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Role of MSCT coronary angiography in evaluating patients with ischemic heart disease

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Abstract
Background: ischemic heart disease occurs when blood flow stops to a part of the heart causing damage to the heart muscle. The most common presenting symptom is chest pain or discomfort. The principle of Multi slice CT is simple: in a conventional computed tomography, a collimated X-ray beam is emitted and data are collected by a row of detectors located on the other patient's side.
Aim of the study: The aim of the study is to evaluate the role of multi-slice CT coronary angiography in evaluation of patients with ischemic- coronary artery disease.
Materials and Method: 40 patients were included in the study, from them 15 patients were excluded according to the Exclusion criteria and 25 patients were included according to the inclusion criteria (11 females (44%)& 14 male(56%). The age of the patients is 40-70 years.The study was done in Baqubah Teaching hospital/ Diyala/ Iraq from April 2021 till March 2022.
Result: This study shows that among 15 patients with positive risk factors,8 patients (53%)had hypertension, 7 patients (46.6%) are smoker,8 patients (53%) had positive family history,6 patients (40%) had DM and 10 patients (66.6%) had hyperlipidaemia. The study shows that 7 patients (28.0%) of 25 patients are normal and no artery affected, 5 patients (20.0%) had one artery affected,5 patients (20.0%) had two arteries affected, 7 patients (28.0%) had three arteries affected and one patient (4.0%) had four arteries affected. The study shows there are 40 artery diseased. 17 (42.5%) of them are LAD, 13(32.4%) of them are RCA, 8 (20%) of them are LCX
Conclusion: Noninvasive Multi slice CT is a valuable technique of high ability to detect coronary artery disease, estimate the degree of obstruction and characterize plaques which can be used as an initial step in the working up in patients with recently diagnosed ischemic heart disease and should be considered as an alternative to invasive diagnostic coronary angiography in this group of patients.

Keywords: multi slice CT, coronary angiography, ischemic heart disease

Introduction

Ischemic heart disease most commonly due to coronary artery disease is still one of the most frequent causes of death worldwide. Computed tomography coronary angiography (CTCA) is a useful tool for the non-invasive assessment of coronary artery disease (CAD) (Arbab-Zadah *et al*.,2012).
Contrast-enhanced computed tomographic angiography (CCTA) has high affinity for the detection of clinically significant coronary artery disease, as compared with invasive coronary angiography in patients in a stable condition with suspected or known coronary artery disease (Hoffman *et al*., 2012).
Contrast-enhanced MSCT is a non-invasive technique for the detection, visualization and characterization of stenotic artery disease. It could act as a gatekeeper prior to cardiac catheterization and finally replace conventional diagnostic modalities. Recent generations of MSCT machines with higher and developing spatial and temporal resolution own a non- invasive approach to accurately delineate coronary vessel anatomic structures, with increasingly more detector rows number and higher gantry speeds, allowing for best visualization of the coronary arteries (Youssef *et al*.,2014) [12].
Ischemic Heart Disease (= Coronary Artery Disease)is the leading cause of disability and death worldwide, and it is expected to increase in its prevalence in the upcoming years. Ischemic Heart Disease events are caused by the interplay of genetic and environmental factors, the effects of which are mainly mediated via cardiovascular risk factors. (Baixeras et al., 2014) [2].
Ischemia is referring to a reduction of oxygenation due to inadequate perfusion. coronary artery disease is a condition of different etiologies; all having in common an imbalance between oxygen supply and demand could be caused by three possible mechanisms:

1. Reduced coronary blood flow-coronary atherosclerosis, overlapped by thrombosis, vasospasm and aggregation of platelets can contribute to the ischemia.
2. Increased myocardial demand-as a result of tachycardia, myocardial hypertrophy, etc.

3. Diminished oxygen transport- severe anemia, advanced lung disease, carbon monoxide poisoning, congenital cyanotic heart disease, cigarette smoking.

Coronary artery disease has a complex etiopathogenesis and a multifactorial origin related to environmental factors, such as diet, smoking, and physical activity, and genetic factors that modulate risk of disease both individually and through interaction. *(Baixeras et al., 2014)* [14].

Principles of Multi-Slice CT coronary Angiography

Multi-Slice CT has undergone rapid technical developments over the last decade, and the most important application of Multi-Slice CT imaging is coronary CT angiography with its widespread application in cardiac imaging. Imaging of coronary arteries is technically challenging because of its small vessel diameters, tortuous path around the myocardium and continuous motion of the heart during cardiac scans (sun, 2013) [11].

