Indian Journal of Basic and Applied Medical Research;
Radiology and Imaging Special Issue – December 2017: Vol.-7, Issue- 1, P. 47-53

Original article:

Study of the calcium score in patients undergoing ultrafast MDCT coronary angiography

***Dr Ramaa Suryawanshi , ** Dr Y.P.Sachdev , ***Dr D.S.Kulkarni**

*Junior Resident , Department of Radiodiagnosis , Rural Medical College , Loni , Maharashtra , India.
** HOD , Department of Radiodiagnosis , Rural Medical College , Loni , Maharashtra , India.
*** Professor , Department of Radiodiagnosis , Rural Medical College , Loni , Maharashtra , India.
Corresponding author **

Abstract:

Introduction: The greatest advantage of catheter angiography is its high spatial resolution and option of directly performing intervention , such as balloon dilatation or coronary stenting. Only 1/3rd of all coronary catheter examinations in the United States were performed in conjunction with an interventional procedure (Percutaneous Transluminal Coronary Angioplasty-PTCA), however , whereas the rest were performed for mere diagnostic purposes (i.e. for verifying the presence and degree of CAD only).

Methodology: The study was conducted in accordance with the approval and recommendations of our institutional ethical board. Initially, written informed consent was obtained from all patients. Thereafter the individual details, clinical history, past history, vitals wererecorded.Atopogram was performed followed by a calcium score. Thereafter contrast enhanced CT coronary angiography was carried out.

Results: Of the 85 patients studied for the calcium score, 49 patients (49.49%) showed no evidence of calcium. Of these, 9 patients (18.36%) had evidence of coronary artery stenosis on MDCT coronary angiography. Out of these 9 patients, 7 (77.77%) had mild , 1(11.11%) had moderate luminal narrowing due to non-calcified plaque and one patient had severe degree of left anterior descending artery proximal segmental block .

Conclusion: From the present study, following conclusions can be drawn , A calcium score of zero cannot rule out coronary artery stenosis. 18.36% of patients with a calcium score of zero had evidence of coronary artery stenosis in the present study. Though a higher calcium score is associated with a higher incidence of CAD, a calcium score of zero does not rule out CAD.

INTRODUCTION

The greatest advantage of catheter angiography is its high spatial resolution and option of directly performing intervention , such as balloon dilatation or coronary stenting. Only 1/3rd of all coronary catheter examinations in the United States were performed in conjunction with an interventional procedure (Percutaneous Transluminal Coronary Angioplasty-PTCA), however , whereas the rest were performed for mere diagnostic purposes (i.e. for verifying the presence and degree of CAD only).[1]The scenario is similar in developing countries. Accordingly, a reliable , non-invasive tool for imaging of the coronary arteries and for early diagnosis of CAD is highly desirable.Imaging of the heart has always been technically challenging

www.ijbamr.com P ISSN: 2250-284X , E ISSN : 2250-2858

because of the heart's continuous motion. CT imaging of the heart moved into the diagnostic realm by the introduction of multidetectorrow CT (MDCT)[2,3] and development of ECG-Synchronized scanning and reconstruction techniques.[4] These modalities allow for faster volume coverage and high spatial and temporal resolution. The introduction of MDCT especially has greatly benefitted cardiovascular CT applications as the speed of image acquisition shortens breath hold and examination time for the patient and reduces the amount of contrast media needed for high and consistent vascular enhancement.[4-8]With the advent of 64-slice MDCT scanner sub millimeter resolution (0.4mm) of substantial anatomic volumes is routinely achieved.

MATERIALS AND METHODS

This study was conducted at a tertiary care hospital, for the period of one year .Data was collected from patients referred to the CT scan department.

Inclusion criteria

1.Symptomatic or asymptomatic patients with cardiac symptoms.

2.Symptomatic or asymptomatic patients with high risk factors for coronary artery stenosis.

3.Patients having heart rate of <65bpm

4.Patients with good breath holding capacity

5.Patients with post stent insertion and post CABG patients

Exclusion criteria

1.Patients with renal dysfunction

2.Allergy to contrast media

3.Unable to breath hold

4.Heart rate of >65bpm inspite of use of beta-blockers.

5.Very obese patients

6.Patients having an irregular ECG rhythm

The study was conducted in accordance with the approval and recommendations of our institutional ethical board. Initially, written informed consent was obtained from all patients. Thereafter the individual details, clinical history, past history, vitals wererecorded.Atopogram was performed followed by a calcium score. Thereafter contrast enhanced CT coronary angiography was carried out.

99 patients were referred for CT coronary angiography. Of these, 57 patients were symptomatic and 42 patients were asymptomatic (patients with risk factors like DM, HTN, etc.). Of these, 14 patients had prior intervention, 12 were post CABG and 2 were post stenting patients.

The patients were in varied age groups, ranging from 25 yrs to 82 yrs. There were 71 male and 28 female patients.

www.ijbamr.com P ISSN: 2250-284X , E ISSN : 2250-2858

OBSERVATION AND RESULTS

99 patients were referred for CT coronary angiography. Of these, 57 patients were symptomatic and 42 patients were asymptomatic (patients with risk factors – Diabetes, Hypertension, Smoking, Alcohol, Family history of IHD).

