Iraqi Journal of Science, 2026, Vol. xx, No. x, pp: xx
DOI: 10.24996/ijs.2026.67.8.2

ISSN: 0067-2904

New insights into lipid panel indications in Atrial fibrillation

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Received: 14/3/2025 Accepted: 11/8/2025 Published: xx

Abstract

Between February and July 2024, an observational study was carried out at Al-Zahraa Teaching Hospital in Al-Kut, Iraq, in partnership with the University of Kerbala's College of Medicine. The study enrolled 120 participants (ages 22–90), divided equally into an AF group (n=60) and a control group (n=60). Most atherogenic exhibit the highest mean values in patients with permanent atrial fibrillation (AF), The lowest mean values are typically observed in lone AF patients, suggesting a reduced atherogenic burden. The results also indicate that, regardless of blood pressure stage, a combination of increased TG/HDL ratio may be a good indication of specific atherogenic indices (AIP and CRI-I) in patients with AF. In conclusion, alongside routine monitoring of traditional lipid measures, parameters like AIP, AC, and CRI-I&II should be considered in day-to-day practice.

Keywords: Atrial fibrillation, AIP, AC, Castelli risk indicators.

رؤى جديدة حول مؤشرات لوحة الدهون في الرجفان الأذيني

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الخلاصة

ين فبراير ويوليو 2024، أجريت دراسة مراقبة في مستشفى الزهراء التعليمي في الكوت، العراق، بالشراكة مع كلية الطب بجامعة كربلاء. شملت الدراسة 120 مشاركًا (تتراوح أعمارهم بين 22 و90 عامًا)، مقسمين بالتساوي إلى مجموعة الرجفان الأذيني (العدد= 60) ومجموعة ضابطة (العدد= 60). تُظهر معظم حالات تصلب الشرايين أعلى قيم متوسطة لدى المرضى الذين يعانون من الرجفان الأذيني الدائم (AF)، وعادةً ما تُلاحظ أدنى القيم المتوسطة لدى مرضى الرجفان الأذيني الوحيدين، مما يشير إلى انخفاض العبء التصلبي. تشير النتائج أيضًا إلى أنه بغض النظر عن مرحلة ضغط الدم، فإن الجمع بين زيادة نسبة الدهون الثلاثية/الكوليسترول النافع قد يكون مؤشرًا جيدًا لمؤشرات تصلب الشرايين المحددة (AIP وCRI–I) لدى المرضى الذين يعانون من الرجفان الأذيني. في الختام، إلى جانب المراقبة الروتينية لمقاييس الدهون التقليدية، يجب مراعاة معايير مثل AIP وAC وCRI–I&II في الممارسة اليومية.

1. Introduction

Over the coming decades, the prevalence of atrial fibrillation (AF) is projected to increase significantly, driven by population ageing, advancements in cardiovascular therapies, and improved survival rates among patients with heart disease [1]. By 2030, it is estimated that there will be 14–17 million individuals with AF in the European Union, with 120,000 to 215,000 new cases diagnosed annually. The onset of AF is associated with substantial increases in morbidity and death are linked to the start of AF, even after controlling for concomitant cardiovascular diseases [2]. Heart failure and the occurrence of thromboembolic events are the two most dangerous side effects of AF [3]. Health care expenditures may be significantly impacted by the identification of community members who are at risk for incident AF, the possibility of prevention, and the ability to intervene early and specifically [4].

Various lipid markers have long been employed to predict the risk of cardiovascular diseases (CVD) and coronary atherosclerosis. Interestingly, lipid ratios have recently gained attention as tools for evaluating cardiovascular risk associated with lipids and lipoproteins [5]. Total cholesterol (TC), low-density lipoprotein LDLc, triacylglyceride TG, and decreased high-density lipoprotein (HDLc) have historically been found to be higher in the atherogenic lipid profile. The atherogenic index of plasma (AIP; Log TG/HDLc), the atherogenic coefficient (AC; Non-HDLc/HDLc), and the lipoprotein combination index (LCI; TC; LDL/HDL) measures are used to improve prognosis in cases of atherosclerosis and CVD [6]. The atherogenic index of plasma (AIP) calculated as the logarithm of the triglyceride to HDL-C ratio [log (TG/HDL-C)], is strongly correlated with particle density and size of lipoproteins as well as the rates of lipoprotein peroxidation. Therefore, AIP can serve as a valuable indicator of the atherogenicity of plasma [7]. Numerous studies have indicated a substantial correlation between AIP and the risk of CAD, heart failure, and stroke [8-10]. It is independently associated with poor prognosis for CAD patients [11].

The Atherogenic Coefficient (AC) is a different lipid ratio that indicates the overall amounts of cholesterol in the VLDLc, IDLc, and LDLc lipoprotein fractions in proportion to the protective value of the HDLc fraction. It is estimated as {(non-HDLc)/HDL-C} and occasionally as [(TC-HDLc)/HDL-C]. Thus, this mimics the atherogenic inclination that the totality of lipoprotein fractions is certain to produce. Again, in 2011, Hermans et al. showed that non-HDLc is considered a legitimate substitute for Apo-B apolipoprotein since it resembles Apo-B's function in assessing atherogenicity level and lipoprotein load [12]. It has been demonstrated that Castelli risk indicators (CRI), which are derived from lipid characteristics, function better as a diagnostic tool for predicting cardiovascular events and illnesses. The development of coronary plaques is reflected in the CRI-I index, which is calculated by dividing

total cholesterol by cholesterol on high-density lipoproteins [13], whereas it has been demonstrated that CRI-II, which is derived by dividing low-density lipoprotein (LDL) cholesterol by HDL cholesterol, is a highly accurate indicator of cardiovascular risk [14]. This study aims to investigate the levels of atherogenic indices in patients with atrial fibrillation and evaluate their utility as potential biomarkers for diagnosing AF.

2. Method

2.1. Setting and design

This observational study was carried out in Al-Kut city at the Al-Zahraa Teaching Hospital between February and July 2024, in cooperation with the College of Medicine, University of Kerbala, Iraq. The study included 60 participants aged 22 to 90 and was conducted as a retrospective cross-sectional study. Each participant was diagnosed with AF based on the interpretation of their electrocardiogram. In cases where arrhythmia is strongly suspected but not detected with a Holter monitor, extended monitoring may be necessary to capture it. Atrial fibrillation was classified by the American Heart Association, European Society of Cardiology, and American College of Cardiology into Lone, Permanent, Persistent, and Paroxysmal AF.

