The current study included thirty patients with diabetes. A total of 20 patients received oral hypoglycemic drugs and 10 patients were on insulin.

Patient characteristics:

The study group consisted of 9 females and 21 males. The mean age was 52.6±6.5 years. The prevalence of various cardiovascular risk factors among the study population was as follow; hypertension 63%, dyslipidemia 43%, smoking 43%, and positive family history 13%.

Table1: The prevalence of various risk factors.

Risk factor	No. of patients	Prevalence
Hypertension	19	63%
Dyslipidemia	13	43%
Smoking	13	43%
Family History	4	13%

The body mass index (BMI) of the study group ranged between 19 and 40 Kg/m² with a mean of 27.9±5.1 Kg/m². Twelve patients (40%) had BMI≥30Kg/ m² and subjects with BMI ranged between 25-29 Kg/ m² constituted 27% of patient population (8 patients). Ten patients were less than 25Kg/m².

Table 2: summary of BMI in study population

Body mass index	No. of patients
BMI>30 Kg/m²	12
BMI25-29Kg/ m²	8
BMI< 25 Kg/ m²	10

The heart rate of the study group during the scan ranged between 45 and 73 bpm with a mean of 61±7 bpm. Twenty one patients (70%) had heart rate less than 65bpm while nine patients (30%) had heart rate≥65bpm.

Table 3: heart rate descriptive data

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>Minimum</td><td colspan="2">45bpm</td></tr>
<tr><td>Maximum</td><td colspan="2">73bpm</td></tr>
<tr><td>Mean± SD</td><td colspan="2">61±7bpm</td></tr>
<tr><td>HR<65bpm</td><td>21(70%)</td><td rowspan="2">P = 0.002</td></tr>
<tr><td>HR≥65bpm</td><td>9(30%)</td></tr>
</table>

A total of coronary calcium score, according to Agatston scoring system, ranged between 11and 886 units with a mean of 257±240.

Nine patients (30%) had calcium score≥400 units whereas twenty one patients (70%) had a total coronary calcium score less than 400 units.

Figure33: comparison between the two groups of calcium score

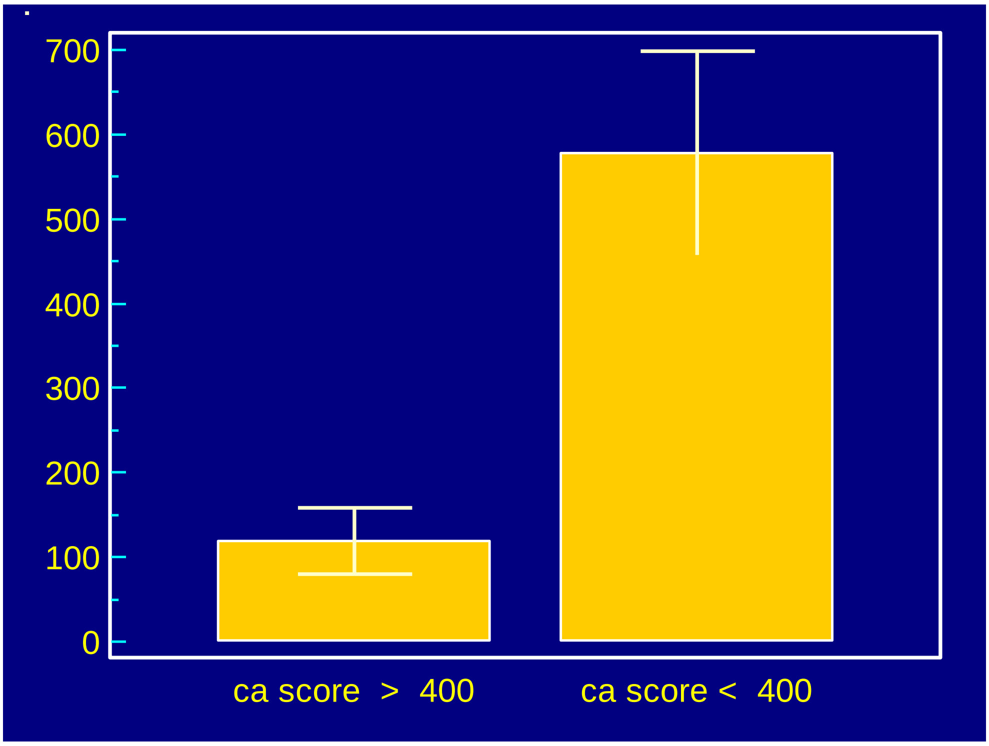


Table 4: comparison between the two groups of calcium score

	No. of patients	Minimum	Maximum	Mean ±SD	P value
400<Ca score	21	11	332	119±86	0.02
400>Ca score	9	450	886	578±157	

Coronary artery stenoses:

Segment –based analysis:

For evaluation of coronary arterial segments by both methods, the standard 15-segment AHA model of the coronary tree was employed ***(Cerqueira et al., 2002)*****.**

A total of 450 segments were subjected to evaluation by both methods.

Among these segments, 30 segments were anatomically absent and segment 15 was the most common one to be absent followed by segment 14.

A total of 420 segments were subjected for evaluation. Non-evaluable segments by CTA represented 5% of these segments (23 segments). The most common cause for non evaluablity was the motion artifacts which constituted 11 segments (3%) of all segments. Excessive calcification impeded evaluablity in 6 segments (1%) of total segments. Other causes of non-evaluablity included 6 segments (1%) of total segments. These causes included reduced signal to noise ratio due to obesity, respiratory movement artifacts, and small-sized vessels.

Among the evaluable segments, 66 segments (16%) had significant stenosis (≥50% luminal narrowing) while the remaining 331 segments (79%) were free of significant stenosis by CTA.

Conventional CA revealed 71 segments (17%) with significant stenosis and 349 segments (83%) with non-significant stenosis.

Table5: CTA analysis of coronary segments:

CTA finding	No. of segments	Percent
Non- significant stenosis	331	79%
Significant stenosis	66	16%
Motion artifact	11	3%
Calcification	6	1%
Others	6	1%

Figure 34: CTA analysis of coronary segments.

