag[1], MD, Mohamed Ali Salem[2], MD, Soliman Ghareeb[1], MD

[1] Cardiology department, Cairo University, [2] Radiology department, Cairo University

Aim: To evaluate the prevalence and morphological characteristics of coronary artery ectasia (CAE) visualized by 64-MSCT coronary angiography and to determine the clinical presentation, the association of CAE with conventional coronary risk factors and coexisting coronary artery disease (CAD).

Methods: This study included 2600 consecutive patients referred to MSCT coronary angiography for a period of 15 months. All patients were subjected to detailed history taking, risk factor assessment, ECG-gated CT angiographic studies were performed to detect and evaluate the coronary artery disease and morphology. Coronary artery ectasia was defined as an arterial segment with a diameter of at least 1.5 times the diameter of the adjacent normal coronary artery. Markis classification was used to clarify the anatomical variation according to the extent of coronary involvement.

Results: Coronary artery ectasia was diagnosed in 192 patients, giving prevalence of (7.4%). Most patients were male 169 (88%), mean age 55± 10 years. Hypertension was the most frequent risk factor in 136 cases (70.8%), 38 were diabetic (19.8%), and 61 (31.8%) were smokers. The most common cause for presentation was atypical chest pain (43.8%), then typical chest pain in (31.8%) and for post myocardial infarction risk stratification in (4.7%). The left anterior descending artery was most frequently involved vessel (LAD: 62%, RCA: 56.8%, LCX: 45.8%, LMT: 6.8%). According to Markis classification type I was present in 44 patients (22.9%), type 2 in 34 patients (17.7%), type 3 in 38 patients (19.8%) and type 4 was in 76 patients (39.6%). Ectasia was associated with coexisting atherosclerotic coronary artery disease in 161 patients (84%) with 10 patients (5.2%) had a past history of coronary artery bypass surgery.

Conclusion: MSCT coronary angiography is a new non invasive diagnostic tool for detection of CAE. The prevalence of CAE was (7.4%), occurred predominantly in male. The LAD artery was the most affected artery. The distribution of CAE was localized or segmental. Hypertension and smoking were the most prevalent risk factors, with a relatively high prevalence of coexisting coronary artery disease. Absence of diabetes mellitus was noticed in patient with CAE.

Key words (MSCT angiography, Coronary artery ectasia, and atherosclerosis)

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List of abbreviations

2D	Two dimensions
3D	Three dimensions
ACC	American College of cardiology
AHA	American Heart association
AVN	Atrioventricular node
b.p.m	Beat per minute
CABG	Coronary arteries bypass graft
CAC	Coronary Artery Calcium
CACS	Coronary Artery Calcium Score
CAD	Coronary artery disease
CAE	Coronary artery ectasia
CASS	Coronary Artery Surgery Study
CCA	Conventional catheter angiography
CI	Coronary ischemia
CMR	Cardiac magnetic resonance
CRP	C-reactive protein
CTCA	Computed Tomography Coronary Angiography
EBCT	Electron Beam Computed Tomography
ECG	Electrocardiogram
ECM	Extracellular matrix
EDRF	Endothelium-derived relaxation factor
EF	Ejection fraction
FH	Familial Hypercholesterolemia
Hs-CRP	High sensitive CRP
HU	Hounsfield Units
I-CAM	Intracellular adhesion molecule

IEL	Internal elastic lamina
INR	International normalized ratio
IVUS	Intravascular ultrasound
LAD	Left anterior descending artery
LCA	Left coronary artery
LCX	Left circumflex artery
LM	Left main coronary artery
LV	Left ventricle
MCC	Monocyte cell count
MDCT	Multi-detector computed tomography
MI	Myocardial infarction
MMP	Matrix metalloproteinase
MRA	Magnetic resonance angiography
MRI	Magnetic resonance imaging
MSCT	Multi-slice computed tomography
NSTEMI	Non ST-segment elevation myocardial infarction
NO	Nitric oxide
PCI	Percutaneous coronary intervention
PTCA	Percutaneous transluminal coronary angioplasty
RCA	Right coronary artery
ROI	Region of interest
RV	Right ventricle
TIMP	Tissue inhibitor metalloproteinase
V-CAM	Vascular cell adhesion molecule
VEGF	Vascular endothelial growth factor
WBCC	White blood cell count

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INTRODUCTION

Coronary artery ectasia (CAE) or aneurismal coronary artery disease is a term which has been observed and described for more than two centuries, at first it was observed by interventionists during conventional coronary angiography, as it was considered an uncommon angiographic finding, then with the development of many modern modalities of investigations, its percentage increased and revealed its associated complication.

