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Original Article

"ROLE OF MDCT IN EVALUATION OF CORONARY VESSELES"

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ABSTRACT

Introduction- Coronary artery disease (CAD) is a leading cause of morbidity and mortality in the developed world. Over the last decade multi-slice computed tomography coronary angiography (MSCT-CA) has emerged as a non-invasive imaging modality capable of visualising the coronary arteries. **Aims and Objectives-** This study aim to evaluate various coronary lesions and anatomical variations. **Material and Methods-** Prospective Analytical-observational type of study conducted in the Department of Radiodiagnosis, and Om Imaging and Diagnostic Centre, Meerut. A total of sixty patients presenting with chest pain or other cardiac complaints and satisfying the inclusion criteria were included in the study. **Observations-** Each patient underwent detailed clinical assessment followed by MDCT coronary angiography. A descriptive analysis of imaging findings was made and compared and results derived. Total of two patients were post CABG and four patients were post coronary stenting. **Conclusion**-Out of the 60 patients evaluated 23 patients (38.4%) were having significant stenosis (=50%) and 18 patients (30%) were having mild stenosis (=10 - =50 %).Out of the patients presenting with stenosis, 25 patients (61%) were having single vessel disease, 7 patients (17%) were having double vessel disease and 9 patients (22%) were having triple vessel disease.

Key words- Coronary artery, MDCT (Multiditector Computed Tomography), CAD (Coronary artery disease), Multi-slice computed tomography coronary angiography (MSCT-CA).

INTRODUCTION

Coronary artery disease (CAD) is a leading cause of morbidity and mortality in the developed world. Over the last decade multi-slice computed tomography coronary angiography (MSCT-CA) has emerged as a non-invasive imaging modality capable of visualising the coronary arteries.[1] Early comparative studies intimated that MSCT-CA had the potential to replace invasive coronary angiography (I-CA) in certain patient groups.[2] Incremental advances in scanner technology have been reflected in clinical studies which have demonstrated considerable accuracy of MSCT-CA in comparison to I-CA for detecting significant coronary artery stenoses.[3,4] Multidetector cardiac computed tomography (CT) angiography has been well established as an accurate noninvasive modality to evaluate for CAD.[5] The gold standard diagnostic test for CAD - invasive coronary angiography.

Imaging of the coronary arteries by computed tomography has traditionally been very difficult due to their small size and constant motion. Respiratory motion presented a further difficulty to be overcome. Initial spiral CT scanners consisted of an x-ray source and a single detector mounted on opposite sides of a continuously rotating gantry. Cardiac scanning was attempted but motion-free images were not attainable due to the long acquisition time required for complete coverage of the heart.[6] The first multi-detector (multi-slice) CT scanners capable of visualising the coronary arteries were introduced in 1999. These scanners utilised four parallel detector rows to reduce scan time and retrospective electrocardiographic gating was employed to minimise artefact due to cardiac motion. However, whilst often diagnostic of CAD, imaging was limited to larger more proximal vessels and the scanners were not deemed reliable enough for use in routine clinical practice.[7,8] As technology developed over the next decade MSCT scanners with 16 then 40 and 64 slices were produced. The increase in number of slices was accompanied by shorter gantry rotation times, narrower collimation and near isotropic voxels which substantially enhanced temporal and spatial

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resolution. These features translated into significant improvements in diagnostic accuracy.

Advances in multidetector CT (MDCT) technology with submillimeter slice collimation and high temporal resolution permit contrast-enhanced imaging of coronary arteries and coronary plaque during a single breath hold. Appropriate patient preparation, detailed technical and technological knowledge with regard to recognition of typical imaging artifacts (such as beam hardening or motion artifacts), and the adequate choice of postprocessing techniques to detect stenosis and plaque are prerequisites to achieving diagnostic image quality. A growing number of studies have suggested that 64-slice coronary CT angiography is highly accurate for the exclusion of significant coronary artery stenosis (.50% luminal narrowing), with negative predictive values of 97%–100%, in comparison with invasive selective coronary angiography. In addition, several studies have indicated that MDCT also can detect calcified and noncalcified coronary atherosclerotic plaques, especially in proximal vessel segments, showing a good correlation with intracoronary ultrasound. Studies on clinical utility, cost, and cost-effectiveness are now warranted to demonstrate whether and how this technique can change and improve the current management of patients with suspected or confirmed coronary artery disease[9].

The right and left coronary arteries originate from the right and left sinuses of Valsalva of the aortic root, respectively. The posterior sinus rarely gives rise to a coronary artery and is referred to as the "noncoronary sinus." The locations of the sinuses are anatomic misnomers: The right sinus is actually anterior in location and the left sinus is posterior. The myocardial distribution of the coronary arteries is somewhat variable, but the right coronary artery (RCA) almost always supplies the right ventricle (RV), and the left coronary artery (LCA) supplies the anterior portion of the ventricular septum and anterior wall of the left ventricle (LV). The vessels that supply the remainder of the LV vary depending on the coronary dominance.