2.2. Patient Inclusion Criteria

All patients with AF were included in the study. Clinical assessments were conducted, which included using a body mass index (BMI) calculator and vital indicators, including blood pressure and heart rate, based on height and weight, were documented. Furthermore, Age, symptoms, normal coronary angiography, echo testing, and family history of AF were considered as determined by a cardiologist. Ischemic heart disease (IHD) individuals were not included in the research.

2.3. Data and samples collection

During participant enrollment, baseline information, including demographic characteristics, medical history, medication use, and lifestyle risk factors, were systematically collected. Following standardized protocols, fasting blood samples were obtained in the morning using serum gel tubes for processing. The serum samples were kept at -80 °C, while all of the blood samples underwent centrifugation at 1000 × g for 10 minutes. An automated biochemistry analyzer (Hitachi 7150, Tokyo, Japan) was used to measure the lipid profiles. In particular, enzymatic techniques were used to assess the levels of triglycerides (TG) and total cholesterol (TC). The selective solubilization technique (low-density lipid cholesterol test kit; Biomerieux, Sa, France) was used to measure the concentration of low-density lipoprotein cholesterol (LDL-C). A homogeneous approach (Determiner L HDL; Biomerieux, Sa, France) was used to measure the concentration of high-density lipoprotein cholesterol (HDL-C). Individuals with a blood pressure reading of more than 140/90 mm Hg and those under antihypertensive drug treatment were classified as having hypertension. The derived atherogenic indices were calculated as follows:

- Atherogenic index of plasma (AIP)= log (TG/ HDL-C).
- Atherogenic coefficient (AC) = non-HDL-C / HDL-C; Non- HDL-C = TC –HDL-C
- Castelli's risk indexes (I & II); CRI-I= TC/ HDL-C ratio; CRI-II= LDL-C/ HDL-C ratio

Human blood pressure (BP) was classified according to a report from the American College of Cardiology (ACC)/ American Heart Association (AHA) task force on clinical practice guidelines (15), which determines the categories of BP as follows:

- Normal Blood Pressure = <120／<80 (Systolic BP/ Diastolic BP; Units in mm HG).
- Elevated Blood Pressure = 120-129／<80 (Systolic BP/ Diastolic BP; Units in mm HG).
- Hypertension, stage 1 = 130-139／80-89 (Systolic BP/ Diastolic BP; Units in mm HG).
- Hypertension, stage 2 = ≥ 140／≥ 90 (Systolic BP/ Diastolic BP; Units in mm HG).

2.4. Statistical Analysis

Information from the questionnaire from all participants was entered into a data sheet and was assigned a serial identifier number. Multiple entries were used to avoid errors. The data analysis for this work was generated using GraphPad Prism 9. Descriptive statistics were performed on the participants' data of each group. Values were illustrated by n (%) for categorical. The distribution of the data was checked using the Shapiro-Wilk test as a numerical means of assessing normality. Spearman correlations assessed relationships between markers. In addition, for comparing markers across clinicopathological subgroups, the Kruskal-Wallis's test was used. Results of all hypothesis tests with p-values <0.05 (two-sided) were considered to be statistically significant. The optimal threshold with high specificity and sensitivity for subgroups was detected using receiver operating characteristic (ROC) analysis.

3. Results

3.1. Demographic characteristics

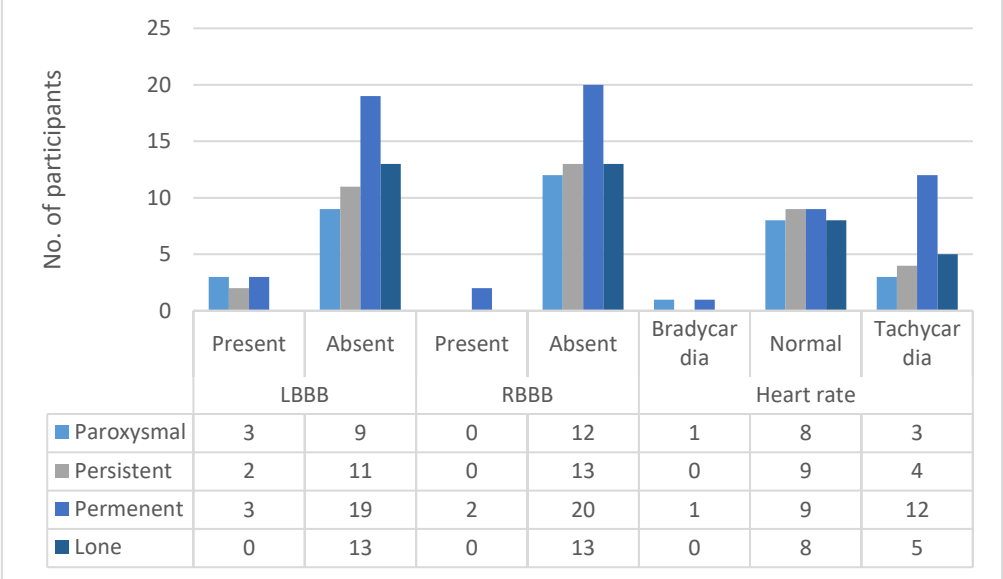
In this retrospective study, the demographic characteristics and clinical features of 60 patients with atrial fibrillation were presented in Table 1. The analysis revealed significant variations in age distribution, sex composition, and comorbidity profiles across the patient groups. The mean age of the study population ranged from 52 years in the lone atrial fibrillation group to 67 years in the persistent atrial fibrillation group. The male-to-female ratio was 6/22 in the permanent AF group and 6/13 in the lone AF group, compared to 3l12 in the paroxysmal AF group and 5/13 in the persistent AF group. Regarding comorbidities, diabetes mellitus was more prevalent in the paroxysmal, persistent, and permanent atrial fibrillation groups, while none of the patients in the lone atrial fibrillation group had diabetes. Similarly, hypertension was more common in the paroxysmal and permanent atrial fibrillation groups, but none of the patients in the lone atrial fibrillation group had hypertension. Dyslipidemia was more prevalent in the paroxysmal group compared to the other groups.