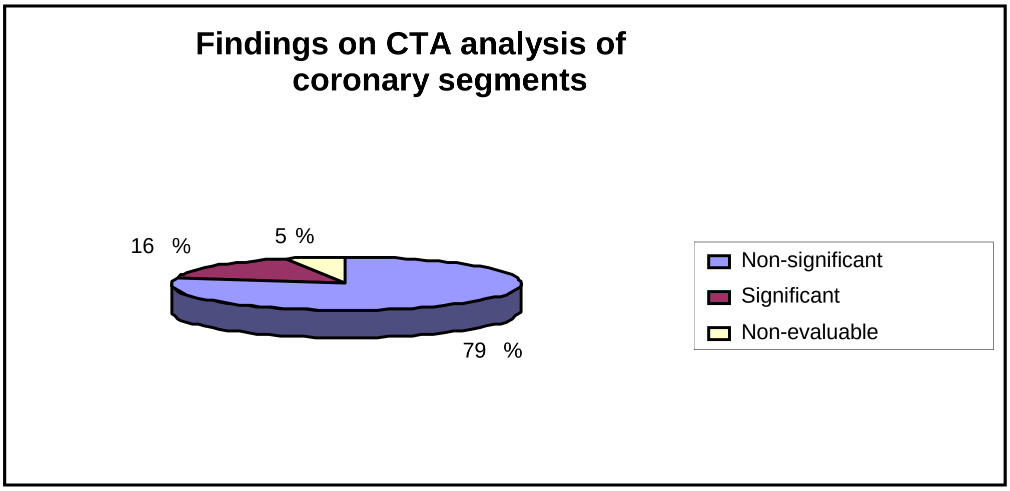
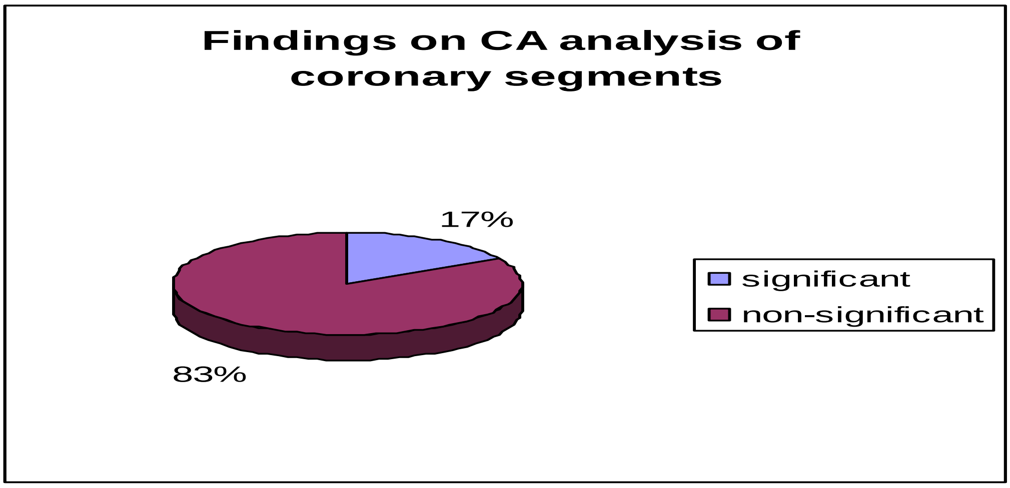


Figure 35: invasive CA analysis of coronary segments



When comparing the results of CTA with the results of invasive CA, it was found that 59 segment with significant stenosis on invasive CA were detected by CTA while CTA missed 6 significant segments which were considered non-significant stenosis. 7 segments which were considered with significant stenosis on CTA were diagnosed as with non-significant stenosis on invasive CA. These results would yield an overall sensitivity, specificity, positive predictive value, and negative predictive value of 92%, 98%, 89%, and 98% respectively with diagnostic accuracy of 97%.

Yet, when evaluating the coronary segments the non evaluable segments would represent a problem with calculating accuracy of the test. To include these segments, which happens in the real world, this would increase the number of false positive findings affecting the whole accuracy of the test. Considering these non evaluable segments in the evaluation would yield overall sensitivity, specificity, positive predictive value and negative predictive values of 84%, 91%, 66%, and 96% respectively with diagnostic accuracy of 90%.

Table 6: distribution of various segments among both techniques:

		Segments by Coronary Angiography		Total
		Significant stenosis	Non-Significant stenosis	
Segments by CTA	Significant stenosis	59	7	66
	Non-Significant stenosis	6	325	331
	Non evaluable	6	17	23
Total		**71**	**349**	**420**

Table 7: comparison between results when non-evaluable segments were not included and when included in analysis:

	Non-evaluable segments not included	Non-evaluable segments included	P value
Sensitivity	**92%**	**84%**	**0.1**
Specificity	**98%**	**91%**	**0.1**
PPV	**89%**	**66%**	**0.04**
NPV	**98%**	**96%**	**0.1**

Vessel-based analysis:

When assessing the accuracy of MSCT for detection of significant lesions or exclusion of significant stenosis for every coronary vessel (LM, LAD, LCx, and RCA) the results were as follows:

LM artery assessment in this study is perfect (diagnostic accuracy was 100%) as the CTA could successfully detect the 3 significant lesions in this study (one proximal and two distal lesions) and excluded the presence of significant lesions among the rest of patients.

LAD artery assessment revealed the following results; CTA could detect 25 significant stenoses from 30 detected by invasive CA and could exclude significant stenosis in 58 segments from 60 detected as non-significant with invasive CA. CTA missed 5 segments with significant stenosis detected by invasive CA. These findings resulted in sensitivity, specificity, PPV, and NPV of 83%, 97%, 92%, and 92% respectively with diagnostic accuracy of 92%.

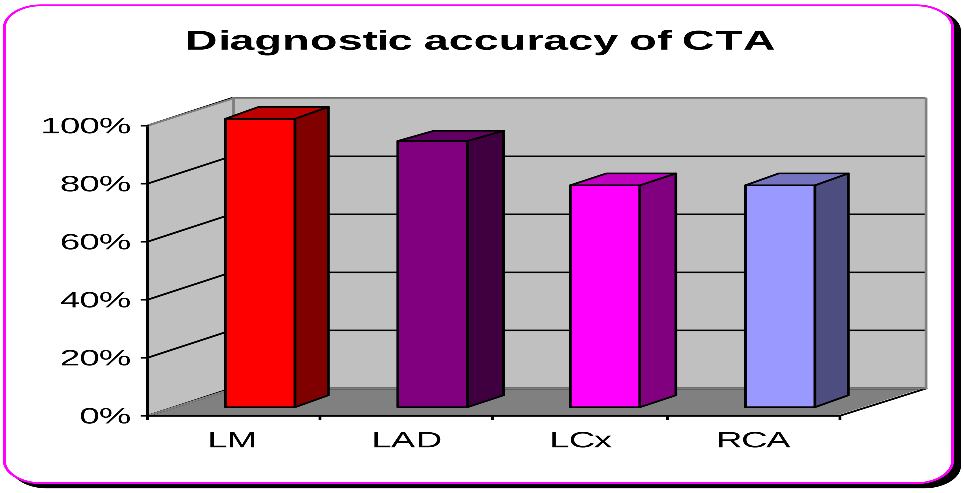
LCx artery assessment revealed the following results; CTA could detect 8 significant stenoses from 15 detected by invasive CA and could exclude significant stenosis in 38 segments from 45 segments detected as non-significant stenosis by invasive CA. CTA missed 7 segments with significant stenoses detected by invasive CA. There were 5 segments were considered non-evaluable by CTA. These results yield sensitivity, specificity, PPV, and NPV of 53%, 84%, 53%, and 84% respectively with diagnostic accuracy of 77%.