Cardiac Computed Tomography : Definitions

Angina: As defined by the ACC/AHA Guidelines on Exercise Testing

• ***Typical Angina*** (Definite):

. **Substernal chest pain, or an ischemic equivalentdiscomfort that is**

a. provoked by exertion or emotional stress and

b. relieved by rest and/or nitroglycerin

• ***Atypical*** **Angina (Probable)**: Chest pain or discomfort with two characteristics of definite or typical angina .

• ***Nonanginal*** **Chest Pain:** Chest pain or discomfort that **meets one or none** of the typical angina characteristics.

Acute Coronary Syndrome: As defined by the ACC/AHA Guidelines for the Management of Patients With STElevation Myocardial Infarction, patients with an acute coronary syndrome include those whose clinical presentations cover the following range of diagnoses: unstable angina, MI without ST-elevation (NSTEMI), and myocardial infarction with ST-elevation (STEMI).

MATERIALS AND METHODS

The present study is Prospective Analytical-observational study type of study was conducted in the Department of Radiodiagnosis, and Om Imaging and Diagnostic Centre, Meerut.

Inclusion criteria: Patients of all age groups, both sexes, referred for C.T. angiography, having acute chest pain from the Department of Radiodiagnosis, Department of medicine, Department of Surgery were included in this study. Exclusion criteria: Any patient with unstable,symptoms where the requirement for I-CA was considered urgent were excluded. Other exclusion criteria relating to patient safety were documented iodine contrast allergy, hyperthyroidism, significant renal dysfunction (defined as serum creatinine > 150 mmol/l or > 120 mmol/l in a diabetic patient) and possible pregnancy. Exclusion criteria based on anticipated technical difficulties with the MSCT-CA protocol were atrial fibrillation (AF) or frequent ventricular or

supraventricular ectopic activity and inability to carry out a 12 second breath hold. General exclusion criteria were mental or legal incapacitation and inability or reluctance to provide informed consent.

Equipment- " SOMATOME SENSATION" (SIEMENS) 64 CARDIAC CT SCAN "Bright speed" (GE) CT scan machine, Non ionic contrast media

OBSERVATIONS

A descriptive analysis of imaging findings was made and compared and results derived. Total of two patients were post CABG and four patients were post coronary stenting.

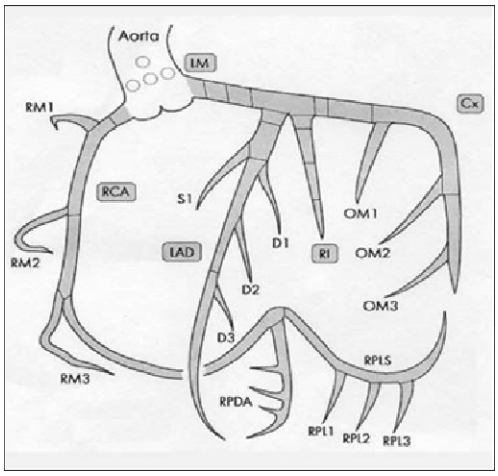

FIGURE 1 : Normal anatomy of coronary vessels

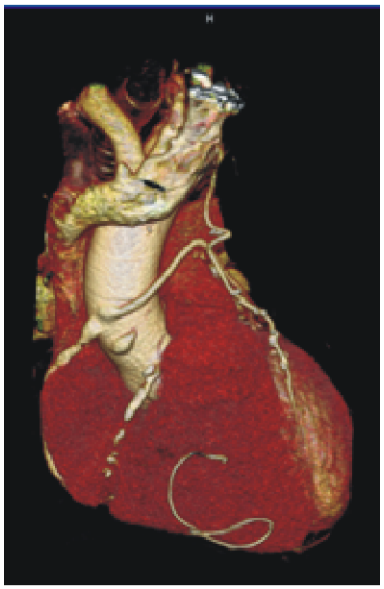

FIGURE2: 3D volume rendered image showing 100% stenosis

TABLE 1 : Age and Sex distribution of patients.

Age-range (in years)	Males		Females		Total	
	No.	%	No.	%	No.	%
>10 yrs	0	0	0	0	0	0
11-20 yrs	0	0	1	2	1	2
21-30 yrs	1	1.66	1	1.66	2	3
31 – 40 yrs	3	5	1	1.66	4	7
41 – 50 yrs	4	6.66	2	3.33	6	10
51 – 60 yrs	10	16.66	9	15	19	32
61 – 70 yrs	10	16.66	7	11.66	17	28
71 – 80 yrs	4	6.66	3	5	7	12
>81 yrs	1	1.66	3	5	4	7
Total	33	55	27	45	60	100

The mean age of the patients was 58 years and the range was 19-86 years. 27 patients (45%) were females and 33(55%) were males. The majority of the patients were in the age group of 50-70 years

TABLE 2: Patient Characteristics

Patient characteristics	No. of patients	Percentage
Hypertension	33	54
Hypercholesterolemia	52	87
Smoking		
Previous History	20	32
Current smokers	12	20
Diabetes Mellitus	7	11
BMI : MEAN 28.6 ± 5.2		
25	15	25
25 – 30	24	40
30	21	35

TABLE 3: Symptoms of the patients

Symptoms	No. of Patients	Percentage
Chest Pain	56	94
Typical Angina	34	56

Number of patients with significant stenosis (= 50%) was 23 i.e. 38.4%.

