ORIGINAL ARTICLE

Association of Coronary Atheroma Volume Evaluated by Intravascular Ultrasound and Serum Lipoprotein (a) Levels

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Abstract

Background: ***There are 18 million fatalities a year due to cardiovascular disease, making it the top cause of death globally. Coronary artery disease (CAD) risk factors include dyslipidemia, which is clearly one of the most important ones.***

Aim and objectives: ***To assess plaque burden and cardiovascular risk in relation to the level of lipoprotein (a) (Lp (a)).***

Subjects and methods: ***The purpose of this cross-sectional study was to evaluate the plaque burden in 56 patients who underwent coronary angiography (CA) and intravascular ultrasonography at the National Heart Institute's Cardiology Department between October 2022 and June 2023. They were divided into two categories based on lipoprotein (a) levels: Patients in Group A (n=22) had lipoprotein levels of 60 mg/dl or higher; patients in Group B (n=34) had lipoprotein levels of 60 mg/dl or lower.***

Results: ***Group A had significantly higher mean values of serum TG, LDL, cholesterol, and uric acid compared to group B (p=0.04, 0.07, 0.018, and 0.032, respectively). With R-values of 0.439, 0.311, 0.418, 0.347, and 0.325, respectively, the levels of intravascular ultrasound (IVUS), serum cholesterol, serum TG, LDL, and serum uric acid were positively correlated with the percentage of atheroma volume (PAV) as measured by intravascular ultrasound (IVUS).***

Conclusion: ***Elevated Lp (a) correlates with greater coronary atheroma volume. High blood Lp(a) levels are linked to negative consequences.***

Keywords: Coronary atheroma; Intravascular ultrasound; Serum lipoprotein

1. Introduction

An extra-large glycoprotein known as apolipoprotein (a) is structurally entangled with lipoprotein (a) (Lp (a)), making it a strange variety of low-density lipoprotein.[1]

More and more research is connecting higher levels of Lp (a) to an increased risk of cardiovascular disease.[2]

Considered proatherogenic, proinflammatory, and maybe anti-fibrinolytic, Lp (a) is primarily determined by the LP (a) gene.[3]

An independent connection between Lp (a) and risk for cardiovascular disease and death has been demonstrated by epidemiological and clinical research in both primary and secondary preventive groups.[4]

Regardless of these links, there are still disagreements and gaps in our understanding of Lp (a)'s utility as a predictive biomarker because there are no universally accepted tests.[5]

One of the most promising new imaging modalities for evaluating the arterial wall is intravascular ultrasound (IVUS). This technology allows for detailed imaging of the coronary artery wall and the accurate measurement of the disease burden caused by atherosclerosis.[6,7,8]

The researchers set out to determine the relationship between Lp levels and plaque burden as well as cardiovascular risk (a).

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2. Patients and methods

From October 2022 through June 2023, 56 patients referred for coronary angiography (CA) and intravascular ultrasonography to evaluate plaque burden were included in this cross-sectional study at the National Heart Institute's Cardiology Department. Based on their lipoprotein levels, they were divided into two categories: Patients in Group A (n=22) had lipoprotein levels of 60 mg/dl or higher; patients in Group B (n=34) had lipoprotein levels of 60 mg/dl or lower.

Inclusion criteria:

Age more than 18 years, both sexes, elective coronary angiography, and patients who planned for IVUS assessment of lesions discovered in elective CA.

Exclusion criteria:

Previous revascularization, and lesions discovered in coronary angiography, with more than 70% or less than 50% stenosis, and more than 30mm length.

Methods:

All cases have been exposed to the following:

History taking and demographic data collection: age, family history, gender, smoking status, body mass index(BMI), and medical history include hypertension(HTN), diabetes mellitus(DM), renal impairment, previous history of coronary artery illness, and medical treatment and any significant history of dye allergy.

General and Physical Examination: with special emphasis on heart rate(HR), diastolic, and systolic blood pressure.