RCA assessment revealed the following results; CTA could detect 9 significant stenoses from 14 segments detected by invasive CA and could exclude 37 significant stenoses from 46 segments detected by invasive CA as non-significant stenoses. These results yield sensitivity, specificity, PPV, and NPV of 64%, 80%, 50%, and 88% respectively with diagnostic accuracy of 77%.

Table 8: accuracy of CTA for each coronary vessel:

	LAD	LCx	RCA
Sensitivity	83%	53%	64%
Specificity	97%	84%	80%
PPV	92%	53%	50%
NPV	92%	84%	88%
Diagnostic accuracy	92%	77%	77%

Figure 36: diagnostic accuracy of CTA for each coronary vessel



When evaluating the accuracy of MSCT in detecting significant coronary artery stenoses according to the percentage stenosis detected by invasive CA, it was found that, in the current study, 35 segments had 50-70% stenosis by invasive CA, of these, 28 segments were detected by CTA with resulting sensitivity of 82%.

Sixteen segments had 70-80% stenosis severity by invasive CA, of these, 13 segments were detected by CTA with resulting sensitivity of 87%.

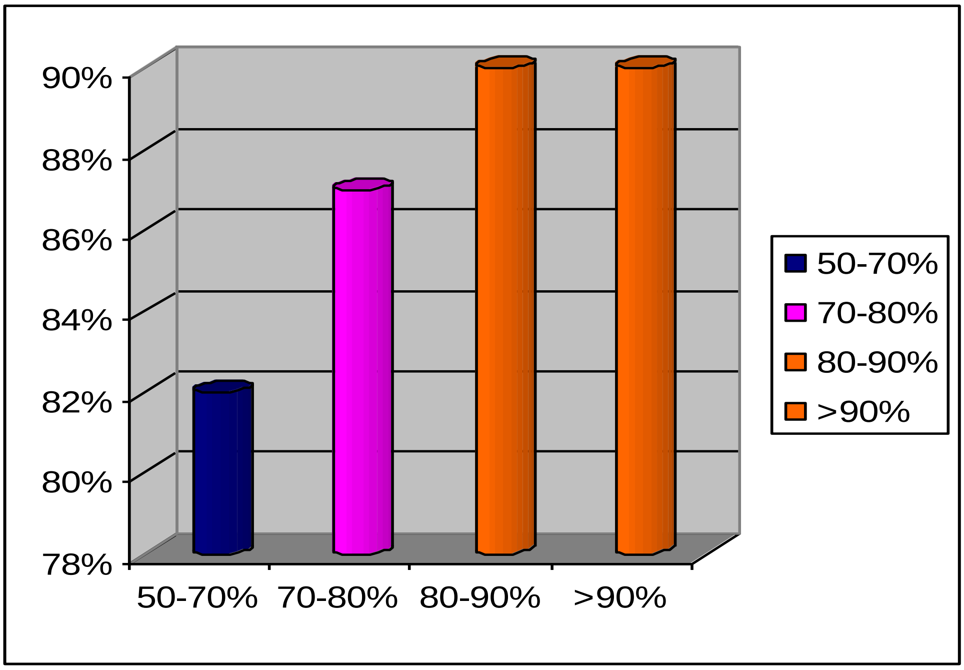
Invasive CA revealed 10 segments with stenosis severity of 80-90%, of these, 9 segments were detected by CTA with resulting sensitivity of 90%.

CTA could detect 9 segments from 10 segments evaluated by invasive CA to have stenosis severity of > 90% with resulting sensitivity of 90%.

Table 9: sensitivity of CTA according to stenosis severity detected by invasive CA:

Stenosis severity	**No. of segments by CA**	**No. of segments by CTA**	**Sensitivity**
50-70%	35	28	82%
70-80%	16	13	87%
80-90%	10	9	90%
>90%	10	9	90%

Figure 37: sensitivity of CTA according to stenosis severity detected by invasive CA:



When we evaluate the accuracy of CTA , according to the present study, as comparing proximal versus non-proximal segments, the results were as follow (proximal segments were defined as segments 1, 5, 6, and 11 according to the AHA 15-segments); invasive CA detect significant stenosis in 40 segments while the other 80 segments were addressed as non-significant stenoses. CTA could detect 36 segments with significant stenosis, of these, 34 segments were compatible with invasive CA. CTA could exclude significant stenosis in 81 segments, of these, 77 segments were compatible with CA findings. There were 3 non-evaluable segments, 2 of them were evaluated as significant in invasive CA. These results yield sensitivity, specificity, PPV, and NPV of 85%, 96%, 89%, and 94%, respectively, with diagnostic accuracy of 92%.

As regard the distal segments, there were 300 segments evaluated by invasive CA, 31 segments had significant stenosis and 269 segments had non-significant stenosis. CTA could detect 25 segments with significant stenosis and exclude significant lesions in 248 segments. There were 20 segments considered as non-evaluable by CTA, of these, 4 segments were found by invasive CA to have significant stenosis and 16 segments to have non-significant lesions.

These results yield sensitivity, specificity, PPV, and NPV of 80%, 92%, 54%, and 97%, respectively with diagnostic accuracy of 91%.

Table10: comparison between proximal and non-proximal segments as detected by both methods

	Proximal segments	Non-proximal segments	P value
Significant stenosis	36	30	
Non-significant stenosis	81	250	
Non-evaluable segments	3	20	0.04
Sensitivity	85%	80%	
Specificity	96%	92%	
PPV	89%	54%	0.02
NPV	94%	97%	
Accuracy	92%	91%	

Patient-based analysis:

On a per patient basis, MSCT was accurate in 26 of 30 patients (87%). In four patients, no significant lesions were detected by invasive CA, and three (75%) of these patients were correctly identified as having non-significant lesions using the MSCT. Of the remaining 26 patients with significant lesions on invasive CA, 23 (88%) were correctly identified using MSCT.

The calculated sensitivity, specificity, PPV, and NPV were 88%, 75%, 96%, and 50% respectively with diagnostic accuracy of 87%.

When the diagnostic accuracy was evaluated in the group of patients with heart rate > 65bpm (9 patients), the calculated sensitivity, specificity, PPV, and NPV were 84%, 80%, 60%, and 96% respectively. On the remaining 21 patients with heart rate < 65bpm, the calculated sensitivity, specificity, PPV, and NPV were 92%, 98%, 89%, and 98% respectively.