Table 4: Coronary Artery Stenosis

Stenosis	No. of patients	Percentage
No stenosis	19	32
=10 – <50 % stenosis	18	30
=50 - <70 % stenosis	14	23.3
=70 % stenosis	09	15

Total of 51(85%) patients had coronary vessel plaque >10% out of which 36(71%) patients had calcified plaque and 15(29%) had noncalcified plaque. 89% of all calcified plaque causes coronary stenosis while 60% of all non calcified plaques causes coronary stenosis.

TABLE 5: Plaque Characteristics

Type of plaque	No. of patients (n=60)	Percentage of total patients with plaque	No. of patients with stenosis	Percentage of plaque with stenosis
Calcified Plaque	36	71	32	89
Non calcified Plaque	15	29	09	60
Total	51	100	41	80

Coronary Dominance could be assessed only in 58 patients.

TABLE 6: Coronary Dominance

Dominance	No. of Patients (n=58)	Percentage
Right Dominance	48	82.7
Left Dominance	10	17.3
Codomoinance	00	------

DISCUSSION

Coronary artery stenosis

Out of the 60 patients evaluated 23 patients (38.4%) were having significant stenosis (=50%) and 18 patients (30%) were having mild stenosis (=10 - =50 %).Out of the patients presenting with stenosis, 25 patients (61%) were having single vessel disease, 7 patients (17%) were having double vessel disease and 9 patients (22%) were having triple vessel disease.On segment based analysis (15 segment model of AHA) Maximum significant stenosis was found in mid LAD (14 patients), proximal LAD (12 patients), proximal RCA (8 patients) followed by distal LAD, mid RCA and proximal LCA.It was seen that the proximal segments involvement for CAD was much higher than the distal segments.

The results were similar to Budoff M. J. et al (2008)[10] and Miller J. M. et al (2008)[11] and to the various other studies for the MDCT evaluation of coronary artery stenosis.

Plaque characteristics

Out of 60 patients, 51 patients (85%) had coronary vessel plaque/s. Of these 51 patients, 36 patients showed plaque calcification and 15 patients did not show plaque calcification.

Out of 36 patients having plaque calcification 32 patients (89%) were having stenosis due to plaque. Out of 15 patients with non calcified plaque 09 patients (60%) were having stenosis, 10 patients (20%) having either type of plaque did not show stenosis.

The findings were in accordance with the plaque characteristics described in **Bovoros et al (2011)12.**

Anatomical consideration and anomalies

Coronary dominance could be assessed with high accuracy using MDCT in 58 patients. Our study showed that 48 patients (82.7%) had Right coronary

dominance and 10 patients (17.3%) had Left coronary dominance. No patient of codominance was found in our study. However in studies with large number of patients as, discussed in Review of Literature, an incidence of <5% had been noted for codominance.

In our study one patient had anamolous origin of coronary artery and one patient had myocardial bridging. Five patients showed variants of course.

Unevaluable segments

Our study included MDCT from a 64 slice and 16 slice CT scanner. In all 900 were considered to be evaluated from 60 patients (15 segments model of AHA), of which 168 segments (18.6%) were unevaluable either due to proximal complete stenosis or imaging pitfall. It was seen that more distal segments were having higher unevaluability. The unevaluability was higher in cases scanned with 16 slice CT scanner than in 64 slice CT as has been observed in various comparative studies discussed before.

Clinical considerations for patient characteristics

In our study it was seen that the incidence of significant coronary stenosis and moderate to high risk coronary calcification was higher in males than in females, and also that hypertension , smoking, hypercholesterolemia, diabetes mellitus and high BMI were individually causing high risk of coronary stenosis and coronary calcification with significant relative risk and odd's ratio value obtained.

CONCLUSION

Considering the comparable accuracy, sensitivity, and specificity of 16 and 64 slice MDCT with I-CA as proved in various studies and clinical trials done in America and Europe which have been discussed in previous segments of our study, the above observations and conclusions appear valid and significant and proves MDCT coronary angiography as an alternative diagnostic modality for coronary artery evaluation, for risk stratification of CAD, for detecting and quantifying coronary stenosis, plaque characterization and for quantification of coronary calcium.

MDCT appears to have higher diagnostic performance than invasive coronary angiography for coronary anatomy and anomalies, especially those having hemodynamic significance, as it allows simultaneous assessment of coronary vessels and surrounding anatomical structures of heart and decreasing the need of unnecessary invasive procedures.

The evolution of newer scanners with 128 and 256 slice CT, the diagnostic performance of MDCT in evaluation of coronary vessels is having even better future.

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