Treatment patterns also differed among the groups. A greater proportion of patients in the persistent, permanent, and lone atrial fibrillation groups were prescribed beta-blockers compared to the paroxysmal group. A high percentage of patients were classified as pre-obesity cases, according to the World Health Organization.

Table 1: Demographic characteristics of atrial fibrillation groups.

Characteristics		Paroxysmal	Persistent	Permanent	Lone
Demographics	Age Mean (Median)	66 (68)	67 (69)	62 (65)	52 (49)
	Gender (Male/Female) %	(25/75)	(38.5/61.5)	(27.3/72.7)	(46.2/53.8)
Comorbidities	DM (Yes/No) %	(50/50)	(46.2/53.8)	(54.5/45.5)	(0/100)
	Hyperthroidism (Yes/No) %	(33.3/66.7)	(7.7/92.3)	(18.2/81.8)	(0/100)
	Hypertension (Yes/No) %	(91.7/8.3)	(84.7/15.4)	(90.9/9.1)	(0/100)
	Dyslipidemiea (Yes/No) %	(58.3/41.7)	(15.4/84.7)	(22.7/77.3)	(0/100)
Treatment	B-Blockers (Yes/No) %	(41.7/58.3)	(84.7/15.4)	(81.8/18.2)	(69.2/30.8)
	Anticoagulation (Yes/No) %	(66.7/33.3)	(76.9/23.1)	(77.3/22.7)	(53.8/46.2)
Baseline Characteristic	BMI Mean (Median)	28.4 (28.55)	27.1 (25.7)	27.5 (27.4)	25.8 (26.3)

An arrhythmia is caused by a blockage or disruption of the heart's electrical signal, known as bundle branch block (BBB). The diagnosis was established through the ECG interpretation. Figure 1 illustrates the distribution of ECG findings among AF patients, with38% of the patients exhibiting an irregular heart rate (e.g: tachycardia), and 13% of the patients had an RBBB. Only 3% of the patients had LBBB at the time were only 3%.



	LBBB Present	LBBB Absent	RBBB Present	RBBB Absent	Heart rate: Bradycardia	Heart rate: Normal	Heart rate: Tachycardia
Paroxysmal	3	9	0	12	1	8	3
Persistent	2	11	0	13	0	9	4
Permenent	3	19	2	20	1	9	12
Lone	0	13	0	13	0	8	5

Figure 1: ECG interpretation distribution among AF patients.

3.2. Distribution of atherogenic indices based on classification of AF

Based on how atrial fibrillation (AF) is classified, Figure 2 shows the distribution of atherogenic indices AC, AIP, CRI-I, and CRI-II. Compared to other AF types, patients with Permanent AF typically exhibit the highest mean values across the majority of atherogenic indices, indicating a possible increased risk for cardiovascular disease. The lowest mean values are typically found in lone AF patients, which may suggest a lesser atherogenic burden.