Table 11: effect of scanning heart rate on diagnostic accuracy of CTA:

	Heart rate > 65 bpm **N=9**	**Heart rate ≤ 65 bpm** **N=21**
Sensitivity	84%	92%
Specificity	80%	98%
PPV	60%	89%
NPV	96%	98%

As regard the effect of BMI on diagnostic accuracy of CTA, there were twelve patients (40%) with BMI≥ 30Kg/m². Sensitivity, specificity, PPV, and NPV were 97%, 90%, 64% and 99% respectively with a total diagnostic accuracy of 91%. Whereas the group of patients with a BMI of less than 30 kg/m^2 (18 patients, 60%) had sensitivity, specificity, positive and negative predictive values of 90%, 87%, 64% and 97% respectively with a total diagnostic accuracy of 88%.

Table 12: diagnostic accuracy in obese and non-obese:

	BMI≥ 30Kg/m² N=12	**BMI<30Kg/m² N=18**	**P value**
Sensitivity	90%	97%	**0.2**
Specificity	87%	90%	**0.2**
PPV	64%	64%	**0.2**
NPV	97%	99%	**0.2**

As regard the effect of total calcium score on the diagnostic accuracy of the MSCT, the study population was classified into two groups; one group (21 patients, 70%) had a low total coronary calcification (< 400 units according to Agatston score) and had sensitivity, specificity, positive and negative predictive values of 83%, 95%, 72% and 97%, respectively, while the second group (9 patients, 30%) had a total coronary calcification of more than 400 units and had sensitivity, specificity, positive and negative predictive values of 83%, 89%, 69% and 94% respectively.

Table 13: comparison of effect of low and high calcium score on the diagnostic accuracy of MSCT

	High Calcium Score (n=9, 30% %)	Low Calcium Score (n= 21, 70%)
Sensitivity	83%	83%
Specificity	89%	95%
PPV	69%	72%
NPV	94%	97%

P value> 0.05

Left ventricular function

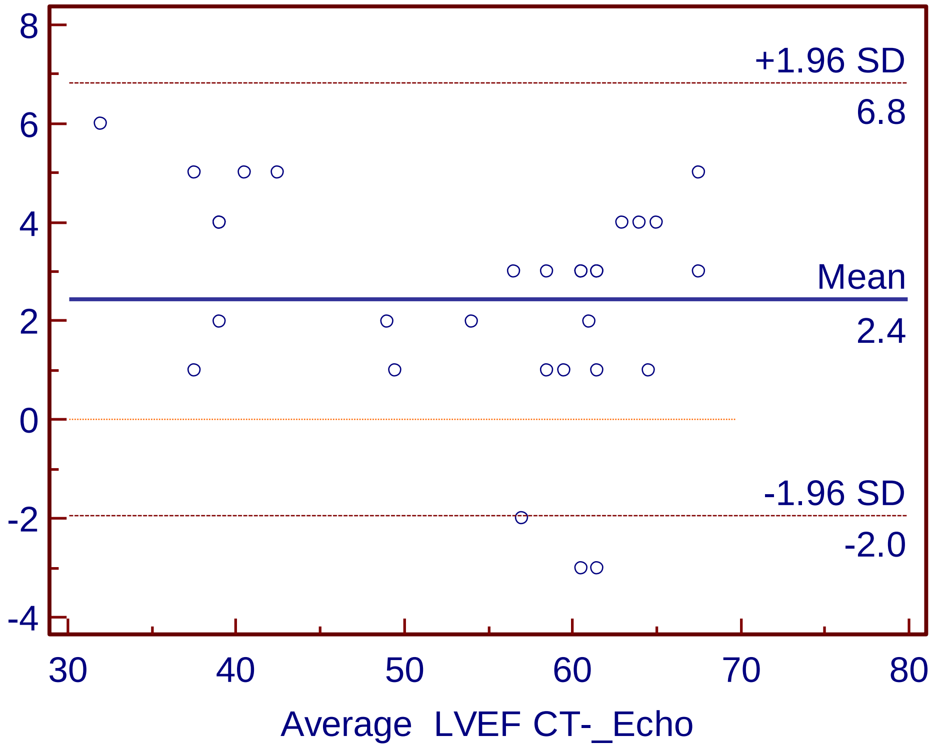
Mean left ventricular ejection fraction, as determined by echocardiography and MSCT, was 55±10% (range 35-70%) and 53±11 (range 29-66%), respectively.

Table 14: LVEF as determined by CT and echo

	Mean	SD	Minimum	Maximum
LVEF-Echo	55.533	10.4113	35.000	70.000
LVEF_CT	53.100	11.1056	29.000	66.000

Bland-Altman analysis in the comparison of MSCT and echo left ventricular ejection fraction demonstrated a mean difference of -2.4±1.96 %, which was not significantly different from 0.

Figure38: Bland-Altman plot in the comparison of MSCT and echocardiography in the assessment of left ventricular ejection fraction (LVEF). The difference between each pair is plotted against the average value of the same pair (solid line, mean value of differences; dotted lines, mean value of differences ±2SD).



Echocardiography revealed contractile dysfunction in 92 of 425 segments (22%); 44 (48%) showed hypokinesia, 40 (43%) showed akinesia, and 8 (9%) showed dyskinesia.

In 85 of the dysfunctional segments (92%), decreased systolic wall thickening was also observed on the MSCT images.

An excellent agreement was shown between the two techniques; 92% of segments were scored identically on both modalities (κ statistics 0.81±0.03.

Agreements for the individual gradings (1-4) were 97, 82, 73, and 92% respectively.