The principle of Multi-Slice CT is simple: in a conventional computed tomography, a collimated X-ray beam is emitted and data are collected by a row of detectors located on the other patient's side, after attenuation of the beam through his or her body. In Multi-Slice CT, there is a system of large data acquisition, composed of an array of detectors arranged in multiple parallel rows along the longitudinal axis. The largest collimation of the X-ray beam is such that all of the detectors are "hit" at the same time, allowing simultaneous evaluation of a larger anatomic area (Pavone, 2009) [10].

The increased performance of Multi-Slice CT compared with single-slice CT significantly reduces the examination time for standard CT protocols, allows for immediate and comprehensive assessment of trauma and non-cooperative patients, and elimination of misregistration during breath- hold imaging (sun,2013) [11].

Indication and contraindication for ct coronary angiography

There are many indication for ct coronary angiography:

1. Detection of IHD in symptomatic patients without known heart disease, either acute or non-acute presentations
2. Detection of IHD in patients with new-onset or newly diagnosed clinical heart failure and no prior IHD.
3. Preoperative coronary assessment prior to non-coronary cardiac operation.
4. Patients with prior electrocardiographic exercise testing - Normal test with sustained symptoms or intermediate risk Duke Treadmill score. (clin *et al*, 2015)

Contraindications to CT coronary angiography

A. Contraindications to iodinated contrast agents

- Renal failure (creatinine level >1.5–2.0 mg/ dl, absolute contraindication unless presence of measures to prevent contrast-induced nephropathy can Betaken).
- Intake of metformin-containing medications (metformin needs to be discontinued for 48 hours after contrast injection).

B. Contraindications to nitroglycerin

1. Intake of phosphodiesterase inhibitors (such as sildenafil andvardenafil).
2. Arterial hypotension, severe aorticstenosis.
3. Hypertrophic obstructive cardiomyopathy.

C. Contraindications to beta blockers:

1. Asthma.
2. Severe obstructive lung disorder.
3. Bradycardia (below 50 beats per min). *(Dewey et al., 2014)* [4].

Aim of the Study

The aim of the study is to evaluate the role of multi-slice CT coronary angiography in evaluation of patients with ischemic- coronary artery disease.

Materials and Method

40 patients were included in the study from them 15 patients were excluded according to the Exclusion criteria and 25 patientS were included according to the inclusion criteria (11 female (44%)& 14 male(56%). Tables no. (1). The age of the patients is 40-70 years table no. (2).the study was done in Baqubah Teaching Hospital /Diyala/ Iraq from April 2021 till March 2022.

Inclusion criteria

1. Patients of both sexes, age between 40-70 years complaining of chest pain presumed due to coronary artery disease.
2. Any patient who had been diagnosed with coronary artery disease and is being checked before revascularization.

Exclusion criteria

1. Hypersensitivity to iodinated contrast agent.
2. Renal insufficiency (creatinine levels >150 μmoll–1).
3. Non-sinus rhythm
4. Hemodynamic instability.

- All patients a 20 gauge IV catheter may sufficient to use for injection contrast medium.

The Examination was performed using 80 MDCT machine with 0.5 mm sections for coronaries, KV =120, mA = 500, mAs=

- 111. The study was done first without contrast for evaluation and quantification of calcium scoring. Then all patients underwent enhancement study for evaluation of stenotic lesion after injection 50-60 cc on high iodinated non-ionic contrast media with injection rate 4-6 ml / s.

Result

The result of the study was shown in the following tables (table 3-10)

Table 1: Age distribution of the study group.

Age (years)	No.	%
40-49	3	12.0%
50-59	8	32.0%
60-69	11	44.0%
≥70	3	12.0%
Total	25	100.0%
Range [Mean SD]	40-72 [60.21 12.91]	

Table 2: Sex distribution of the study group.

Sex	No.	%
Male	14	56.0%
Female	11	44.0%
Total	25	100.0%

Table 3: Risk factors distribution of the study group.

Risk factors	No.	%
Positive	15	60.0%
Negative	10	40.0%
Total	25	100.0%

Table 4: Risk factors distribution of the study group.