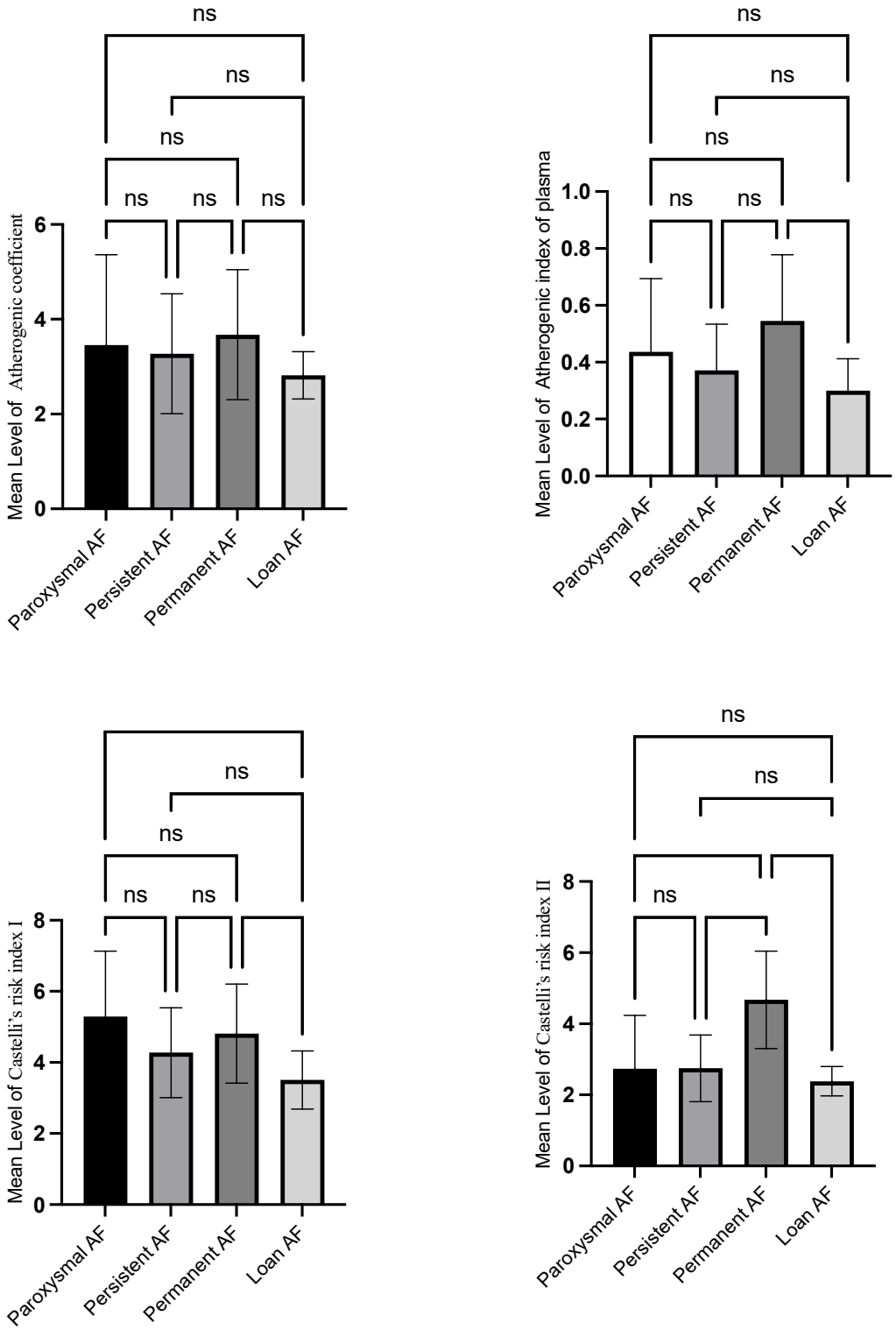


Figure 2: Distribution level of atherogenic indices among patient groups of atrial fibrillation. (Post Hoc test was *: significant at p-value ≤ 0.05, **: significant at p-value ≤ 0.01, ***: significant at p-value ≤ 0.001).

3.3. Distribution of atherogenic indices among patient groups of atrial fibrillations with different stages of hypertension

The distribution of atherogenic indices (AC, AIP, CRI-I, and CRI-II) among patients with atrial fibrillation (AF) was displayed in Figure 3, classifying the patients according to their

blood pressure stages. Throughout the blood pressure phases, the mean values of all atherogenic indices (AC, AIP, CRI-I, and CRI-II) gradually increased. These findings suggest a direct association between elevated blood pressure and worsening atherogenic profile. The findings showed that in individuals with atrial fibrillation, blood pressure stages and atherogenic indices were positively correlated. Higher blood pressure seems to be associated with a more atherogenic lipid profile, which could raise the risk of cardiovascular disease.

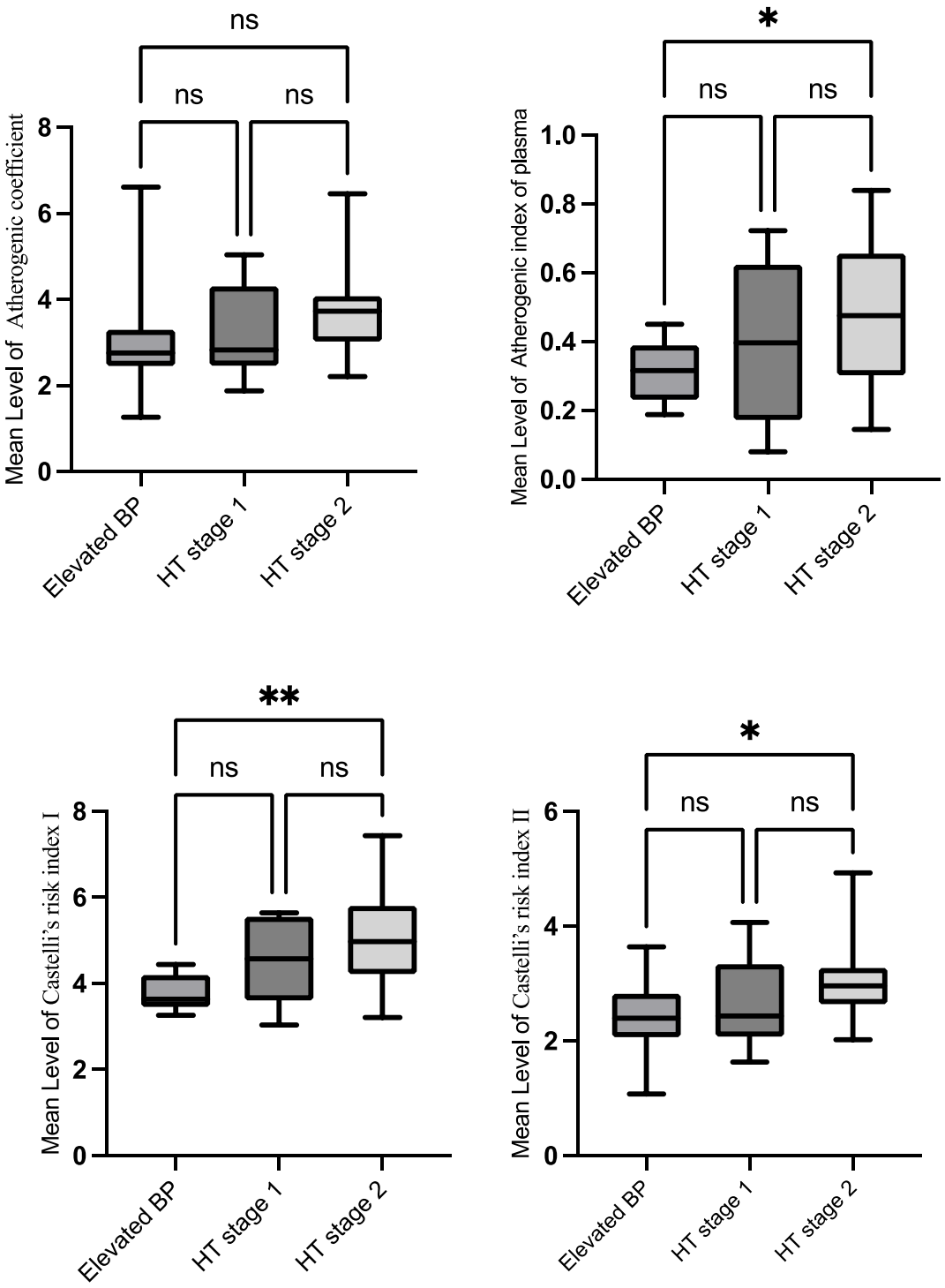


Figure 3: Distribution level of Atherogenic Indices among patient groups of atrial fibrillation with different stages of hypertension. (Post Hoc test was *: significant at p-value ≤ 0.05, **: significant at p-value ≤ 0.01, ***: significant at p-value ≤ 0.001).