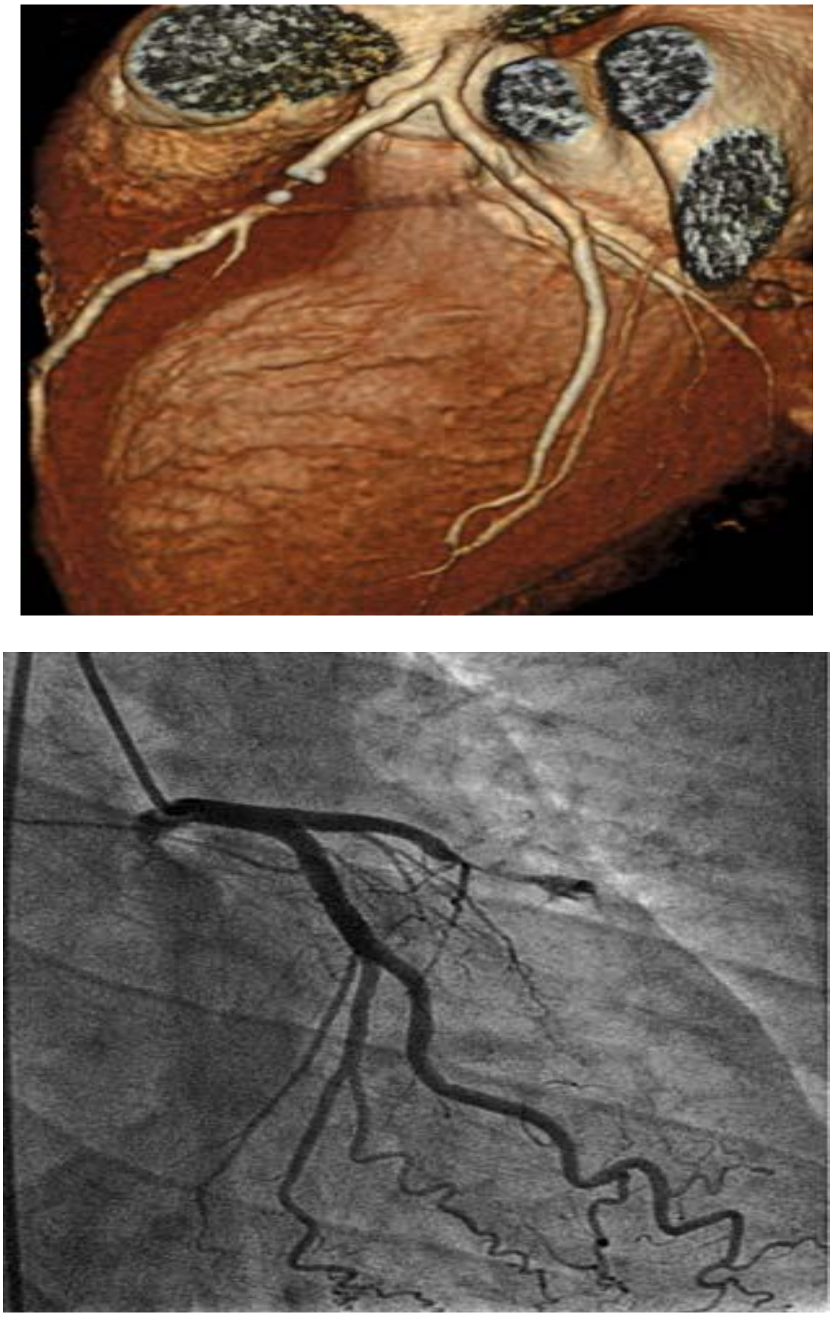


Figure 39:3D image of a case of the study shows a severe stenosis of the middle segment of the LAD due to a calcified plaque. Catheter coronary angiography confirms the diagnosis and the absence of vascular flow distal to the diseased segment.

Figure 40: Three-dimensional volume-rendering images show occlusion the LAD. The circumflex artery is hypertrophic. Catheter coronary angiography shows occlusion of the LAD and stenosis of the circumflex x artery which is not apparent in the 3-D VR image.

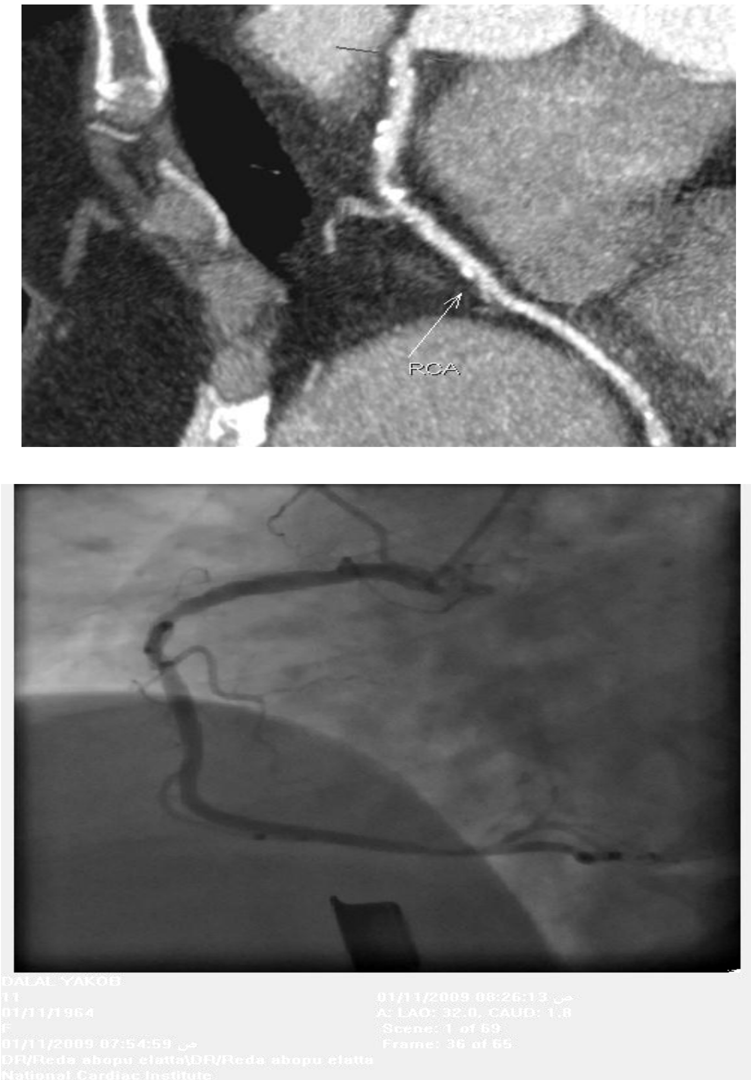


Figure 41: curved MPR of the RCA shows distal significant lesion which was confirmed by invasive CA that shows bifurcational lesion

Figure 42: MPR of RCA showed atherosclerotic average sized vessel that shows a very proximal well opacified segment followed by a totally occluded long segment (35mm), this total occlusion is caused by a non calcified plaque. The corresponding CA confirmed MSCT finding.