Risk factors	No.	%
Hypertension	8	53
Smoking	7	46.6
Family History	8	53
Diabetes Mellitus	6	40
Hyperlipidaemia	10	66.6

Table 5: No. of arteries affected in the study group.

No. of arteries affected	No.	%
Zero	7	28.0%
I	5	20.0%
II	5	20.0%
III	7	28.0%
IV	1	4.0%
Total	25	100.0%

Table (6): Distribution of arteries affected of the study group.

Distribution of arteries	No.	%
LAD	17	42.5
RCA	13	32.5
LCX	8	20

LM	2	5
total	40	100

Table 7: Type of plaque distribution of the study group.

Type of plaque	No.	%
Calcified	13	48.15%
Mixed	8	29.63%
Soft	6	22.22%

Table 8: Stenosis distribution of the study group.

Stenosis	No.	%
None	8	32.0%
Non significant	7	28.0%
Significant	10	40.0%
Total	25	100%

Table 9: Distribution of stenosis among diseased arteries.

	Total No.	Non significant		Significant		Chi-square	
		No.	%	No.	%	x2	p-value
LM	2	2	100.00	0	0.00	1.000	0.317
LAD	17	7	41.18	10	58.82	0.470	0.490
LCX	8	5	62.50	3	37.50	0.250	0.617
RCA	13	4	30.77	9	69.23	2.461	0.117

Table (10): Calcium scoring distribution of the study group.

Calcium scoring	No.	%
Normal (Zero)	5	20.0%
Minimal (1-10)	3	12.0%
Mild (11-100)	8	32.0%
Moderate (101-400)	5	20.0%
Severe (>400)	4	16.0%

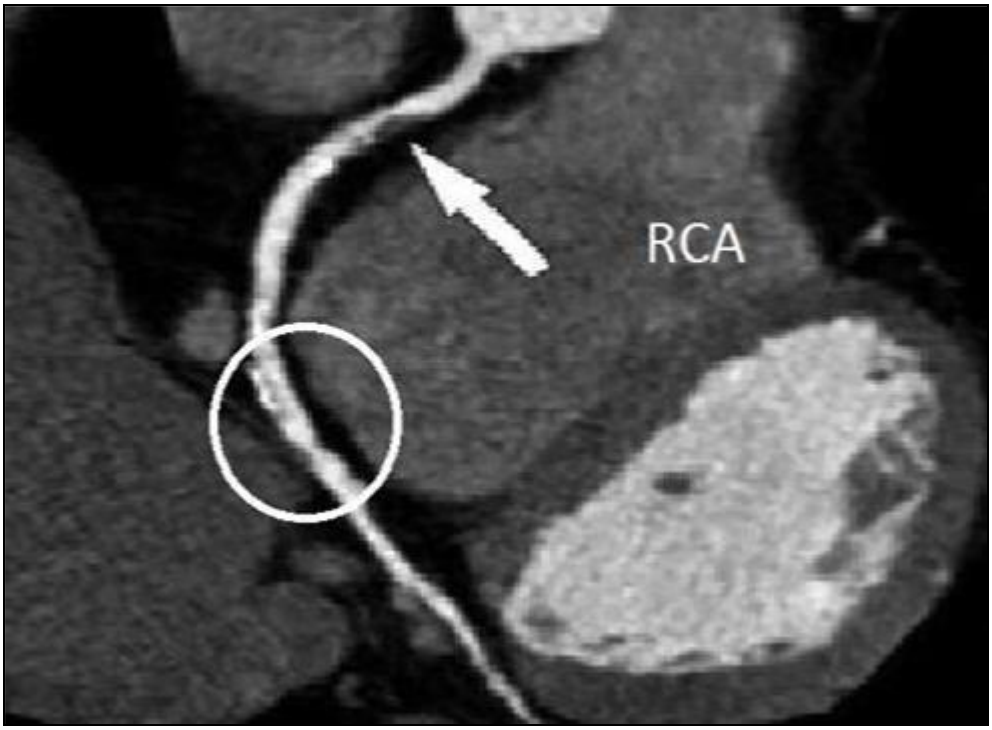

Fig 1: Proximal RCA soft atherosclerotic plaque (arrow) and mid RCA mixed plaque (circle) which are causing significant stenosis