3.4. Correlation Coefficients between Biomarkers among patient groups of atrial fibrillations with increased blood pressure

The response relationship between the TG/HDL ratio and the atherogenic indices (AC, AIP, CRI-I, and CRI-II) among patients with atrial fibrillation (AF) classified by blood pressure stage was examined using Spearman correlation coefficients. The correlation study revealed numerous significant relationships among the measured parameters; *p*-value were <0.05. Blood pressure Stage 1 showed a positive moderate to strong relationship (correlation coefficient was 0.6 and 0.9) between the TG/HDL ratio and atherogenic indices. The *P* values were significant with AC, AIP, and CRI-I. The only parameters that demonstrated a significant positive link with AIP, however, were stage 2 and moderate blood pressure (*p*-value <0.05). The findings also suggested that, independent of blood pressure stage, a combination of increased TG/HDL ratio may be a good indication of specific atherogenic indices (AIP and CRI-I) in individuals with atrial fibrillation, as shown in Figures 4 and 5.

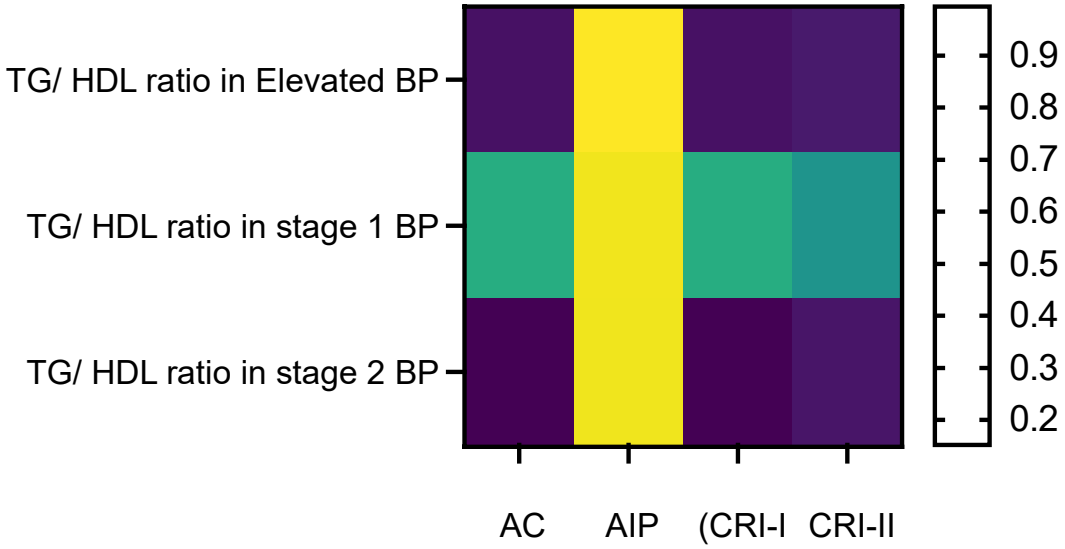


Figure 4: The correlation coefficient (r) between TG/HDL ratio and Atherogenic Indices among patients' group of atrial fibrillations in different stages of hypertension.

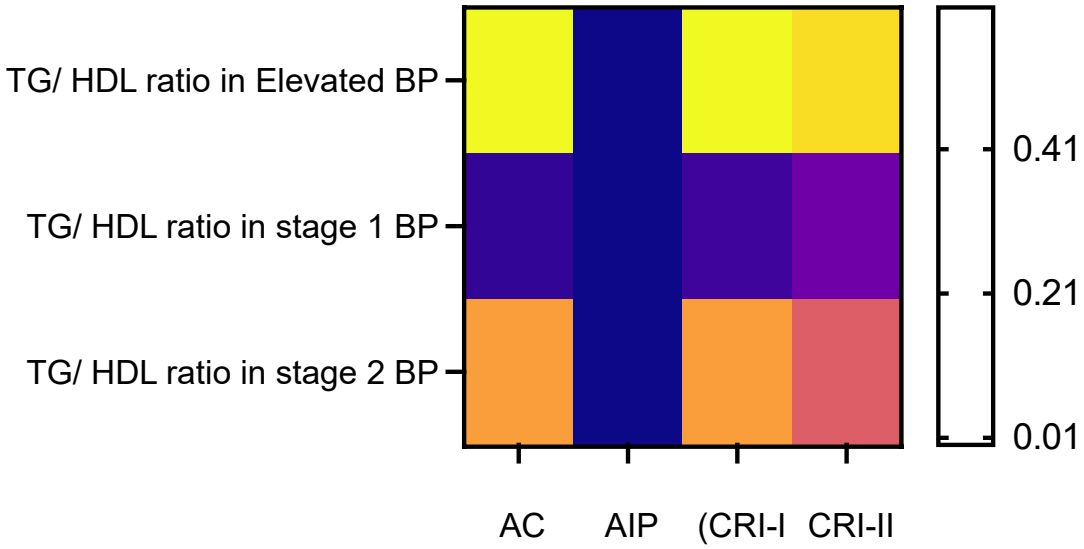


Figure 5: The significant of *P* value between TG/HDL ratio and Atherogenic Indices among patients' group of atrial fibrillations in different stage of hypertension.

3.5. Correlation Coefficients between biomarkers among patient groups of atrial fibrillations

The study further investigated the association between AC, AIP, CRI-I, and CRI-II and TG/HDL ratio related to patients with AF based on their classification. The TG/HDL ratio has been connected to a number of different cardiac conditions recently; however, it is not a diagnostic tool for any kind of AF. Many important correlations between the measured parameters were shown by the correlation analysis. *p*-value were less than 0.001. A substantial and positive connection (correlation coefficient of 0.9) was seen between the TG/HDL ratio and atherogenic markers in all forms of atherosclerosis. In Permanent AF, however, a moderate to strong positive connection (r= 0.5–0.9) was discovered between the TG/HDL ratio and atherogenic markers, see Figure 6 and Figure 7.