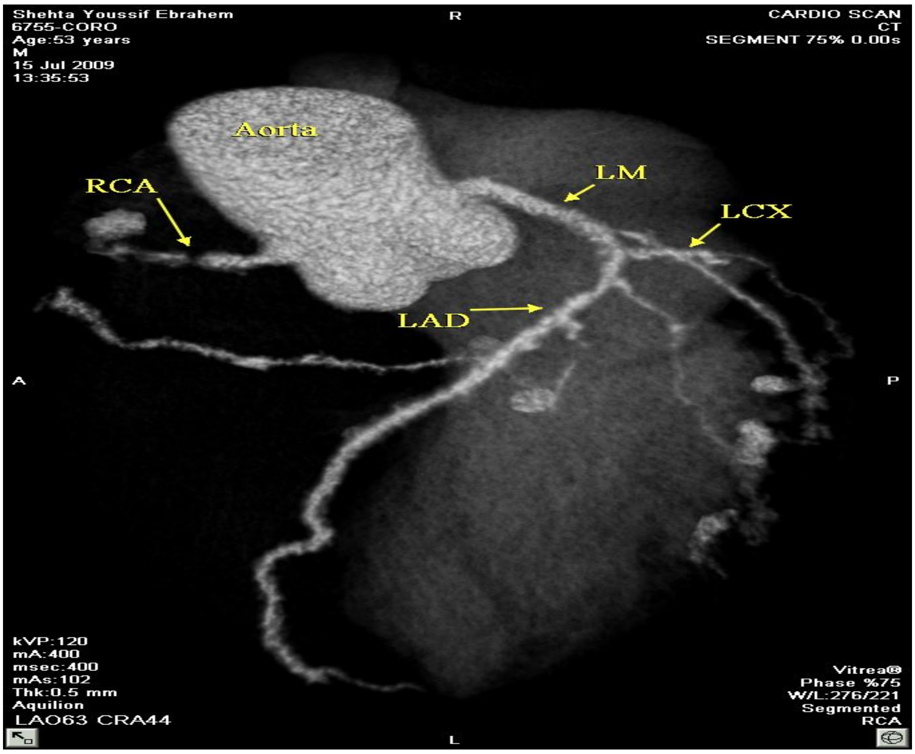
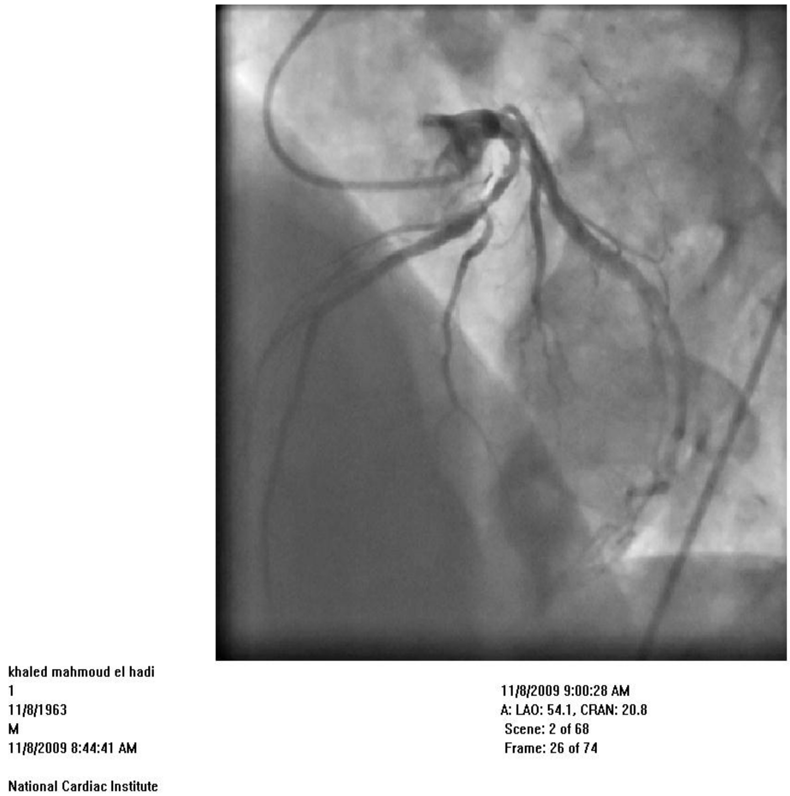


Figure 43: MIP image showing mid-segment moderate lesion of LAD and totally occluded mid to distal LC x. the corresponding CA image confirmed MSCT findings.



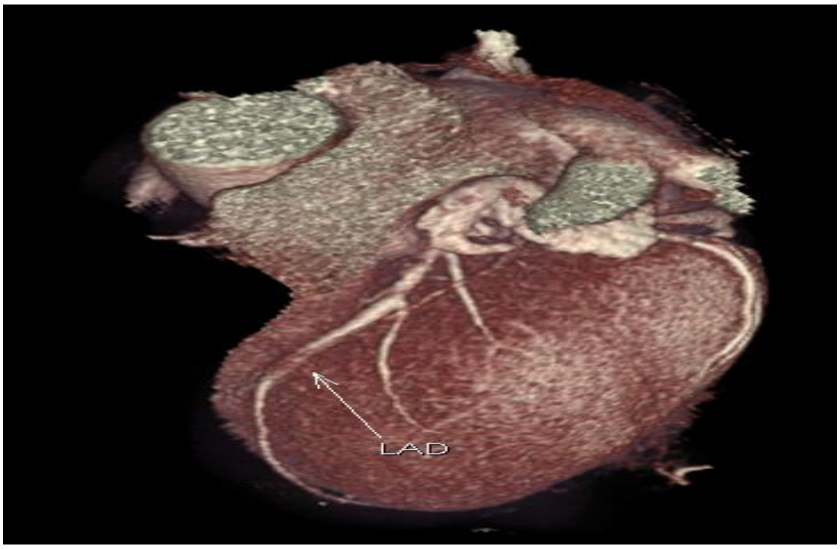


Figure 44: 3D VR image shows proximal significant lesion of the LAD which was confirmed by invasive CA image.

