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Computerized Tomography (CT) Liver Attenuation Index Versus Coronary Calcium Score as Predictors of Coronary Artery Diseases among patients examined with Coronary Computed Tomographic Angiography

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Original Article

Summary

Liver attenuation index (LAI) used as a predictor of hepatic steatosis . Several previous studies and literatures tried to correlate between steatosis and coronary artery disease, hence we aimed to evaluate validity of liver attenuation index as a predictor of coronary artery disease compared to coronary calcium score . We conducted a cross-sectional study included 100 adult patients who met the inclusion criteria and referred to the multi detector computed tomographic unit in faculty of medicine \ Kufa university \ Iraq , between July 2019 to end of January 2020 . Calcium score and LAI are measured in unenhanced study and we compared the results with the coronary computed tomographic angiographic findings. Our data analysis revealed that revealed 21 steatotic patients, 41patients with calcification was more frequent in steatotic than non-steatotic cases, 47.6% and 39.2%, respectively. Liver attenuation index showed low sensitivity (44%), fair specificity of (62%), low accuracy (58%), in prediction of significant angiographic findings. CAC score a 78% sensitivity, 89% specificity and 84% accuracy (84%). In conclusion Liver attenuation index had no significant prediction of coronary artery disease. Coronary calcium score was a good predictor of coronary artery disease. So we recommend continue using coronary calcium score in assessment of patients with coronary artery disease.

Keywords: *Coronary artery disease, steatosis, computerized tomography, coronary calcium score , liver attenuation index*

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1. INTRODUCTION

Coronary artery disease (CAD) is one of the most frequent health problem and kills many people (1,2). Multiple factors are linked to increased incidence of atherosclerotic heart diseases, these factors can be categorized as non-modifiable risk factors such as age, gender, ethnicity , genetic predisposition and family history of CAD. Modifiable risk factors contribute to CAD include hypertension, diabetes mellitus, smoking, alcohol consumption, besity/overweight, poor diet and nutrition, physical inactivity, stress, microalbuminurea and atherogenic dyslipidemia (3)

Diagnosis of Coronary Artery Disease based on clinical features, history and investigations such as Electrocardiogram, Echocardiogram (ECHO) and stress Echocardiogram, Stress Thallium Test, Coronary computed tomographic angiography (CCTA) remains the gold standard in the diagnosis of coronary artery disease, it has increasingly become a viable non-invasive alternative. Studies assessing the diagnostic performance of CCTA have typically compared its ability to detect significant coronary lesions (blockage of greater than 50%) versus lesions discovered in those same patients on subsequent invasive coronary angiography (4–8). Prediction and diagnosing CAD have a great concerns among clinicians , cardiologists as well as radiologists. Previous literatures and studies investigates the role of different tools for prediction of CAD, one of these indices is calcium score (CAC score) (9,10). Hepatic attenuation index or liver attenuation index (LAI) used as a predictor of hepatic steatosis and several previous studies and literatures tried to correlate between steatosis and CAD (11–16). Coronary artery calcium score (CAC score) is a test that measures the amount of calcium in the walls of the heart's arteries. Coronary calcium scan is one way to estimate someone's risk of developing heart disease or having a heart attack or stroke(17). Multidetector computed tomography (MDCT) angiography is a predictive tool for (CAD) (6) . Fatty liver disease comprises a spectrum of conditions (simple hepatic steatosis, steatohepatitis with inflammatory changes, and end-stage liver disease with fibrosis and cirrhosis) . Diffuse steatosis reduces liver attenuation. On non-contrast CT, moderate to severe steatosis (at least 30% fat fraction) is predicted relative hypo attenuation (liver attenuation lower than 10 HU less than that of spleen), absolute low attenuation: liver attenuation lower than 40 HU (18–20), liver-to-spleen attenuation ratio less than 1 (21) . In comparison, contrast enhanced CT is poorly predictive of steatosis. Nevertheless, some

criteria for diffuse hepatic steatosis on contrast enhanced CT have been propose (20). Liver attenuation index (LAI) is derived and defined as the difference between mean hepatic and mean splenic attenuation. The LAI greater than 5 HU correlated with macro vesicular steatosis of <5%. The LAI between -10 and 5 HU correlated well with macro vesicular steatosis in the mild-to-moderate range of 6%–30%. The LAI of less than -10 HU correctly predicted four of four donor livers with greater than 30% macro vesicular steatosis (22–24)