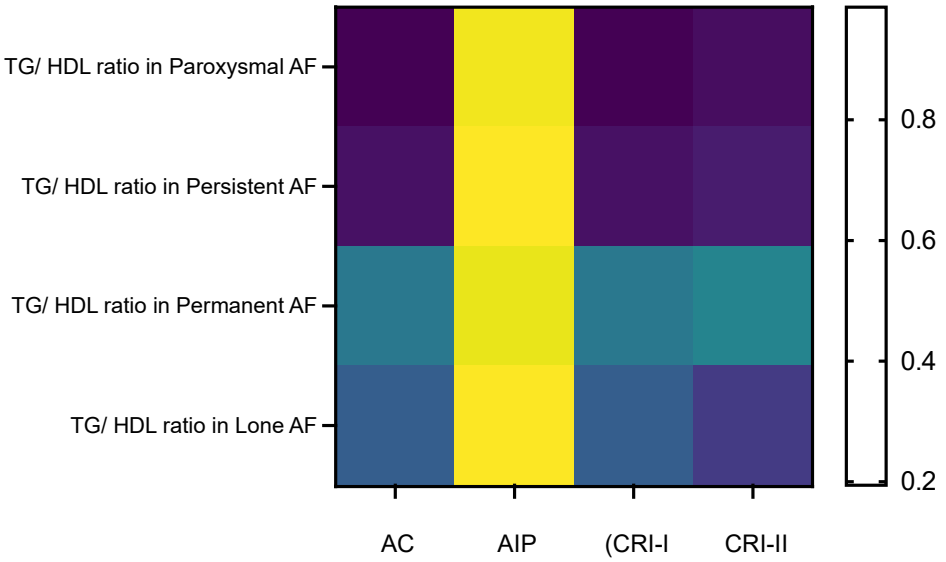


Figure 6: The correlation coefficient (r) between TG/HDL ratio and atherogenic indices among patients' groups of atrial fibrillations.

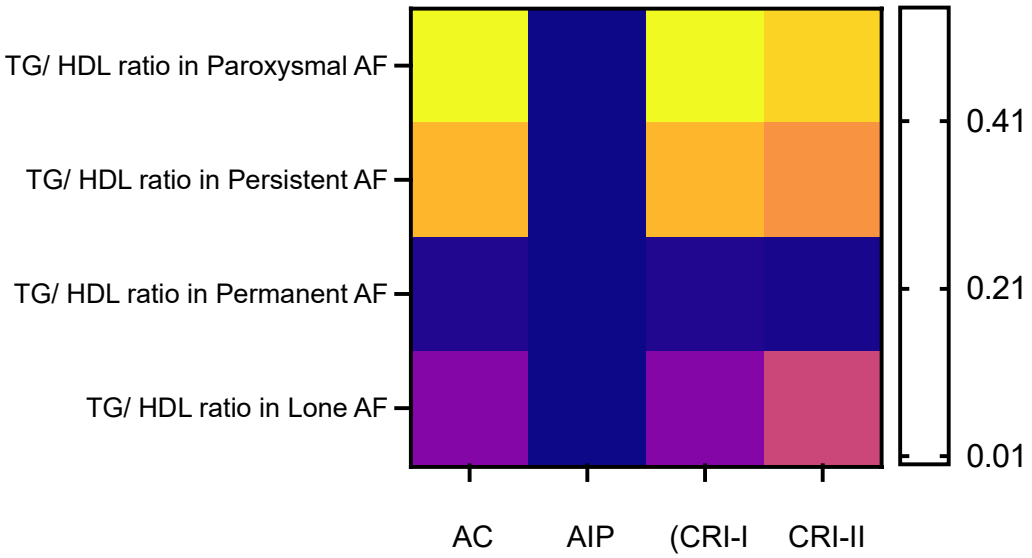


Figure 7: The significance of *the p*-value between TG/HDL ratio and the atherogenic indices among patients' group of atrial fibrillations.

3.6. ROC analysis: Evaluation of Atherogenic Indices in Atrial Fibrillation groups

This study evaluated the performance of various atherogenic indices (AC, AIP, CRI-I, CRI-II) in a group of patients with paroxysmal atrial fibrillation. The following metrics were

assessed: sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the curve (AUC). AIP demonstrated better sensitivity, indicating its ability to correctly identify (50%) of patients with paroxysmal atrial fibrillation. AIP exhibited the highest specificity (95%), indicating their effectiveness in correctly identifying patients without the condition, as presented in Tables 2 and 3, along with Figure 8, illustrates the distribution of patients with paroxysmal atrial fibrillation and healthy controls based on the suggested cutoff values for the atherogenic indices AC, AIP, CRI-I, and CRI-II. In a very close to the cutoff off paroxysmal AF, AIP showed a 46.15% sensitivity and similar specificity toward persistent AF at the threshold of 0.433, as presented in Tables 4, and, along with Figure 9 shows the distribution of patients with persistent atrial fibrillation and healthy controls based on the suggested cutoff values.

Among the evaluated atherogenic indices, AIP demonstrated the most promising diagnostic performance for permanent atrial fibrillation. The optimal cutoff points for AIP were 0.401, which demonstrated the highest sensitivity (72.73%) and highest specificity (86.67%). As presented in Tables 6 and 7, along with Figure 10 presented the distribution of patients with permanent atrial fibrillation and healthy controls based on the suggested cutoff values for the atherogenic indices AC, AIP, CRI-I, and CRI-II. Among patients with lone AF, the atherogenic index of plasma (AIP) demonstrated the highest AUC value; however, these findings require cautious interpretation (see Table 8, Table 9, and Figure 11). The AUC values for all indices were relatively low, suggesting that these atherogenic indices may have limited diagnostic utility for lone atrial fibrillation. Since the AUC values for all atherogenic indices were below 0.6, this suggests that they have limited ability to differentiate between patients with and without lone atrial fibrillation.