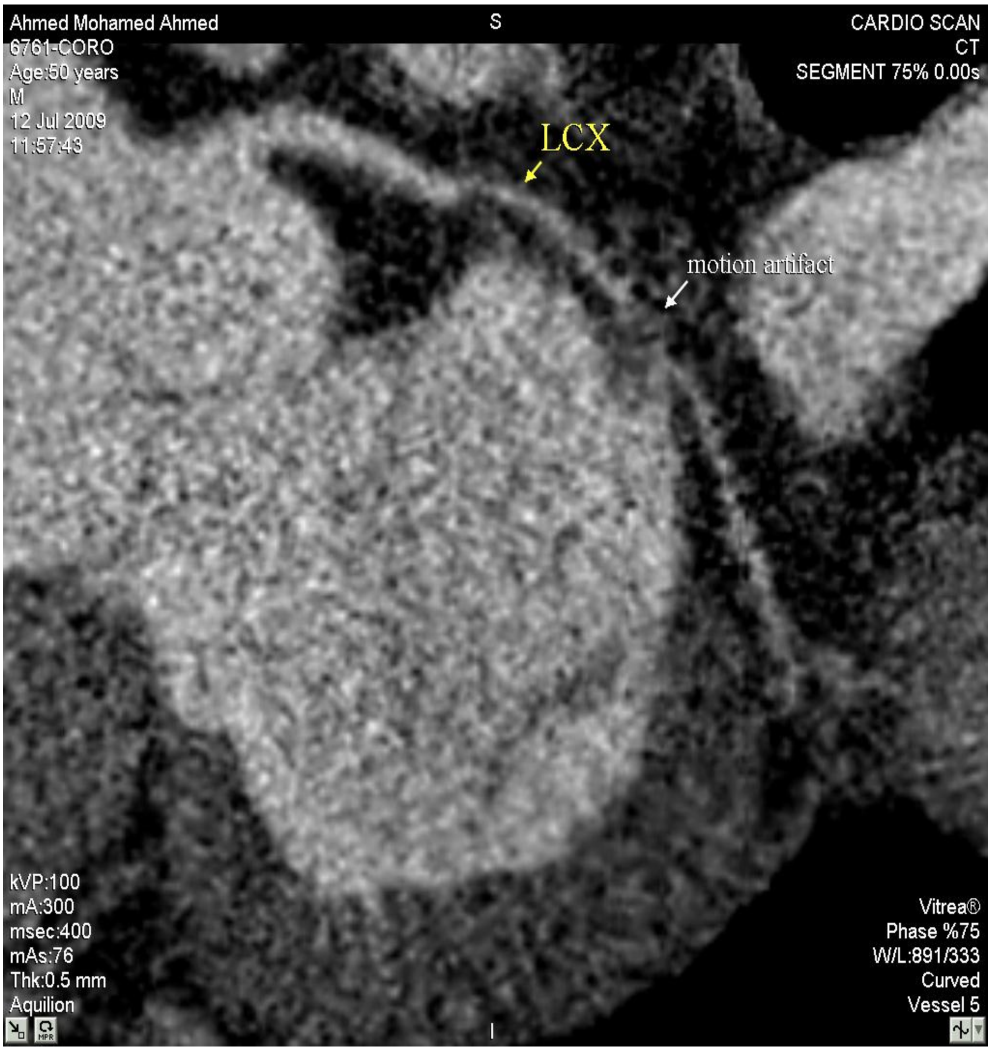


Figure 45: MPR image for a case in the study showing motion artifact in the LCx artery precluding interpretation

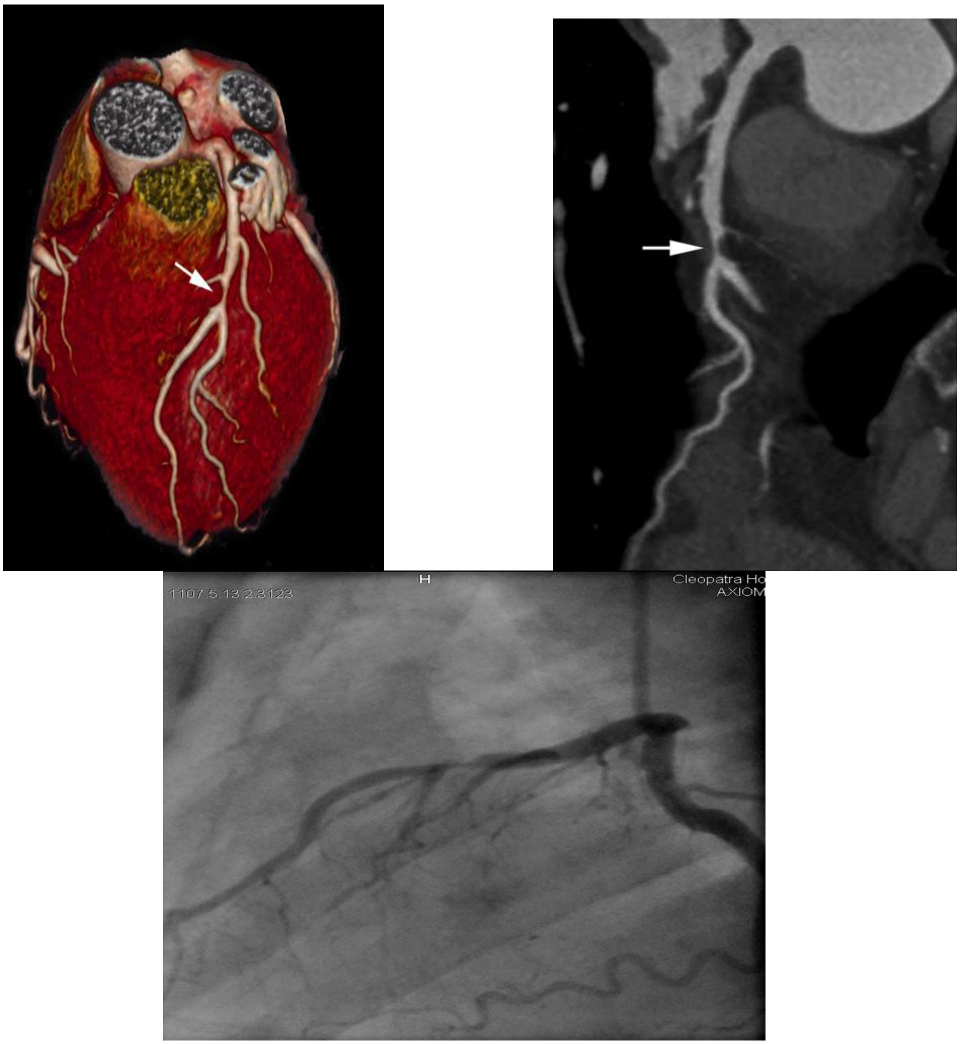


Figure 46: 3D VR and MPR images showing significant midsegment lesion of LAD and the corresponding CA.