Laboratory investigations: complete blood count(CBC) (Hemoglobin (Hb)), lipoprotein(a) levels using enzyme-linked immune assay test(ELISA), serum uric acid, kidney function test(serum creatinine), and total lipid profile(total cholesterol, low-density lipoprotein(LDL), high-density lipoprotein(HDL), serum cholesterol, and serum TG).

Electrocardiography(ECG): ECG has been performed for all cases on a routine basis, with a particular focus on ischemic alterations. The electrocardiogram(ECG) has been examined and

evaluated in the following manner: ST-segment depression has been measured at eighty milliseconds post-J point; meanwhile, twenty milliseconds after the J point, ST-segment elevation was measured. The isoelectric line, or baseline, was the prior TP segment. To be considered significant, an ST-segment shift of 0.05 mV or more and a T-wave inversion of greater than 0.1 mV were required.

Transthoracic echocardiography(TTE): TTE has been performed as a standard procedure for all cases based on American Society of Echocardiography(ASE) guidelines using the Siemens Acuson X300 echocardiography machine and 8V3 transducer, with particular focus on assessing left ventricular dimensions, ejection fraction estimated by M-mode, and wall motion score index(WMSI). The WMSI was determined by adding the scores of each individual segment and then dividing this sum by the number of segments that were evaluated.

Angiographic analysis: The SYNTAX Score is a grading measure that assesses the complexity of coronary artery disease by adding points to each lesion with over 50% narrowing in vessels with a diameter greater than 1.5 millimeters. In each case, an interventional operator identifies a specific blood artery without previous revascularization or over 70% narrowing in a segment of at least 30 millimeters.

Intravascular ultrasound(IVUS): In order to determine the percent atheroma volume (PAV), IVUS has been conducted on every single case. The following equation was used to calculate PAV: By dividing the lumen's cross-sectional area by the external elastic membrane's (EEM) area, the formula PAV determines the percentage difference. The lumen area is subtracted from the EEM area, the total of the EEM areas is divided by the result, and then 100 is multiplied.

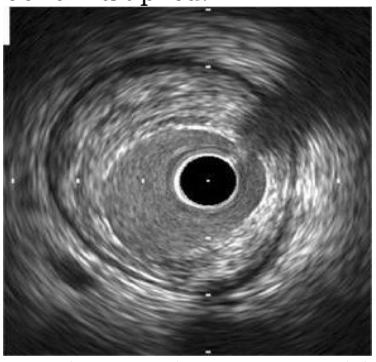

Figure 1. Atheroma in group A with PAV=75% measured by IVUS.

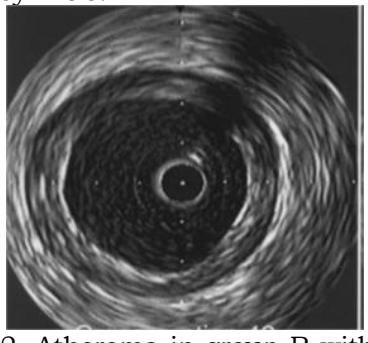

Figure 2. Atheroma in group B with PAV=45% measured by IVUS.

The primary endpoint:

Obtaining a baseline PAV volume with IVUS. The following equation was used to determine PAV:

PAV∑(EEM area−Lumen area) / ∑EEM area/100.

The external elastic membrane (EEM) area and the lumen area are both measured in cross-sectional units.[9]

Ethical considerations:

Approval was obtained for performing the study from the National Heart Institute(NHI). Ethical committee in the Faculty of Medicine. Informed consent was obtained from each participant.

Statistical analysis:

The data that was recorded were examined with the use of SPSS Inc.'s statistical software for the social sciences, version 23.0. For parametric (normal) quantitative data, the standard deviation and ranges were used to represent the data, whereas for non-parametric (non-normally distributed) variables, the median with inter-quartile range (IQR) was used. Quantitative variables were also shown as percentages and figures. Using the Shapiro-Wilk and Kolmogorov-Smirnov tests, we looked for normality in the data.