The most commonly used angiographic definition of CAE, albeit arbitrary, is the diameter of the ectatic segment being more than 1.5 times larger compared with an adjacent healthy reference segment. [(1)] However, as the distribution of CAE is quite variable and not always focal, normal reference segments may not be readily apparent, and this definition potentially underestimates the true incidence of the disease.

Although the incidence may overestimate the true frequency in the general population, CAE has been found in 1–5% during coronary angiography. [(2)] In the largest series from the CASS registry, Swaye et al. [(3)] found CAE in 4.9% of more than 20 000 coronary angiograms they reviewed.

Although coronary angiography is the gold standard for the assessment of coronary artery ectasia, various new and safe non invasive modalities may have a role in detection and analysis of this phenomenon.

Multi-slice computed tomography (MSCT) during the past years has gained a significant place in the non-invasive imaging of cardiac morphology and coronary arteries, also in diagnosis of anatomical vascular abnormalities due to its high level of reliability and accuracy especially in which conventional coronary angiography is not applicable for many reasons like difficult arterial access, unusual coronary anatomy, or sometimes preference of the patient.

I hope this study helps to highlight a phenomenon like coronary artery ectasia, which is not a completely understood issue till now, and also to encourage many researchers to focus on the ever progressing field of cardiac computed tomography.

AIM OF THE WORK

Our objectives are:

- To study the prevalence of CAE in patients referred for 64-MSCT coronary angiography.
- To describe clinical characteristics of patients with CAE, analyzing their presentations and cardiovascular risks.
- To study CT angiographic characteristics of patients with CAE.
- To compare clinical and angiographic variables in patients with and without CAE.

Introduction and historical review:

The Latin term corona, or crown, aptly describes coronary arteries that supply cardiac parenchyma with nutrient blood flow. Coronary arteries (most often two) are normally the only vessels arising immediately above the free margin of aortic valve from the ascending aorta. The name and nature of a coronary artery or branch is defined by that vessel's distal vascularization pattern or territory, rather than by its origin. The right coronary artery (RCA) most commonly arises separately from an ostium just below the sinotubular junction of the right (right anterior) sinus of Valsalva. The RCA courses in the right atrioventricular groove and provides nutrient branches to the right ventricular free wall, extending to the acute margin of the heart; the first branch arising from the RCA is the conal or infundibular branch. In 90% of patients, the RCA supplies the posterior descending coronary artery branch which supplies the atrioventricular (AV) node and the posterior aspect of the interventricular septum. The sinus node artery arises from the proximal RCA in approximately 50% of patients.

The left coronary artery (LCA) arises from the mid position of the left (left anterior) sinus of Valsalva just above the level of the free margin of the aortic valve leaflet and generally below the sinotubular junction, the left coronary ostium is usually single, giving rise to a short, common LCA trunk that branches into the left anterior descending (LAD) and circumflex (Cx) coronary arteries.

The LAD courses in the anterior interventricular groove, giving rise to the anterior septal perforating branches as it extends toward the cardiac apex. Small branches may arise from the LAD and supply the anterior wall of the right ventricle. Diagonal branches arise from the LAD and course at downward angles to supply the antero-lateral free wall of the left ventricle.

The Cx coronary artery courses along the left AV groove, around the obtuse margin, and posteriorly toward the crux of the heart. Atrial branches may arise from the Cx coronary artery and supply the sinus node in 40% of patients. Obtuse marginal branches arise from the Cx system to supply the postero-lateral aspect of the left ventricle. In an estimated 70% of patients, a coronary branch (termed ramus medianus, intermedius, or intermediate branch) arises early off the left coronary system to supply an area between diagonal branches from the LAD and obtuse branches from the Cx systems.