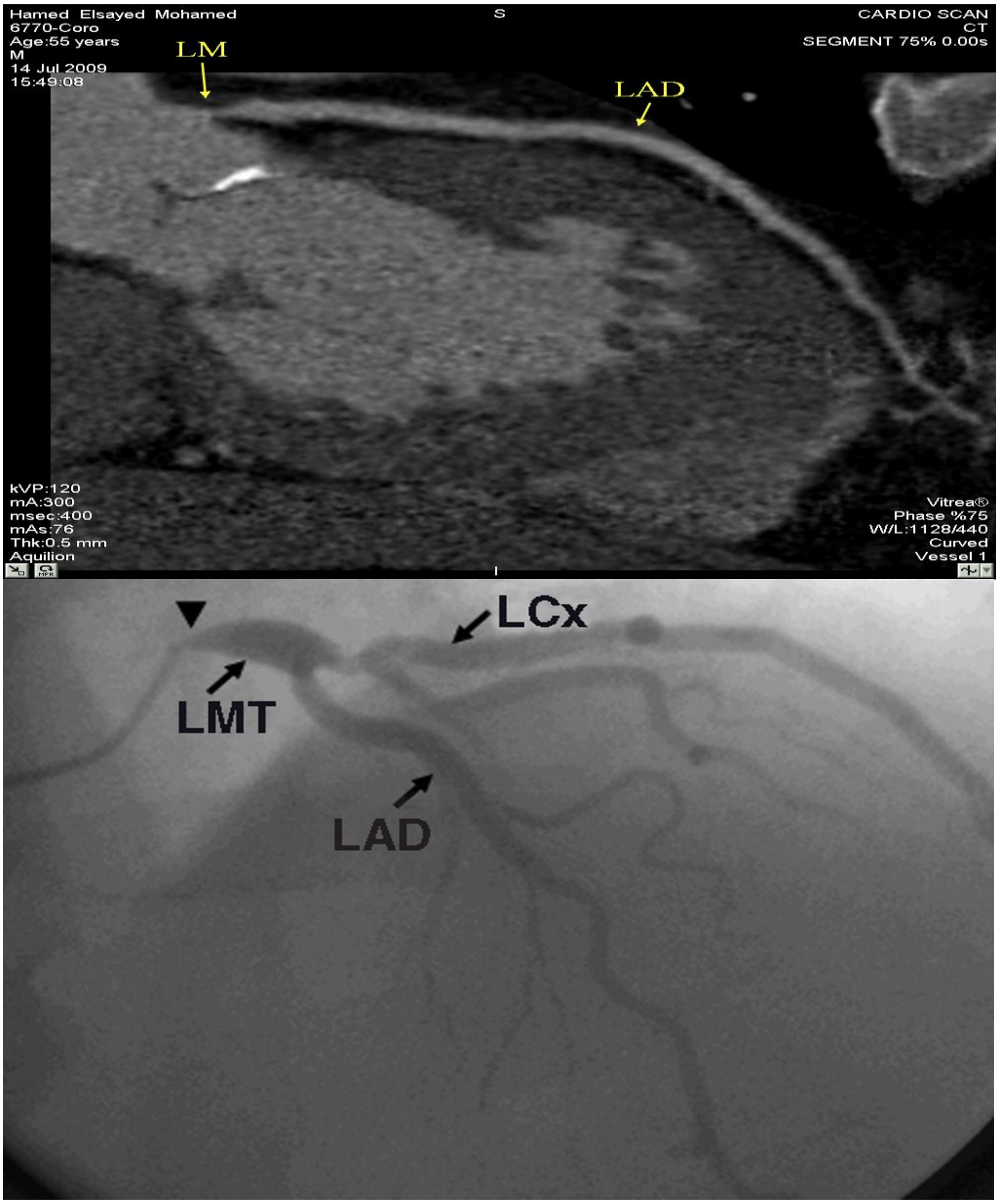


Figure 47: curved MPR image showing critical proximal LM disease which was confirmed by invasive CA

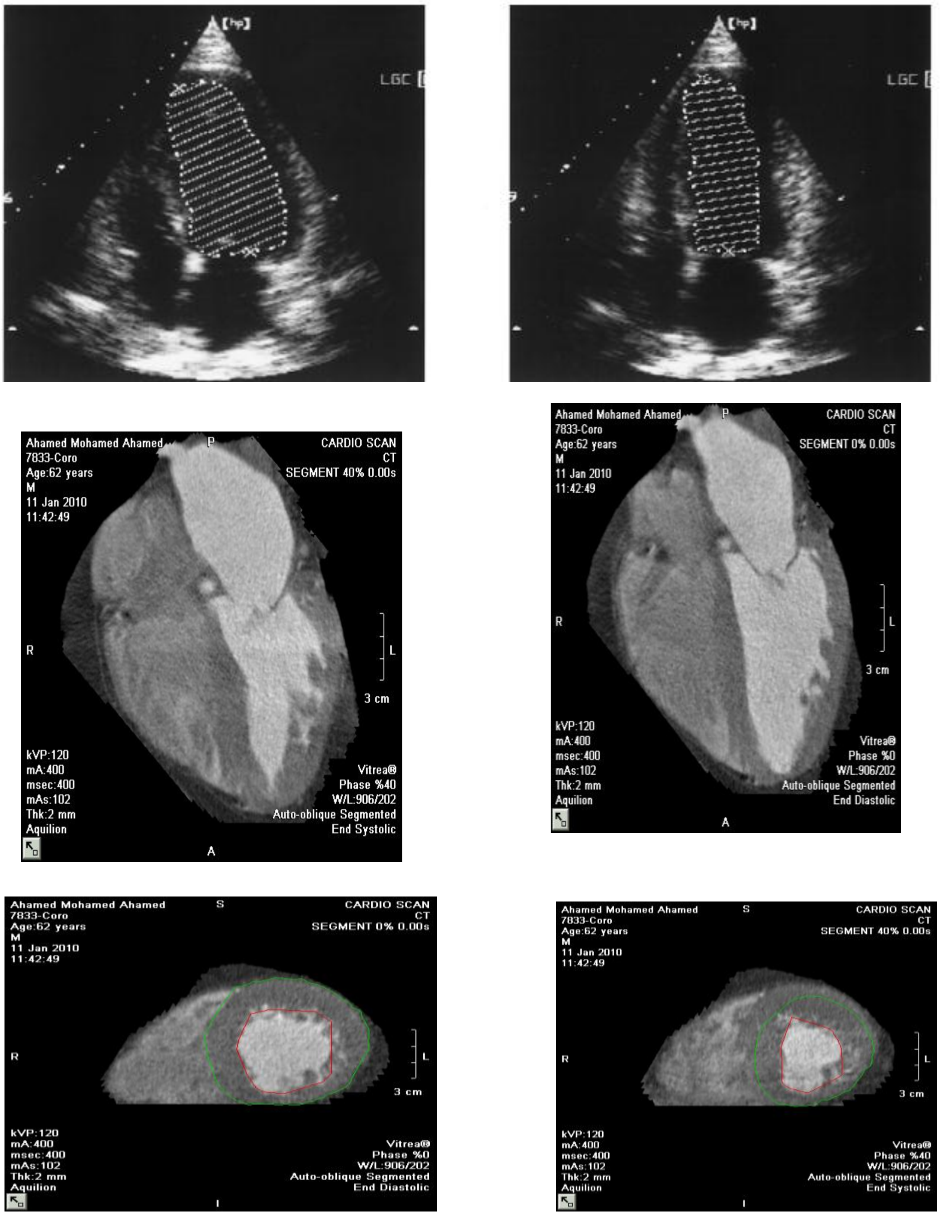


Figure48: (case No. 17) upper panel shows EF estimation by 2D Simpson's BP apical 4-chamber method. Middle and lower panels show corresponding MSCT estimation of LVEF of one case of the study. Estimated EF was 38% by MSCT and 37% by 2D echo.