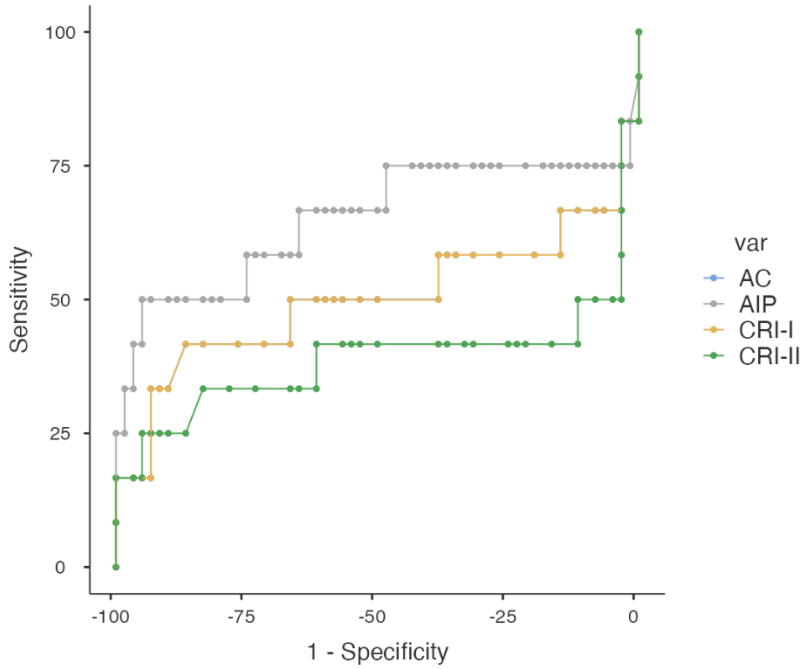


Figure 8: Receiver operating characteristic curve of atherogenic indices among Paroxysmal Atrial Fibrillation group.

Table 2: AUC, optimal threshold, sensitivity and specificity of atherogenic indices among group of Paroxysmal Atrial Fibrillation.

	Cutpoint	Sensitivity %	Specificity %	PPV %	NPV %	Youden's index	AUC
AC	3.5	41.67%	86.67%	38.46%	88.14%	0.283	0.5
AIP	0.432	50%	95%	66.67%	90.48%	0.450	0.7
CRI-I	4.5	41.67%	86.67%	38.46%	88.14%	0.283	0.5
CRI-II	3.20	25%	91.67%	37.5%	85.94%	0.167	0.4

Table 3: Distribution of patients in Paroxysmal Atrial Fibrillation Group and Healthy control according to the suggested Cutoff Value.

	AC 3.5		AIP 0.432		CRI-I 4.5		CRI-II 3.20	
	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive
Negative	52 (TN)	8 (FP)	57 (TN)	3 (FP)	52 (TN)	8 (FP)	55 (TN)	5 (FP)
Positive	7 (FN)	5 (TP)	6 (FN)	6 (TP)	7 (FN)	5 (TP)	9 (FN)	3 (TP)

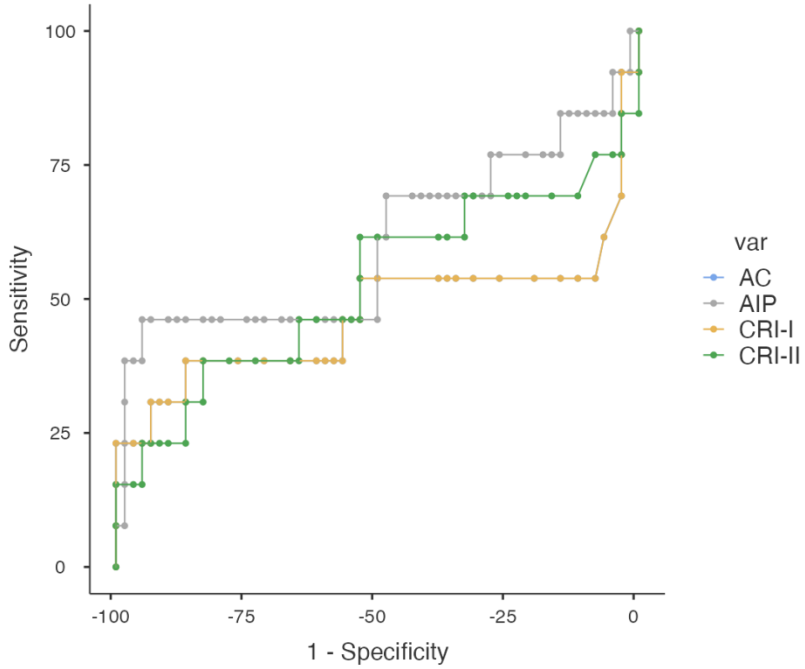


Figure 9: Receiver operating characteristic curve of atherogenic indices among the Persistent Atrial Fibrillation group.

Table 4: AUC, optimal threshold, sensitivity and specificity of atherogenic indices among a group of Persistent Atrial Fibrillation.

	Cutpoint	Sensitivity %	Specificity %	PPV %	NPV %	Youden's index	AUC
AC	3.97	30.77%	93.33%	50%	86.15%	0.241	0.5
AIP	0.433	46.15%	95%	66.67%	89.06%	0.412	0.61
CRI-I	4.47	38.46%	86.67%	38.46%	86.67%	0.251	0.5
CRI-II	2.94	38.46%	83.33%	33.33%	86.21%	0.218	0.53

Table 5: Distribution of patients in the Persistent Atrial Fibrillation Group and Healthy Controls According to the suggested Cutoff Value.

	AC 3.97		AIP 0.433		CRI-I 4.47		CRI-II 2.94	
	Negative	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**
Negative	56 (TN)	4 (FP)	57 (TN)	3 (FP)	52 (TN)	8 (FP)	50 (TN)	10 (FP)
Positive	9 (FN)	4 (TP)	7 (FN)	6 (TP)	8 (FN)	5 (TP)	8 (FN)	5 (TP)

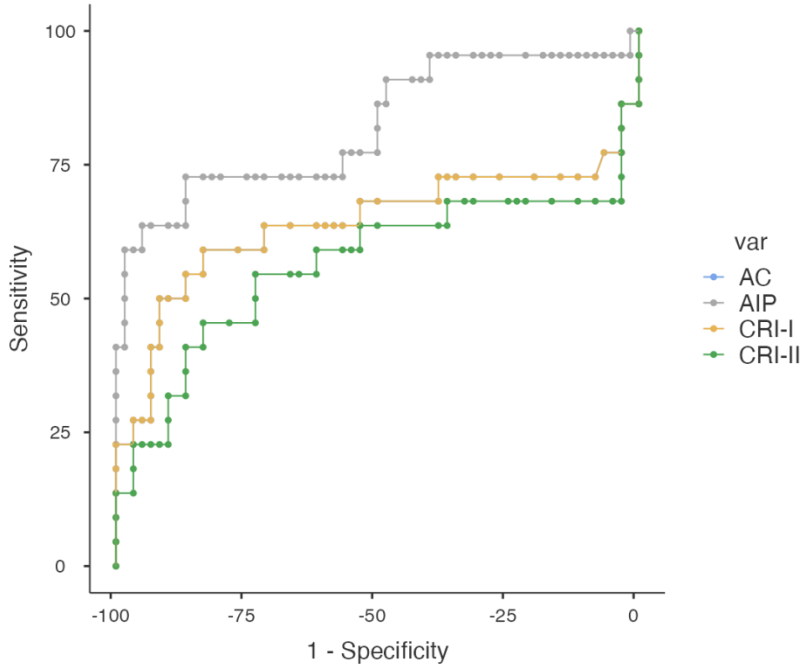


Figure 10: Receiver operating characteristic curve of atherogenic indices among the Permanent Atrial Fibrillation group.