A battery of tests was conducted:

When we compared two means, we utilized the independent-samples t-test for significance. If the predicted count in any cell was less than 5, then Fisher's exact test was used instead of the Chi-square test for group comparisons utilizing qualitative data. The level of relationship between two sets of variables was evaluated using Pearson's correlation coefficient (r) test. When one increases the independent variable, the dependent variable also increases; this relationship is positive. The dependent variable decreases as the independent variable increases, which is a negative relationship. The pattern of the dots that come from plotting the values of two variables along two axes reveals the presence of correlation in a scatter plot. The margin of error accepted was set at 5%, while the confidence interval was set to 95%. This led to the conclusion that the p-value was statistically significant:

P-value (probability): If the p-value was less than 0.05, it was deemed significant; if it was less than 0.001, it was deemed very significant; and if it was greater than 0.05, it was deemed inconsequential.

3. Results

Table 1. Comparison of the clinical histories of the two groups.

CLINICAL HISTORY	GROUP-A (N=22)	GROUP-B (N=34)	TOTAL (N=56)	TEST VALUE	P-VALUE	SIG.
AGE(YEARS)						
MEAN±SD	58.77±9.14	57.91±10.62	58.25±9.99	-0.312	0.756	NS
RANGE	42-73	37-76	37-76			
SEX						
MALE	15(68.2%)	24(70.6%)	39(69.6%)	0.037	0.848	NS
FEMALE	7(31.8%)	10(29.4%)	17(30.4%)			
SMOKING						
NO	9(40.9%)	16(47.1%)	25(44.6%)	0.204	0.651	NS
YES	13(59.1%)	18(52.9%)	31(55.4%)			
BMI [WT./ (HT.)^2]						
MEAN±SD	29.97±4.00	24.16±4.49	28.24±4.28	2.135	0.026	S
RANGE	21.7-35.7	21.5-36.9	21.5-36.9			
<25	6(37.5%)	24(70.6%)	30(53.6%)	5.2967	0.008	S
>25	16(62.5%)	10(29.4%)	26(46.4%)			
HTN						
NO	14(63.6%)	20(58.8%)	34(60.7%)	0.130	0.719	NS
YES	8(36.4%)	14(41.2%)	22(39.3%)			
DM						
NO	8(36.4%)	27(79.4%)	31(55.4%)	6.993	0.013	S
YES	14(63.6%)	7(20.6%)	25(44.6%)			
F.H						
NO	5(22.7%)	26(76.5%)	31(55.4%)	4.573	0.015	S
YES	17(77.3%)	8(23.5%)	25(44.6%)			
PRIOR CAD						
NO	14(63.6%)	20(58.8%)	34(60.7%)	0.130	0.719	NS
YES	8(36.4%)	14(41.2%)	22(39.3%)			
BASELINE HR						
MEAN±SD	78.68±9.63	75.18±12.10	76.55±11.24	-1.143	0.258	NS
RANGE	65-93	59-111	59-111			
SBP						
MEAN±SD	125.00±18.71	125.59±19.88	125.36±19.26	0.111	0.912	NS
RANGE	90-160	90-160	90-160			

For Mean±SD, use the t-Independent Sample t-test; for Number(%), use the x2:Chi-square test or, if applicable, Fisher's exact test. NS stands for non-significant, S for significant, and HS for highly significant

The range of age was 37-76 with mean 58.25±9.99; while 17-patients (30.4%) were females and 39-patients (69.6%) were males; while 31-patients (55.4%) were smokers, as for the range of BMI was 21.5-36.9 with mean 28.24±4.28; also, there was 22-patients (39.3%) had HTN, 25-patients (44.6%) had DM, 25-patients (44.6%) had positive family history of IHD, 22-patients (39.3%) had prior CAD; as for the range of baseline HR was 59-111 with 76.55±11.24 and SBP ranged from 90-160 with mean 125.36±19.26.