Table 1 : Patients having risk factors with coronary artery disease

The patients with risk factors included diabetes, hypertension, smoking, alcohol and patients with family history of ischemic heart disease.

Factors	No. of cases	Coronary artery stenosis
Diabetes	42	26 (61.9%)
Hypertension	53	28 (52.8%)
Smoking	12	7 (58.3%)
Alcohol	8	5 (62.5%)
Family history of IHD	8	5 (62.5%)

Table no2 : Distribution of coronary artery stenosis in patients with risk factors

	Patients with Coronary Artery Stenosis	Patients with no Coronary Artery Stenosis
Patients with risk factors (n = 80)	57(71.25%)	23(28.75%)
Patients with no risk factors(n = 19)	6(31.57%)	13(68.42%)

Total calcium score of all patients were calculated with dedicated software and expressed as Agatston scores. In our institute, we used the following charts.

Table 3 :Standard reference table for percentile range of coronary artery calcium score[47]

Age (years)									
Calcium scores	**<40**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**	**65-69**	**70-74**	**>74**
Men (n)	3504	4238	4940	4825	3472	2288	1209	540	235
25th centile	0	0	0	1	4	13	32	64	166
50th centile	1	1	3	15	48	113	180	310	473
75th centile	3	9	36	103	215	410	566	892	1071
90th centile	14	59	154	332	554	994	1299	1774	1982

www.ijbamr.com P ISSN: 2250-284X , E ISSN : 2250-2858

Women (n)	641	1024	1634	2184	1835	1334	731	438	174
25th centile	0	0	0	0	0	0	1	3	9
50th centile	0	0	0	0	1	3	24	52	75
75th centile	1	1	2	5	23	57	145	210	241
90th centile	3	4	22	55	121	193	410	631	709

Table 4 :Calcium score giudelines[48]

Calcium Score	**Plaque Burden**	**Probability of Significant CAD**	**Implications for CV Risk**
0	No identifiable plaque	Very low, generally < 5%	Very low
1-10....	Minimal identifiable plaque burden	Very unlikely, <10%	Low
11- 100...	Definite, at least mild atherosclerotic plaque burden	Mild or minimal coronary stenosis likely	Moderate
101-400	Definite, at least moderate atherosclerotic plaque burden	Non – obstructive CAD highly likely, although obstructive disease possible	Moderately high
>400	Extensive atherosclerotic plaque burden	High likelihood (>90 %) of at least one significant coronary stenosis	High

www.ijbamr.com P ISSN: 2250-284X , E ISSN : 2250-2858

Table 5 : Relationship of coronary calcium with coronary artery stenosis (CAS)

Calcium score (percentile)	No. of pts with calcium score	No. of pts having Coronary Artery Stenosis			Total no. of patients with CAS
		Mild	Mod.	Severe	
0	49 (49.49%)	7	1	1	9 (18.36%)
Upto 25^{th}	4 (4.04%)	3	0	0	3 (75%)
Bet. 25^{th} – 50^{th}	5 (5.05%)	1	1	3	5 (100%)
Bet. 50^{th} – 75^{th}	16 (16.16%)	6	3	3	12 (75%)
Bet. 75^{th} – 90^{th}	6 (6.06%)	1	4	1	6 (100%)
$>90^{th}$	5 (5.05%)	0	2	3	5(100%)

Discussion:'

Total calcium scores of all patients were calculated with dedicated software and expressed as Agatston scores. The Agatston score is commonly used scoring method that calculates the total amount of calcium on the basis of the number, area and peak Hounsfield units of the detected calcified lesions.[9]

Fig 11 : Calcium Scoring

The calculated Agatston score was classified into **:**

1. Zero (no coronary calcification)
2. Upto 25^{th} percentile
3. Between 25^{th} and 50^{th} percentile
4. Between 50^{th} and 75^{th} percentile
5. Between 75^{th} and 90^{th} percentile
6. $>90^{th}$ percentile

Patients with post surgical intervention patients (n=14) were not included in this study.

www.ijbamr.com P ISSN: 2250-284X , E ISSN : 2250-2858

Of the 85 patients studied for the calcium score, 49 patients (49.49%) showed no evidence of calcium. Of these, 9 patients (18.36%) had evidence of coronary artery stenosis on MDCT coronary angiography. Out of these 9 patients, 7 (77.77%) had mild , 1(11.11%) had moderate luminal narrowing due to non-calcified plaque and one patient had severe degree of left anterior descending artery proximal segmental block .