2. PATIENTS and METHODS

A cross sectional study conducted at multi detector CT unit in Faculty of Medicine \ Kufa university during the period from July 2019 to end of January 2020. A total of 120 adult Iraqi patients with chest pain and clinical criteria of CAD undergoing CAC score and coronary CT angiography were included. Patient with any absolute or relative contraindication to CCTA, performed special interventional cardiac procedures , alcoholic or with chronic liver diseases were excluded from the study, however, twenty patients were excluded

Data were collected using a pre constructed data collecting sheet, included demographic and clinical variables

Calcium score was measured as the total and detailed measurements including the major 3 vessels : 1. Right coronary artery (RCA) , 2.Left anterior descending artery (LADA) and 3.Left circumflex artery(LCXA).

The total Agatston score (AS) was calculated by summation of every calcific focus in all above mentioned coronary arteries .

According to CAC score that based on first Rumberger guidelines they were sub grouped as following : no calcium (0 CAC score) and with calcium (≥ 1)

After assessment of patients with CTCA , the following findings were searched for : 1.normal 2. Non-significant stenosis (less than 50 %) in each one of the three vessels and 3.significant stenosis (more than 50 %) in each one of three vessels and according to these findings , the patients were categorized into :

1. Patients with CAD , including both with significant stenosis (more than 50 %) and non-significant (less than 50 % stenosis) .
2. Patients with negative findings assigned as Non CAD patients .

Liver attenuation index (LAI) was estimated by measuring density of visualized parts of liver and spleen by measuring at least 5 region of interest and then mean value was considered as hepatic or splenic density and then calculated according to equation of :

LAI = mean density of liver in Hounsfield unit (HU) –mean density of spleen in (HU) The examinations were done at spiral CT unit in faculity of medicine \ Kufa university by Siemens computed tomography (Somatom definition edge -256 slice) which is made in Germany. Section thickness of 0.625 mm was obtained with Gantry rotation of 350–500 msec) .

Data were entered and analyzed using the statistical package for social sciences (SPSS) version 25. Appropriate statistical tests and procedures were applied accordingly at a level of significance (P value) of less than or equal to 0.05 considered significant .

3. RESULTS

Among the studied group, 21(21%) were steatotic and the remaining 79 were not , on the other hand, calcification (calcium score ≥ 1) was reported in 41 cases (41%) while 59 (59%) of the cases had no calcification, (Table 1).

Ten steatotic patients (47.6%) and 31 non-steatotic patients (39.2%) had calcification, indicated more frequent calcification in steatotic cases , however, the difference did not reach the statistical significance , (P. value > 0.05), (Table 2)

Furthermore, the distribution of angiographic findings across the steatosis status revealed no statistical significant differences in the distribution of angiographic findings among steatotic and non-steatotic cases, (P. value > 0.05), moreover, the validity of Liver attenuation index in prediction of significant angiographic findings revealed low sensitivity (44%), fair specificity of (62%), low accuracy (58%), poor positive predictive value (PPV) (23%) and good negative predictive value (NPV) (80%). In prediction of insignificant angiographic findings, steatosis had low sensitivity (36%), fair specificity and accuracy of (66%) and (60%), respectively, while poor PPV (21%), and good NPV (80%). When the validity assessed using total abnormal angiographic findings (significant and insignificant) as one group vs. normal findings, the validity was not much different, but a relative increase in the sensitivity (63%) , specificity was 48%, accuracy 51%, PPV was 22% and NPV was 85%, (Table 3).

Regarding the relationship between calcification and angiographic findings (Figure 3), it had been significantly found that significant angiographic findings were more frequent , 23/41 (56.1%) , among cases with calcification compared to only 7/59 (11.9%) of those with no calcification , also insignificant findings were more frequent in this subgroup than those with no calcification, (P = 0.001). From other point of view, CAC score had good sensitivity (78%), specificity (89%), and accuracy (84%), PPV (83%) and NPV (85%), in prediction of significant angiographic findings, lower validity parameters were reported in prediction of insignificant findings or total abnormal findings, (Table 4).

Further analysis was performed using Z statistics to compare the validity of Liver attenuation index vs. CAC score in prediction of angiographic findings, this analysis revealed that calcification had significantly higher validity parameters in prediction of significant and insignificant angiographic findings, however, the difference in specificity accuracy and NPV of prediction of insignificant findings were statistically insignificant , (P>0.05) , (Table 5).