There is no statistically significant distinction between the two groups in terms of age, sex, smoking, HTN, and clinical examination, but there is a correlation of statistical significance between elevated BMI>25, DM, and a positive family history of IHD with a serum Lp (a) level ≥60 mg/dl ($p<0.05$), (table 1;figures 1 & 2).

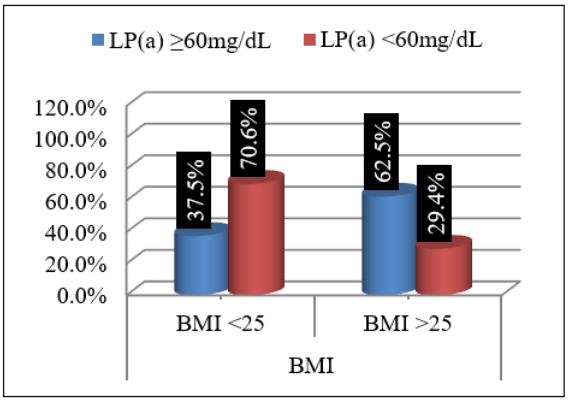

Figure 1. Comparison between two groups regarding BMI.

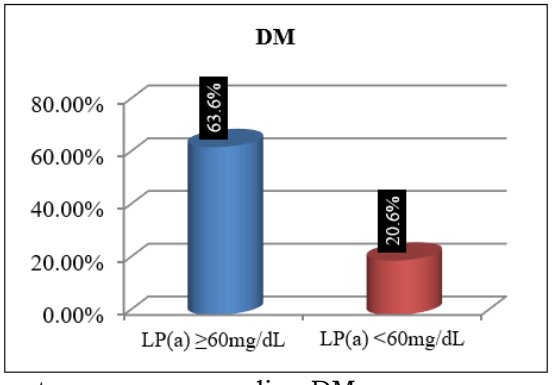

Figure 2. Comparison between two groups regarding DM.

Table 2. Comparison between two groups regarding Echo Doppler Findings

ECHO DOPPLER FINDINGS	GROUP-A (N=22)	GROUP-B (N=34)	TOTAL (N=56)	TEST VALUE	P-VALUE	SIG.
		EF%				
MEAN±SD	59.82±8.62	61.59±6.77	60.89±7.52	0.858	0.395	NS
RANGE	38-70	40-70	38-70			
		VALVULAR LESION				
MILD AR	0(0.0%)	1(2.9%)	1(1.8%)	7.427	0.491	NS
MILD AS	1(4.5%)	1(2.9%)	2(3.6%)			
MILD MR	2(9.1%)	4(11.8%)	6(10.7%)			
MILD TR	3(13.6%)	2(5.9%)	5(8.9%)			
MODERATE MR	2(9.1%)	1(2.9%)	3(5.4%)			
MODERATE TR	2(9.1%)	2(5.9%)	4(7.1%)			
NON	12(54.5%)	23(67.6%)	35(62.5%)			
		RWMA				
GLOBAL HK	1(4.5%)	1(2.9%)	7(12.5%)	16.626	0.002	S
HK OF ANT. WALL	10(45.5%)	6(17.6%)	13(23.2%)			
HK OF INF WALL	7(31.8%)	3(8.8%)	8(14.3%)			
NO RWMA	4(18.2%)	24(70.6%)	28(50.0%)			

For Mean±SD, use the t-Independent Sample t-test; for Number (%), use the x2:Chi-square test or, if applicable, Fisher's exact test. NS stands for non-significant, S for significant, and HS for highly significant

Patients in group A had a statistically significant greater frequency of rising RWMA than patients in group B, with a p-value of p<0.05; however, there was no statistically significant distinction between the two groups in terms of EF% or valvular lesions, with a p-value of p>0.05, (table 2;figure 3).