Coronary artery ectasia (CAE) has been observed by pathologists and cardiologists for more than two centuries, this coronary anomaly was first described by Morgagni [(4)] in 1761. Bourgon [(5)] in 1812 was the first to describe the postpartum finding of a right coronary artery dilatation in a patient who died suddenly. The term ectasia was first coined to describe dilated coronary arteries in vivo by Bjork [(6)] in 1966, the literatures prior to this date consisted of only postmortem reports; he included three patients who underwent angiography for cyanosis, at cardiac catheterization, they were found to have tetrology of Fallot and also markedly dilated coronary arteries, surgical repair of the tetrology was performed without complication. The surgeon dealt with the dilated coronary arteries simply by manually pushing the ectatic vessels aside at the time of surgery. No etiology for the never before described anomaly was offered and no follow-up was provided.

Previous reports of pathological dilatation of the coronary arteries have described the abnormal dilatation as an aneurysm, whether saccular or fusiform (Scott, 1948; Daoud et al., 1963; Befeler et al., 1977). Since the dilatation may be diffuse and involve the majority of the artery, it is more appropriate to describe the lesion as ectatic (Markis et al., 1976) rather than aneurismal.

Definition:

Coronary artery ectasia is defined as an abnormal Irregular saccular dilatation of more than a third segment of the coronary artery to > 1.5 times the diameter of the normal segment.[(3)] There is an overlap in this condition with coronary artery aneurysm which is more focal and probably caused by the same pathology.

Another definition: Hartnell et al. [(2)] defined CAE as an arterial segment with a diameter at least 1.5 times the diameter of the adjacent normal coronary artery; this is the most commonly used angiographic definition of CAE. However, as the distribution of CAE is quite variable and not always focal, normal reference segments may not be readily apparent, and this definition potentially underestimates the true incidence of the disease.

CAE could be iatrogenic or idiopathic. Iatrogenic ectasia results from using interventional devices to dilate coronary artery stenosis which destroy the media of coronary artery; these include true or pseudo-aneurysms during coronary balloon angioplasty, but more importantly following coronary stent placement, atherectomy and brachytherapy,[7] and it's not clear whether these iatrogenic ectatic arteries are subject to the same complication as idiopathic CAE.

Occasionally large ulcerated coronary plaques can be misinterpreted angiographically as coronary aneurysms. Their true cause can be usually revealed with intravascular ultrasound (IVUS). [8]

Underlying pathology:

The exact mechanism of development of CAE is unknown, but evidence suggests a combination of genetic predisposition, common risk factors for coronary artery disease and abnormal vessel wall metabolism. It frequently coexists with aneurysms elsewhere, mostly involving the aorta; the following theories represent the most common causes of underlying pathology of CAE.

1- Similar to coronary atherosclerosis (in more than half of cases), including lipid deposition with foam cells, foreign body giant cells, cholesterol crystals, with formation of fibrous cap, focal calcification and fibrosis, plus significant loss of musculoelastic vascular wall components, as the main histological abnormalities. Compensatory vessel enlargement in the presence of coronary atherosclerotic plaques is a common phenomenon that is viewed as positive remodeling, [9] progressive overcompensation leading to ectasia may be caused by an inadequate extent of media atrophy and disruption of the internal and external elastic lamina, as well as atypical rearrangement of smooth muscle cells, [10, 11] so coronary ectasia represents an exaggerated form of expansive vascular remodeling (i.e. excessive expansive remodeling) in response to atherosclerotic plaque growth.

The reason why stenosis develops in some individuals with atherosclerosis while dilatation occurs in others is unknown. Genetic susceptibility is likely to explain why certain individuals are at risk of developing CAE.

In terms of path physiology, it is well known that atheromatous plaques do not project into the lumen but lie in a depression in the media that may bulge out-wards. In this way, the triad of atheroma, thrombosis and aneurysm becomes linked in one continuous pathological process and both expansion and shrinkage of coronary vessel are important processes in coronary artery disease (CAD). This process of arterial remodeling is fundamental to the path physiology of CAD in native coronary lesions after interventional procedures. However the