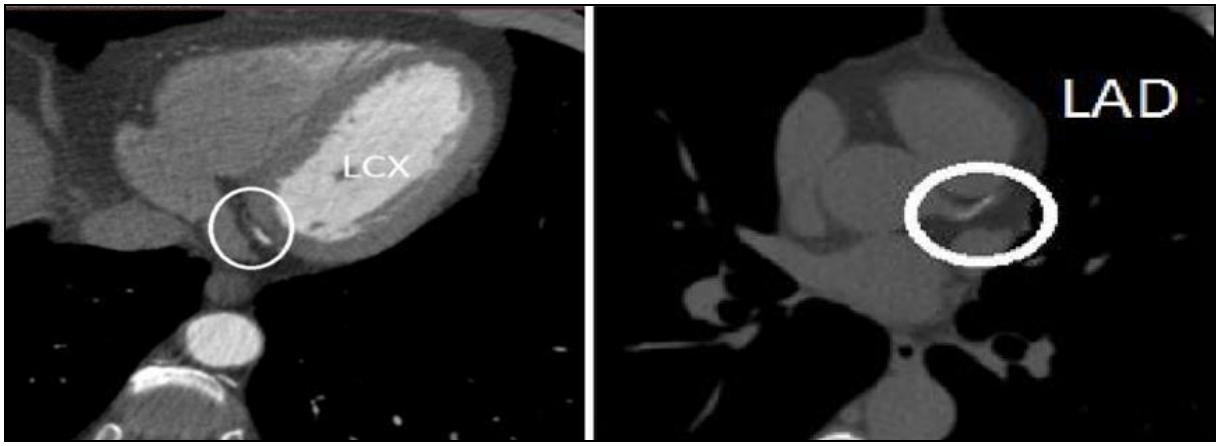

Fig 2: A. Axial CECTimage shows small occlusive mixed plaque at distal LCx (circle). B. Axial non-contrast CTimage shows proximal LAD mixed plaque (circle).calcium score =30

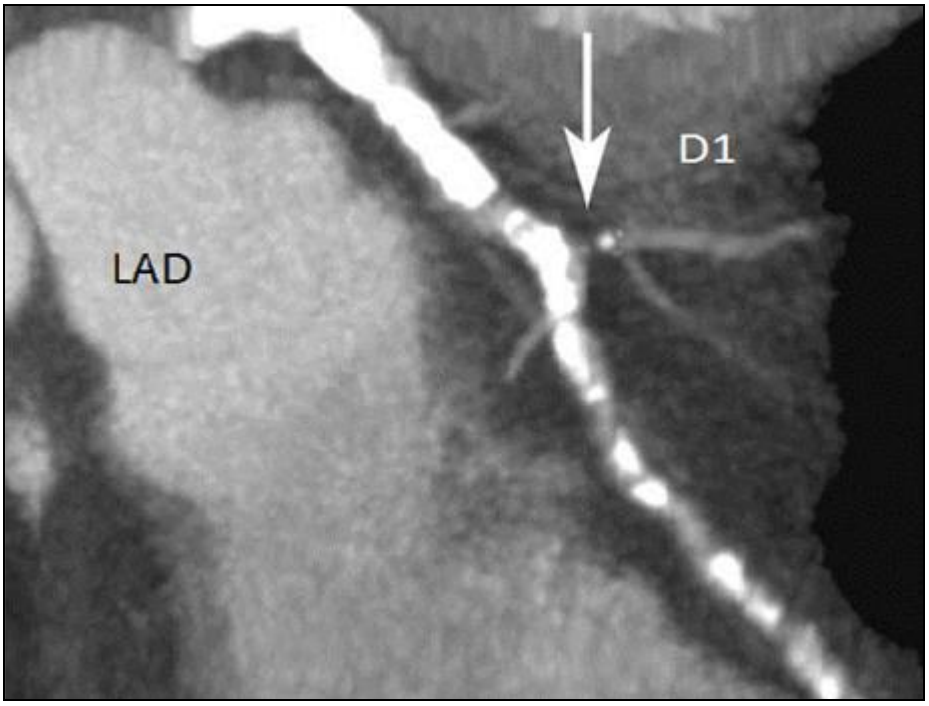

Fig 3: Diffus E calcification of LAD causing significant stenosis. And small soft plaque at D1ostium (arrow).