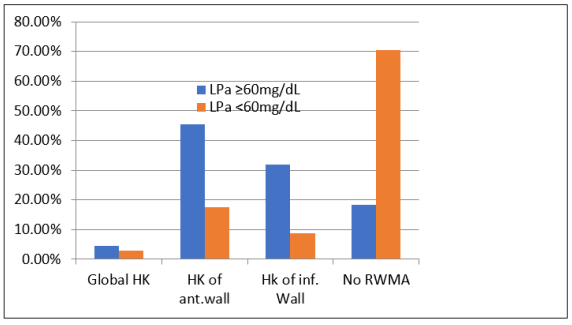

Figure 3. Comparison between two groups regarding RWMA affection.

Table 3. Comparison between two groups regarding CA and IVUS.

CA & IVUS	GROUP-A (N=22)	GROUP-B (N=34)	TOTAL (N=56)	TEST VALUE	P-VALUE	SIG.
VESSEL AFFECTED						
LMT	2(9.1%)	10(29.4%)	12(21.4%)	3.902	0.272	NS
LAD	13(59.1%)	13(38.2%)	26(46.4%)			
LCX	3(13.6%)	4(11.8%)	7(12.5%)			
RCA	4(18.2%)	7(20.6%)	11(19.6%)			
SITE OF LESION						
OSTIAL	3(13.6%)	4(11.8%)	7(12.5%)	4.407	0.221	NS
PROXIMAL	11(50.0%)	13(38.2%)	24(42.9%)			
MID	7(31.8%)	8(23.5%)	15(26.8%)			
DISTAL	1(4.5%)	9(26.5%)	10(17.9%)			

When applicable, use Fisher's exact test or the x2:Chi-square test for numbers (%).

NS stands for non-significant, S for significant, and HS for highly significant

No statistically significant difference between two groups regarding vessel affected and Site of lesion, with p-value(p>0.05), (table 3).

Table 4. Comparison between two groups regarding PAV% by IVUS.

	GROUP-A (N=22)	GROUP-B (N=34)	TOTAL (N=56)	TEST VALUE	P-VALUE	SIG.
MEAN±SD	71.23±9.88	65.12±10.33	67.52±10.51	2.198	0.032	S
RANGE	45-83	40-78	40-83			

Using:t-Independent Sample t-test for Mean±SD;NS:Non-significant; S:Significant; HS:Highly significant

Statistically significant higher mean value of PAV% by IVUS in group-A that was 71.23±9.88 than group-B that was 65.12±10.33, with p-value(p=0.032), (table 4; figure 4).

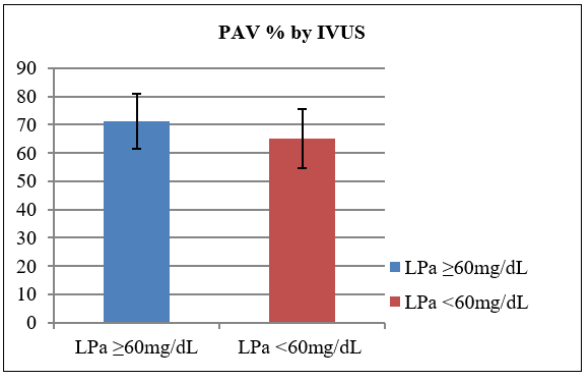

Figure 4. Comparison between two groups regarding to PAV% by IVUS.

Table 5. Comparison between two groups regarding Lab Results.