No significant association between history of hypertension and Steatosis was found (P>0.05). Conversely, hypertension was significantly associated with the presence of calcification (P. value = 0.008) and Significant angiographic findings (P. value = 0.014) , where calcification was more frequent among hypertensive patients, (58.3%) compared to 31.3% among non-hypertensive. Abnormal angiographic findings was significantly more frequent in hypertensive patients compared to non-hypertensive, insignificant stenosis found in 38.9% of hypertensive and 15.6% of non-hypertensive. Significant stenosis found in 47.2% compared to 20.3% among hypertensive and non-hypertensive, respectively, (P. value = 0.001), (Table 6).

The relationship between Diabetes mellitus was significant with Steatosis , calcification and abnormal angiographic findings, in all comparison, (P. value<0.05), (Table 7). Similarly, Hyperlipidemia was significantly associated with each of Steatosis , calcification and abnormal angiographic findings, in all comparison, (P. value<0.05), (Table 8).

Steatosis was more frequent in smokers (35.7%) compared to non-smokers (18.6%), however, the difference did not reach the statistical significance, (P>0.05). Calcification was significantly more frequent among smokers, (69.6%) compared to 32.5% among none

smokers, (P. value = 0.027), indicated a significant association . Another significant association was found between smoking and abnormal angiographic findings where these findings were more frequent among smoker, compared to non-smoker, , (P. value = 0.006), (Table 9).

As it shown in (Table 10), obese patients were more likely to be steatotic than non-obese, where 53.1% of obese were steatotic compared to only 5.9% among non-obese (P. value = 0.001). Additionally, calcification and abnormal angiographic findings were significantly associated with obesity, (P<0.05).

Table 1. Distribution of Steatosis and Calcification of the studied group

Variable		No.	%
Steatosis	Yes	21	21.0
	No	79	79.0
Calcification Calcium score ≥ 1	Yes	41	41.0
	No	59	59.0

Table 2 Distribution of calcification among steatotic and non-steatotic patients

Calcification	Steatotic		Non Steatotic	
	No.	%	No.	%
Yes	10	47.6	31	39.2
No	11	52.4	48	60.8
Total	21	100.0	79	100.0
P. value; 0.488 not significant				

Table 3. Distribution of angiographic findings among steatotic and non-steatotic patients and the validity of LAI in prediction of angiographic findings

Angiographic finding	Steatotic		Non Steatotic	
	No.	%	No.	%
Normal*	9	42.9	37	46.8
Insignificant	5	23.8	19	24.1
Significant	**7**	33.3	**23**	29.1
Total	**21**	100	**79**	100
Validity parameter	**Angiographic finding**			
	Significant	**Insignificant**	**Abnormal**	
SENSITIVITY	44.0%	36.0%	63%	
Specificity	62.0%	66.0%	48%	
Accuracy	58.0%	60.0%	51%	
PPV	23.0%	21.0%	22%	
NPV	80.0%	80.0%	85%	

*normal subgroup used as reference group,
P. value > 0.05,not significant,
PPV: positive predictive value, NPV: negative predictive value, Abnormal: abnormal angiographic findings (significant and insignificant)

Table 4. Distribution of angiographic findings among patients with and without calcification and the validity of calcification in prediction of angiographic findings

Angiographic finding	Calcification		No Calcification	
	No.	%	No.	%
Normal	7	17.1	39	66.1
Insignificant	11	26.8	13	22.0
Significant	23	56.1	7	11.9
Total	41	100.0	59	100.0
Validity parameter	**Angiographic finding**			
	Significant	**Insignificant**	**Abnormal**	
Sensitivity	78%	56%	83%	
Specificity	89%	72%	66%	
Accuracy	84%	69%	73%	
PPV	83%	38%	63%	
NPV	85%	85%	85%	

*normal subgroup used as reference group,
P. value < 0.05 significant,
PPV: positive predictive value, NPV: negative predictive value, Abnormal: abnormal angiographic findings (significant and insignificant)

Table 5. Comparison of validity parameters of Steatosis and Calcification in prediction of significant , insignificant and abnormal angiographic findings