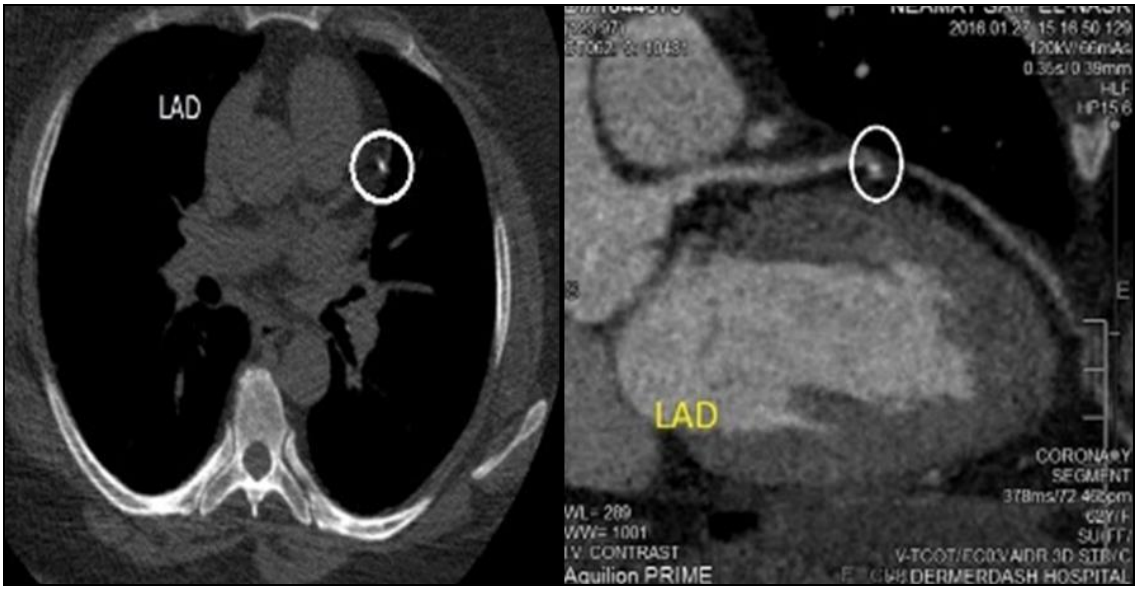

Fig 4: A Axial non-contrastCT imageshows mid LADeccentric calcified plaque (circle). Calcium score=20. B Curved MPR show mid LAD eccentric calcified plaque (circle), causing non- significant stenotsis (+30%).

Discussion

In this study we evaluate the patients whom recently diagnosed as ischemic heart disease based on history, examination and laboratory investigation by using multi-slice ct coronary angiography as a non-invasive imaging tool. Among 25 patients with IHD, 14 patients (56%) are males and 11 patients (44%) are females. This result represent the ischemic heart disease commonly affected males. This may be due to incidence of risk factors like smoking is greater in male than female; the second theory is females hormones thought to play protective role against heart disease.

In the present study; we found that incidence of ischemic heart disease is higher in patients >55 years old and less common in ages <50 and> 70 years old. This agrees with a study by youssef *et al* 2014; the commonest age group was fifty to sixty years and the least common affected age group was 40 years to 50 years and 70 years or more.

In our study we found a great relation between ischemic heart disease and presence of risk factors like (Hypertension, DM, smoking, drinking alcohol…..etc). About 15(60%) of patients had positive risk factors and 10(40%) had negative risk factors.In the present study, we found good relation between positive family history of ischemic heart disease and coronary artery disease, as 8 patients (53%) out of 15 patients with coronary artery disease had positive family history of ischemic heart disease.

However *Otaki et al (2013)*; concluded that, young patients with positive family history had higher presence, extent, and severity of coronary artery disease, which was associated with increased risk for MI. Compared with other clinical coronary artery disease risk factors, positive family histry was the strongest clinical predictor of future MI.

In the present study, we found good relation between hypertension and incidence of coronary artery disease, about 8 (53%) of patients with positive risk factors had hypertension. This agree with milane *et al* 2014; the dominant majority of coronary artery disaese cases were associated with at least one traditional risk factor with 63.9% reported having high blood pressure.

In our study, we found fair relation between coronary artery disease and Diabetes Mellitus as 6 patients (40%) out of 15 patients with coronary artery disease were Diabetic.