LAB RESULTS	GROUP-A (N=22)	GROUP-B (N=34)	TOTAL (N=56)	TEST VALUE	P-VALUE	SIG.
SERUM CREATININE						
MEAN±SD	2.08±2.97	1.68±1.63	1.84±2.24	-0.642	0.524	NS
RANGE	0.7-13	0.7-8	0.7-13			
HB LEVEL						
MEAN±SD	12.47±1.44	12.70±1.31	12.61±1.36	0.601	0.550	NS
RANGE	10.2-15.6	9.8-15.1	9.8-15.6			
SERUM URIC ACID						
MEAN±SD	12.14±3.78	8.68±3.38	10.79±8.32	-2.352	0.011	S
RANGE	4.2-52	3.9-49	3.9-52			
S.UA ≥7	16(72.7%)	10(29.4%)	26(46.4%)	8.410	0.004	S
S.UA <7	6(27.3%)	24(70.6%)	30(53.6%)			
SERUM CHOLESTEROL						
MEAN±SD	251.36±64.23	195.56±55.08	217.48±59.65	-2.092	0.041	S
RANGE	131-825	68-370	68-825			
S.CHOL. ≥200	17(77.3%)	14(41.2%)	31(55.4%)	5.657	0.017	S
S.CHOL.<200	5(22.7%)	20(58.8%)	25(44.6%)			
SERUM TG						
MEAN±SD	195.55±70.43	155.65±61.87	171.68±64.93	2.133	0.014	S
RANGE	52-344	32-310	32-380			
S.TG. ≥160	18(81.8%)	11(32.4%)	29(51.8%)	11.183	0.002	S
S.TG. <160	4(18.2%)	23(67.6%)	27(48.2%)			
LDL						
MEAN±SD	167.86±70.05	87.39±41.02	139.09±74.37	-2.431	0.018	S
RANGE	41-570	29-193	29-570			
LDL≥70	15(68.2%)	12(35.3%)	27(48.2%)	4.544	0.033	S
LDL<70	7(31.8%)	22(64.7%)	29(51.8%)			
HDL						
MEAN±SD	53.05±31.40	47.09±8.34	49.43±20.66	-1.055	0.296	NS
RANGE	23-182	24-63	23-182			

Using: t-Independent Sample t-test for Mean±SD; NS: Non-significant; S:Significant; HS:Highly

significant

Statistically significant higher mean value of serum uric acid level ≥7, serum cholesterol level ≥ 200, serum TG level ≥160and LDL level ≥70 in group-A comparing to group-B, with p-value($p<0.05$). While there is no statistically significant difference between two groups regarding serum creatinine, Hb level and HDL, with p-value($p>0.05$), (table 5:figures 5 & 6).

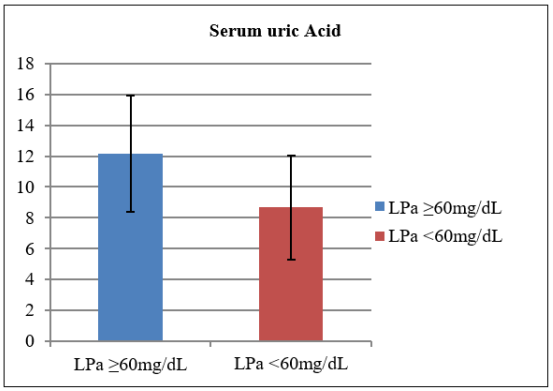

Figure 5. Comparison between two groups regarding serum uric acid.

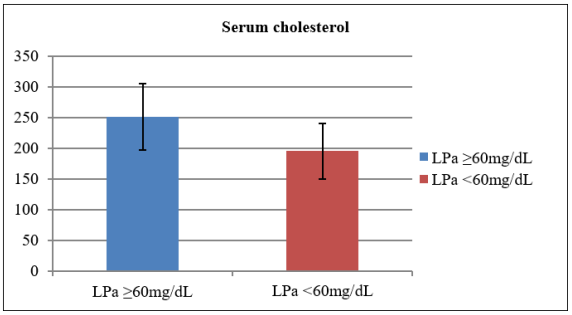

Figure 6. Comparison between two groups regarding serum cholesterol.

Table 6. Pearson's correlation coefficient (r) is used to examine the relationship between the Lp (a) level and other factors in the patient group.