INDEX	Validity parameter	Angiographic finding		
		Significant	Insignificant	Abnormal
Steatosis	Sensitivity	44%	36%	63%
	Specificity	62%	66%	48%
	Accuracy	58%	60%	51%
	PPV	23%	21%	22%
	NPV	80%	80%	85%
Calcification	Sensitivity	78%	56%	83%
	Specificity	89%	72%	66%
	Accuracy	84%	69%	73%
	PPV	83%	38%	63%
	NPV	85%	85%	85%
P. values				
P1 (compare sensitivity)		0.001 sig	0.007 sig	0.002 sig
P2 (compare Specificity)		0.001 sig	0.445 ns	0.015 sig
P3 (compare Accuracy)		0.001 sig	0.237 ns	0.002 sig
P4 (compare PPV)		0.001 sig	0.013 sig	0.001 sig
P5 (compare NPV)		0.457 ns	0.457 ns	0.843 ns

sig: significant, ns: not significant, z test used to compare rates

Table 6. Relationship of hypertension with Steatosis , Calcification and Angiographic findings of the studied group

Parameter		Hypertension				P. value
		Yes		No		
		No.	%	No.	%	
Steatosis (n=21)	Steatotic	5	13.9	16	25.0	0.190 ns
	Non Steatotic	31	86.1	48	75.0	
Calcification (n=41)	Yes	21	58.3	20	31.3	0.008 sig
	No	15	41.7	44	68.8	
Angiographic finding	Normal	5	13.9	41	64.1	0.001 sig
	Insignificant	14	38.9	10	15.6	
	Significant	17	47.2	13	20.3	

Table 7. Relationship of Diabetes with Steatosis , Calcification and Angiographic findings of the studied group

Parameter		Diabetes				P. value
		Yes		No		
		No.	%	No.	%	
Steatosis	Steatotic	12	44.4	9	12.3	0.001 sig
	Non Steatotic	15	55.6	64	87.7	
Calcification	Yes	17	63.0	24	32.9	0.012 sig
	No	10	37.0	49	67.1	
Angiographic finding	Normal	4	14.8	42	57.5	0.001 sig
	Insignificant	11	40.7	13	17.8	
	Significant	12	44.4	18	24.7	

Table 8. Relationship of Hyperlipidemia with Steatosis , Calcification and Angiographic findings of the studied group

		Hyperlipidemia				P. value
		Yes		No		
		No.	%	No.	%	
Steatosis	Steatotic	9	39.1	12	15.6	0.032 sig
	Non Steatotic	14	60.9	65	84.4	
	Total	23	100.0	77	100.0	
Calcification	Yes	16	69.6	25	32.5	0.033 sig
	No	7	30.4	52	67.5	
	Total	23	100.0	77	100.0	
Angiographic finding	Normal	4	17.4%	42	54.5%	0.007 sig
	Insignificant	8	34.8%	16	20.8%	
	Significant	11	47.8%	19	24.7%	
	Total	23	100.0	77	100.0	

Table 9. Relationship of Smoking with Steatosis , Calcification and Angiographic findings of the studied group

		Smoking				P. value
		Yes		No		
		No.	%	No.	%	
Steatosis	Steatotic	5	35.7	16	18.6	0.145 ns
	Non Steatotic	9	64.3	70	81.4	
Calcification	Yes	10	71.4	31	36.0	0.027 sig
	No	4	28.6	55	64.0	
Angiographic finding	Normal	1	7.1	45	52.3	0.006 sig
	Insignificant	5	35.7	19	22.1	
	Significant	8	57.1	22	25.6	

Table 10. Relationship of Obesity with Steatosis , Calcification and Angiographic findings of the studied group

Parameter		Obesity				P. value
		Obese		Non-obese		
		No.	%	No.	%	
Steatosis	Steatotic	17	53.1	4	5.9	0.001 sig
	Non Steatotic	15	46.9	64	94.1	
Calcification	Yes	19	59.4	22	32.4	0.019 sig
	No	13	40.6	46	67.6	
Angiographic finding	Normal	7	21.8	39	57.4	0.004 sig
	Insignificant	11	34.4	13	19.1	
	Significant	14	43.8	16	23.5	

4. DISCUSSION

The present study assessed the value of LAI in prediction of CAD among group of Iraqi patients who performed CCTA. Liver attenuation index validity was assessed against the angiographic findings and further compared to CAC score . Among the studied group, (21%) were steatotic while calcification (calcium score ≥ 1) was reported in 41 cases . The distribution of calcification across steatosis, revealed that 10 steatotic patients (47.6%) ,31 non-steatotic cases (39.2%) had calcification, which indicated more frequent calcification in steatotic cases , however, the difference did not reach the statistical significance , (P. value > 0.05). Furthermore, the distribution of angiographic findings across the steatosis status revealed no statistical significant differences in the distribution of angiographic findings among steatotic and non-steatotic cases, (P. value > 0.05), moreover, the validity of steatosis index in prediction of significant angiographic findings revealed low sensitivity (44%), fair specificity of (62%), low accuracy (58%), poor PPV (23%) and good NPV (80%). In prediction of insignificant angiographic findings, steatosis had low sensitivity (36%), fair specificity and accuracy of (66%) and (60%), respectively, while poor PPV (21%), and good NPV (80%). When the validity assessed using total abnormal angiographic