However, *Bartnik et al (2004);* in their prevalence study of patients who had coronary artery disease across Europe, 58% of patients were DM, 36% of them were impaired glucose regulation, and 22% were newly diagnosed.This difference could beexplained by random study with specific locations not covering wide area, food style, in addition to socioeconomic causes.

In the present study, among 27 lesions, 6 lesions (22.2%) were soft plaques, 13 lesions (48.2%) were calcified plaques, while 8 lesions (29.6%) were mixed (soft & calcified) plaques. These result were in agreement with *Koulaouzidis et al(2012) [6]*; who recorded a total number of 72 plaques: 44 (61%) were calcified plaques, 15(20.8%) were mixed plaques, and 13 (18.2%) were soft plaques.

The following study show the calcium scoring of patients calculated by CT device was

1. Normal (zero): 5 patients (20%).
2. Minimal (1-10): 3 patients (12%).
3. Mild (11-100): 8 patients (32%).
4. Moderate (101-400): 5 patients (20%).
5. Severe (> 400): 4 patients (16%)

This result is greatly similar to a study by you ssef et al 2014; normal (12%), minimal (10%), mild (36%), moderate (22%), severe (20%).

Among 25 patients with coronary artery disease, 8 patients (32%) had normal CTCA, 7 patients (28%) had non-significant (< 50%) CAD and 10 patients (40%) had significant (≥ 50%) coronary artery disease. These results were slightly different from study by Naue *et al* 2015; a total of 97patientswereincluded, of which 69% weremen, meanage 64 ± 12 years. CCTA revealed that 18 (18%) patients had no coronary artery disease, 38 (39%) had non-obstructive (< 50%) lesions and 41 (42%) had at least one obstructive ≥ 50% lesion.

This difference could be explained by random study with specific locations not covering wide area, in addition to socioeconomic causes.

In our study, a total of 40 coronary vessels were affected by plaques. The most common affected vessel was the LAD artery which was affected in 42.5% of affected arteries, compared to RCA which was affected in 32.5%, LCx which was affected in 20%, and LM which was affected in only 5% of the affected arteries.These results were similar to *Chu et al (2010);* whose results showed that among 287 coronary vessels; the most common diseased coronary vessel was the LAD artery (35.9%) vs. 27.2% (RCA), 22.6% (LCX) and 14.3%(LM).

Table 11: List of Abbreviations

CACS	Coronary Artery Calcium Scoring	LAO	Left Anterior Oblique
CAD	Coronary Artery Disease	LM	Left Main Coronary
CHD		LCX	Left Circumflex
CT	Computed Tomography	LV	Left Ventricle
CTCA	CT Coronary Angiography	mA	milli-Ampere

DM	Diabetes Mellitus	mAS	milli-Ampere Second
IHD	Ischaemic Heart Disease	MDCT	Multi-Detector ComputedTomography
IMB	Inferior Marginal Branch	MI	Myocardial Infarction
KV	Kilo Volt	MSCT	Multi-Slice Computed Tomography
KVP	Kilo Voltage Peak	mSV	milli-Sievert
LAD	Left Anterior Descending	mS	milli-Second
LAO	Left Anterior Oblique	PDA	Posterior Descending Artery
LM	Left Main Coronary	PLB	Posterior Lateral Branch
LCX	Left Circumflex	RAO	Right Anterior Oblique
LV	Left Ventricle	RCA	Right Coronary Artery
LAD	Left Anterior Descending	RI	Ramus Intermedius Artery

Conclusion

Non-invasive Multi –slice CT is a valuable technique of high ability to detect coronary artery disease, estimate the degree of obstruction and characterize plaques which can be used as an initial step in the working up in patients with recently diagnosed ischemic heart disease and should be considered as an alternative to invasive diagnostic coronary angiography in this group of patients.

Recommendations

Regarding the CT coronary angiography in patients with ischemic heart disease, we recommend:

- CT Coronary angiography should be considered as one of the initial steps in the workup of patients with recently diagnosed ischemic heart disease older or younger than 60 years old.
- Even in case of Calcium Scoring (CS) is Zero, We need to proceed with CT Coronary angiography , as we had significant coronary artery disease with CS Zero in some patients.
- We need to encourage the use of new generations of Multi-slice CT in centers like 320-slice CT, so that to decrease the radiation exposure as general, and decrease the incidence of poor quality exams, in order to prevent chances of lesion misdiagnosis, or redoing the examination with extra radiation exposure.

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