PARAMETERS	LIPOPROTEIN (A) LEVEL		
	R-value	p-value	Sig.
AGE (YEARS)	-0.050	0.713	NS
BMI [WT./ (HT.) ^2]	0.392	0.024	S
BASELINE HR	0.151	0.268	NS
SBP	0.009	0.949	NS
EF%	-0.058	0.673	NS
PAV BY IVUS%	0.439	0.001	HS
SERUM CREATININE	0.036	0.795	NS
HB LEVEL	-0.043	0.753	NS
SERUM URIC ACID	0.488	0.014	S
SERUM CHOLESTEROL	0.311	0.020	S
SERUM TG	0.319	0.021	S
LDL	0.347	0.009	S
HDL	0.136	0.318	NS

NS stands for non-significant, S for significant, and HS for highly significant when using Pearson's correlation coefficient (r)

PAV% by IVUS, BMI, DM, positive F.H of IHD, serum uric acid, serum cholesterol, serum TG, serum LD, and RWMA by Echo all showed statistically significant positive correlations with a p-value of $p<0.05$ in group-A, whereas the remaining parameters showed insignificant correlations with a p-value of $p>0.05$, (table 6 : figures 7 & 8).

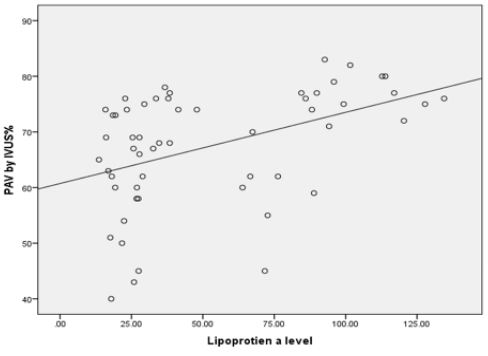

Figure 7. Scatter plot between Lp (a) level and PAV% by IVUS.

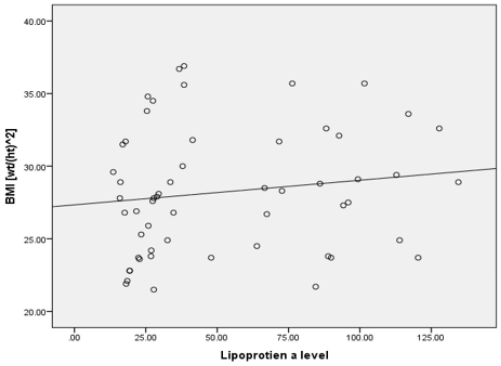

Figure 8. Scatter plot between Lp (a) level and BMI.

4. Discussion

Cardiovascular disease is the largest cause of mortality in the world, accounting for 18 million fatalities per year.[10] Dyslipidemia is a key and well-established risk factor for CAD.[11]

The buildup of fatty deposits, or atheroma, on the coronary artery walls is frequently the cause of CHD. Atherosclerosis is the result of atheroma, which narrows the arteries and lowers blood flow to the heart muscle. An effective imaging method for evaluating the artery wall is IVUS. It enables precise determination of the atherosclerotic disease load and high-resolution imaging of the coronary artery wall.[6]

We examined the sociodemographic characteristics of 56 patients who were split into two groups: Patients in Group A had LP (a) ≥60 mg/dl (n = 22), while those in Group B had LP (a) <60 mg/dl (n = 34). While similar studies as Huded et al.,[12] According to the study, patients were classified as either low Lp (a)<60 mg/dl (n = 3260) or high Lp (a)≥60 mg/dl (n = 683).

In terms of sociodemographic characteristics, our patients in group A were 58.25 years old on average, while those in group B were 57.91 years old. Studies similar to the one conducted by Dai et al. revealed that patients with high LP (a) had an average age of 63.8 years old, while those with low LP (a) had an average age of 63.5 years old.[13]

Most of our patients in group A were males(68.2%), and male patients in group B represented 70.6%. Also, Dai et al.,[13] study showed that most patients with high LP (a) were males(62.9%), while male patients with low LP (a) represented 71.4%.