findings (significant and insignificant) as one group vs. normal findings, the validity was not much different, but a relative increase in the sensitivity (63%) , specificity was 48%, accuracy 51%, PPV was 22% and NPV was 85%. The current study found that calcification had significantly higher validity parameters in prediction of significant and insignificant angiographic findings, however, the difference in specificity accuracy and NPV of prediction of insignificant findings were statistically insignificant , (P>0.05). The following studies are consistent with our study as Perry. et al said that steatosis was a biomarker for subsequent CAD but not an independent risk factor (25) . A previous study concluded that NAFLD is less likely to be a direct mediator of subclinical CAD and instead of that may be regarded as (Epiphenomena) (26) . Kathleen Jacobe and Shron Brouha found no obvious correlation between CAD and steatosis .and the visceral adiposity can be used as a risk factor for coronary heart disease (27). Nazim Ghouri , David Preiss et al who found that they conclude that a diagnosis of steatosis (or elevated liver enzymes) is insufficient to warrant labeling patients as being at high risk for CAD. And conversely , the evidence of NAFLD should be an indication for screening for DM . The evidence for CAD risk screening based on the presence of hepatic steatosis is weaker and they recommend that assessment of risks is determined according to measurement of established risk factors using existing charts (28) .Rashmee Patil and Gagan K howed that steatotic patients may get benefit from more careful surveillance and early management . But, despite evidence linking increased CAD risk with NAFLD, there is still uncertainty about the prognostic role of hepatic steatosis in risk stratification for CAD ad suggest Additional, follow-up studies are advised to assess if steatosis can be added as risk scoring predictor . And Furthermore, the question is whether there is a prognostic value of steatosis in the development and progression of CAD (29). P. Loria and A. Lonardo et al also agreed that there is a relationship between steatosis and CAD clinically and epidemiologically but further studies need to be done to confirm that significantly (30) . Cadematiri & Sverzellati et al found in a study done at 2016 that there is no standardized approach to measure liver fatty tissues in computed tomography because there are many parameters and different strategies that may affect quantifications (31) . Wai-Sun Wong & Wong et al conclude that steatosis cannot predict mortality and morbidity in patients with established coronary artery disease (32) . Tantawy & Ali et al. said that there is significant association between

hepatic steatosis & atherosclerosis (insignificant CAD) but no significant correlation between NAFLD and significant CAD , so they suggest that NAFLD may be used as a predictor for insignificant CAD not for significant one (16) .Targher & Arcaro et al in previous study also agreed that NAFLD patients may developed subclinical CAD when compared with Non steatotic one (33). Rajiv Chabra and O'Keefe (in study done at 2013) correlated between steatosis as an independent risk factor for increasing CAC score but agree that steatosis as an independent predictor for CAD need to be further studied (34) . Ling, SUN; Shu-zheng , LÜ in a previous cross sectional study. also suggested that steatosis is associated with coronary heart disease , in addition to the known risk factors, but they could not assure that NAFLD is an independent risk factor or epiphenomenon of CAD (35) .

Conversely the following studies disagree with our study in different points as following : Mustafa Koplay & Mustafa Gok et al found in study done at 2019 Using MRI ,CT and ultrasonography that NAFLD as part of metabolic syndromes is associated with increased risk of CAD and it might be not only a marker but also an early mediator for coronary heart disease (36). Dae Hee Choi, Sung Joon Lee et al in a study done in Korea at 2013 suggested that cases of CAD proved by CCTA is strongly correlated with steatosis (by ultrasonography) , and NAFLD is a significant predictor of coronary heart disease (37) . Mary F.Feitosa and Alexander P.Reiner et al (in study done at 2013) said that they found hepatic steatosis is a predictor of CAD independent on other risk factors . The study was done using CT and ALT level (38) . Donghee Kim & Su Yeon Choi et al. found that patients with NAFLD will show increased risk of coronary artery disease . A group of patients with steatosis shows increase in CAC score more than 100 . Additionally NAFLD might be regarded as an independent risk factor for CAD (39) . Wolff & Daniel Bos et al (study at 2016) also found that high amount of steatosis is related to larger volumes of epicardial fat and CAC score independent of CAD risk factors providing an promising novel about role of liver as a marker of vascular disease (40) .