In the present study, 18.36% of patients with no calcium in coronary arteries had coronary artery stenosis, this is more than that revealed by various prior studies. Most of the studies, which predict high exclusion probability in low calcium score were conducted in symptomatic or suspected coronary artery disease. In the present study, the cohort comprises of both symptomatic and asymptomatic patients.Current literature states that calcium scoring by CT has negative predictive values of 96% to 100% meaning that an individual with zero calcium score has no obstructive angiographic disease. However, as seen from the present study, 18.36% of patients with a calcium score of zero had evidence of coronary artery stenosis. Thus a calcium score of zero cannot rule out CAD.[10,11]Thusanunstable or vulnerable plaque may go undetected and may rupture and cause thrombosis and obstruction of the coronary artery.

Hadamitzky et al (2011)[72] compared CCTA with calcium scoring and clinical risk scores for the ability to predict cardiac events. Patients (n = 2,223) with suspected CAD undergoing CCTA were followed-up for a median of 28 months. The end point was the occurrence of cardiac events (cardiac death, nonfatal myocardial infarction, unstable angina requiring hospitalization, and coronary re-vascularization later than 90 days after CCTA). Patients with obstructive CAD had a significantly higher event rate (2.9 % per year; 95 % CI: 2.1 to 4.0) than those without obstructive CAD, having an event rate 0.3 % per year (95 % CI: 0.1 to 0.5; hazard ratio, 13.5; 95 % CI: 6.7 to 27.2; $p < 0.001$). Coronary computed tomography angiography had significant incremental predictive value when compared with calcium scoring, both with scores assessing the degree of stenosis ($p < 0.001$) and with scores assessing the number of diseased coronary segments ($p = 0.027$). The authors concluded that in patients with suspected CAD, CCTA not only detects coronary stenosis but also improves prediction of cardiac events over and above conventional risk scores and calcium scoring.

There were 4 patients (4.04%) with calcium score below 25th percentile. Of these, 3 patients (75%) had evidence of mild to moderate coronary artery stenosis on MDCT coronary angiography.

5 patients (5.05%) had calcium score between 25th and 50th percentile, of which 1 (20%) patient had mild degree of luminal narrowing,1 (20%) had moderate degree and 3 (60%) had severe degree coronary artery stenosis on MDCT coronary angiography.

There were 16 patients (16.16%) with a calcium score between 50th and 75th percentile. Of these, 12 patients (75%) had evidence of coronary artery stenosis.

Between 75th and 90th percentile, there were 6 patients (6.06%), of which all 6 (100%) patients had evidence of coronary artery stenosis.5 patients had a calcium score of >90th percentile of which all 5 (100%) had evidence of coronary artery stenosis.

Combining patients between 25th and 75th percentile, of the 21 patients (24.70%), 17 patients (17.17%) had evidence of coronary artery stenosis on MDCT coronary angiography.

CONCLUSION

From the present study, following conclusions can be drawn , A calcium score of zero cannot rule out coronary artery stenosis. 18.36% of patients with a calcium score of zero had evidence of coronary artery stenosis in the present study. Though a higher calcium score is associated with a higher incidence of CAD, a calcium score of zero does not rule out CAD.

BIBLIOGRAPHY

1. AHA 2002. Heart and stroke statistical update. Dallas (TX):American Heart Association; 2001.
2. McCullough CH, Zink FE. Performance, evaluation of multi- slice CT system. Med Phys 1999; 26: 2223-30.
3. Klingenbeck – Regn K, Schaller S, Flohr T, et al. Sub-second multislice computed tomography: basic and applications. Eur J Radiol 1999; 31: 110-24.
4. Ohnesorge B, Flohr T, Becker C, et al. Cardiac imaging by means of electrographyically gated multisection spiral CT: initial experience. Radiology 2000; 217: 564-71.
5. Becker CR, Ohnesorge BM, Schoepf UJ, Reiser MF. Current development of cardiac imaging with multi-detector row CT. Eur J Radiol 2000; 36: 97-103.
6. Schoepf UJ, Becker CR, Obuchawski NA, et al. Multislice computed tomography as a screening tool for colon cancer, lung cancer and coronary artery disease. Eur J Radiol 2001; 11: 1975-85.
7. Flohr T, Bruder H, Stierstorfer K, et al. New technical developments in multislice CT, part 2: submillimeter 16-slice scanning and increased gantry rotation speed for cardiac images. RofoFortschrGebRontgenstrNeuenBildgebVerfahr 2002; 174: 1022-27.
8. Kopp AF, Kuttner A, Heuschmid M, et al. Multidetector row CT cardiac imaging with 4 and 16 slices for coronary CTA and imaging of atherosclerotic plaques. EurRadiol 2002; 12 (2): S17-24.
9. Hounsfield GN. Computerized transverse axial scanning (tomography): Part 1. Description of system. Brit J Radiol 1973; 46: 1016-22.
10. Agatston AS, JanowitzWF ,Hildner FJ , et al.Quantification of coronary artery calcium using ultrafast computed tomography. JAmCollCardiol 1990;15: 827-32.
11. Achenbach's , Moshage W, Ropers D, Cohen J, et al. Value of electron- beam computed tomography for the non-invasive detection of high grade coronary artery stenosis and occlusions. N Engl J Med 1998; 339: 1964-1971.