In agreement with Kaiser et al.,[14] study, most patients with high LP (a) were males(72.1%), while male patients with low LP (a) represented 82.2%.

Also, Matsushita et al.[15] According to the study, men made up 82% of patients with high Lp (a), while men made up 67% of patients with low Lp (a).

Most of our patients in group A were smokers (55.4%), and the same with group B, smokers represent(52.9%). While similar studies to Huded et al.,[12] study showed that smokers with high Lp (a) represent(25%) and smokers with low Lp (a) represent(24%).

Regarding smoking, Matsushita et al.,[15] The study's findings were consistent with our own: 53% of patients with elevated Lp (a) levels smoked, whereas 48% of patients with decreased Lp (a) levels did the same.

Our patients in group A had a mean BMI of 29.97 kg/m2, whereas those in group B had a mean BMI of 24.16 kg/m2, while Dai et al.,13 According to the study, patients with low LP (a) had a mean BMI of 24.5 kg/m2, whereas those with high LP (a) had a mean BMI of 25 kg/m2.

Regarding comorbidities, hypertension in group A represents 36.4%, and in group B, it represents 41.2%.

Huded et al.,[12] study showed that hypertensive patients with high Lp (a) represent(79%) and hypertensive patients with low Lp (a) represent (77%).

Regarding comorbidities, diabetes in group A represents 63.6%, while in group B, it represents 20.6%. According to Huded et al.,[12] According to the study, diabetic patients with low Lp (a) comprise 20% of the population, whereas those with high Lp (a) represent 23%.

In our investigation, group-A's mean PAV% by IVUS was statistically significantly greater than group-B's (71.23 versus 65.12), with a p-value of P=0.032, while Matsushita et al.,[15] According to the study, there was no statistically significant difference in the mean PAV% by IVUS between the groups with high and low Lp (a) levels (46.9 and 45.6), with a p-value of 0.65.

LP (a) level and PAV by IVUS% showed positive significant connections with regard to the relationship between coronary atheroma volume and Lp (a) (R-value=0.439 and P=0.001).

In terms of lab tests, group A's mean serum cholesterol was 251.36 mg/dl, whereas group B's

mean serum cholesterol was 195.56 mg/dl.

While Dai et al.,[13] study showed a mean total cholesterol of patients with high LP (a) was 163.9 mg/dl, while patients with low LP (a) had a mean total cholesterol of 146.1mg/dl.

Regarding laboratory investigations, the mean serum TG in group A was 195.65mg/dl, while group B patients had a mean serum TG of 145.55mg/dl. While Dai et al.,[13] study showed a mean triglyceride of patients with high LP (a) was 163.9mg/dl, while patients with low LP (a) had a mean triglyceride of 146.1mg/dl.

Regarding laboratory investigations, the mean LDL in group A was 167.86 mg/dl, while group B had a mean LDL of 87.39. While Dai et al.,[13] study showed a mean LDL of patients with high LP (a) was 88.1 mg/dl, while patients with low LP (a) had a mean LDL of 72.3mg/dl.

Regarding laboratory investigations, the mean HDL in group A was 53.05mg/dl, while group B had a mean HDL of 47.09. While Dai et al.,[13] study showed a mean HDL of patients with high LP (a) was 46.8mg/dl, while patients with low LP (a) had a mean HDL of 41.4mg/dl.

Regarding laboratory investigations, the mean serum uric acid in group A was 9.47mg/dl, while group B had a mean serum uric acid of 6.32mg/dl. While Matsushita et al.,[15] study showed that the median serum uric acid of patients with high Lp (a) was 5.9mg/dl and low Lp (a) was 5.5 mg/dl.

4. Conclusion

Elevated Lp (a) correlates with greater coronary atheroma volume. High blood Lp(a) levels are linked to negative consequences.

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