We can explain this discrepancy in that different tools are used to evaluate the amount of fatty steatosis including ultrasonography , MRI, CT and biochemical markers , different cut off points for the definition of steatosis , a relatively small sample of general population taken in our study with short period in comparison with large sample and long period of

other studies and some studies choose a selected patients with steatosis.

From other point of view, in the present study, steatosis and Calcification were more frequent in smokers compared to non-smokers. Additionally, smoking was significantly associated with abnormal angiography findings. Hyperlipidemia also as another risk factor for CAD was found in 23 % of the studied sample in this study which was lower than expected among Iraqi population (41) , while it approximate the prevalence recorded in neighbor countries according to the same study (10-23 %) .

Hyperlipidemia was significantly associated with each of steatosis , calcification and abnormal angiographic findings. The relationship between Diabetes mellitus was significant with steatosis , calcification and abnormal angiographic findings. No significant association between history of hypertension and Steatosis. Conversely, hypertension was significantly associated with the presence of calcification and Significant angiographic findings . Abnormal angiographic findings was significantly more frequent in hypertensive patients compared to non-hypertensive, insignificant stenosis. Our findings regarding the demographic factors agreed many previous studies (42-50)

Regarding the descriptive statistics of the studied parameters ; CAC score showed a wide range of variation (0-2286) with a mean of 121 , this variation attributed to degree of calcification particularly the angiographic findings revealed that 30% patients were found to have significant stenosis that attributed to plaque formation and calcification of arteries . Regarding the relationship between calcification and angiographic findings, it had been significantly found that significant angiographic findings were more frequent , 23/41 (56.1%) , among cases with calcification compared to only 7/59 (11.9%) of those with no calcification , also insignificant findings were more frequent in this subgroup than those with no calcification, (P = 0.001). From other point of view, CAC score had good sensitivity (78%), specificity (89%), and accuracy (84%), PPV (83%) and NPV (85%), in prediction of significant angiographic findings, lower validity parameters were reported in prediction of insignificant findings or total abnormal findings. The following studies are found to be consistent with our study as following : Shabestari et al. who agree that CAC score is accepted as a standard reference for detection of risk of subsequent heart attacks (51) K.N.Zhuravlev & V.E.Sinitsyn et al. who found that CAC score should be regarded as a strong screening method for CAD (52) . Mark .J.Pletcher and Jeffrey A.Tice et al in

addition to Geluk & Dikkers who found in a previous studies that CAC score is an independent predictor for coronary heart problems (53) and is a suitable initial noninvasive procedure in asymptomatic patients . S.Leschka & H.Scheffel et al who said that combination of CAC score & CCTA with increase the specificity without affecting the sensitivity of diagnosing CAD (54). Christopher Herzog and Martina Britten et al said that Calcium scoring as asingle method showed highest sensitivity in the detection of coronary atherosclerosis ,and combination with MD CTA helped to distinctly increase specificity and NPV (55) . George T. Lau, Lloyd J. Ridley et al agreed that A calcium score can be used to potentially identify patients with significant coronary stenoses not detected at CT angiography (56) .

Maeda & Yamamoto et al found in study done in Japan in 2016 agreed that both measures are also significantly correlated as a predictor and diagnostic measures respectively (57) . Kazuhiro Osawa and Toru Miyoshi et al found that, the prevalence of DM in patients with NAFLD was significantly higher than that in patients who did not have NAFLD (58) . The liver attenuation index in the prevalent study ranged from (-10)-(33) and according to standard cut points of steatosis which was in our study depending on absolute low attenuation: liver attenuation lower than 40 HU (20, 59) , liver-to-spleen attenuation ratio less than 1 (21, 60)

5. CONCLUSIONS

Liver attenuation index had no significant prediction of coronary artery disease. Coronary calcium score was a good predictor of coronary artery disease. So we recommend continue using coronary calcium score in assessment of patients with coronary artery disease.

Ethical Clearance: Ethical clearance and approval of the study are ascertained by the authors. All ethical issues and data collection were in accordance with the World Medical Association Declaration of Helsinki 2013 for ethical principles for medical research involving human subjects. Data and privacy of patients were kept confidentially.

Conflict of interest: Authors declared none

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