Table 6: AUC, optimal threshold, Sensitivity and specificity of atherogenic indices among a group of Permanent Atrial Fibrillation.

	Cutpoint	Sensitivity %	Specificity %	PPV %	NPV %	Youden's index	AUC
AC	3.37	59.09%	83.33%	56.52%	84.75%	0.424	0.64
AIP	0.401	72.73%	86.67%	66.67%	89.66%	0.594	0.82
CRI-I	4.372	59.09%	83.33%	56.52%	84.75%	0.424	0.64
CRI-II	2.875	54.55%	73.33%	42.86%	81.48%	0.279	0.6

Table 7: Distribution of patients in Permanent Atrial Fibrillation Group and Healthy Controls according to the suggested Cutoff Value.

	AC 3.37		AIP 0.401		CRI-I 4.372		CRI-II 2.875	
	Negative	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**
Negative	50 (TN)	10 (FP)	52 (TN)	8 (FP)	Negative	Positive	44 (TN)	16 (FP)
Positive	9 (FN)	13 (TP)	6 (FN)	16 (TP)	50 (TN)	10 (FP)	10 (FN)	12 (TP)

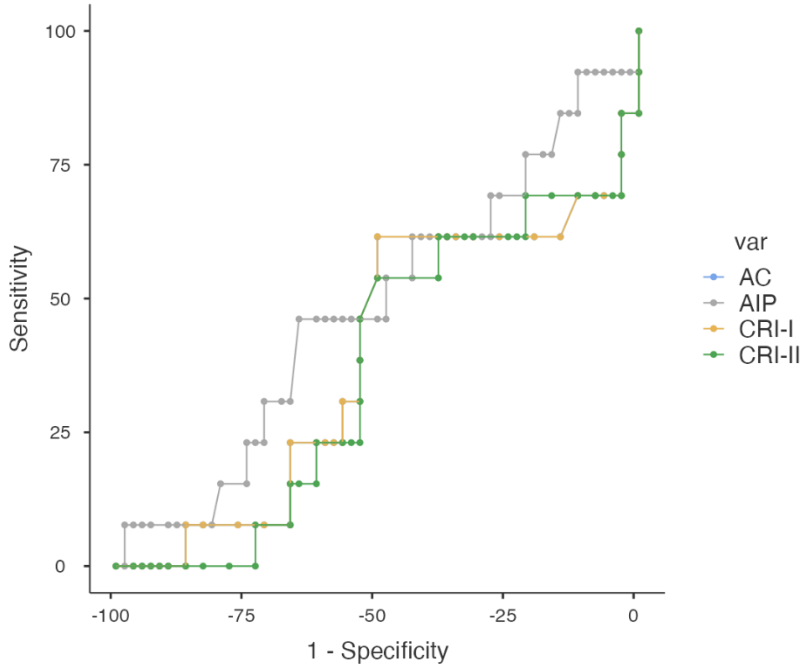


Figure 11: Receiver operating characteristic curve of atherogenic indices among the Lone Atrial Fibrillation group.

Table 8: AUC, optimal threshold, sensitivity, and specificity of atherogenic indices among a group of Lone Atrial Fibrillation.

	Cutpoint	Sensitivity %	Specificity %	PPV %	NPV %	Youden's index	AUC
AC	2.95	61.54%	50%	21.05%	85.71%	0.115	0.4
AIP	0.352	46.15%	65%	22.22%	84.78%	0.1115	0.5
CRI-I	3.95	61.54%	50%	21.05%	85.71%	0.115	0.4
CRI-II	2.57	53.85%	50%	18.92%	83.33%	0.03846	0.6

Table 9: Distribution of patients in Lone Atrial Fibrillation Group and Healthy control according to the suggested Cutoff Value.

	AC (2.95)		AIP (0.352)		CRI-I (3.95)		CRI-II (2.75)	
	Negative	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**
Negative	30 (TN)	30 (FP)	39 (TN)	21 (FP)	30 (TN)	30 (FP)	30 (TN)	30 (FP)
Positive	5 (FN)	8 (TP)	7 (FN)	6 (TP)	5 (FN)	8 (TP)	6 (FN)	7 (TP)

4. Discussion

Among the variables contributing to AF, hypertension (HT) confers the largest population attributable risk. Hypertension-related atrial remodeling is gradual yet reversible. However, the most promising approach to enhance the results of AF has been the suppression of the renin-angiotensin-aldosterone pathway [16,17]. Despite the variations in average cholesterol levels, coronary artery disease in both research groups. One significant independent risk factor for CAD is dyslipidemia. This variance may be the outcome of lifestyle modifications and the advancement of CAD caused by a variety of risk factors [18]. The explanation is that low plasma levels of HDL-C are the cause of the tendency to hypertrophic cardiomyopathy [19]. This leads to structural abnormalities in the atria, which raises the risk of atrial fibrillation instead of lipid profile changes.

Numerous studies have emphasized the necessity to validate the role of atherogenic indices and investigate whether specific threshold values or changes in these indices can be clinically applied to assess and monitor patients with various types of AF. These findings established the cut-offs and indicated the reference ranges of such cases to get a broader context on their levels. No previous studies were found to compare these results. The potential utility of atherogenic indices in assessing cardiovascular risk by combining conventional lipid profiles with these parameters. Targeted managements can benefit from knowledge of the particular factors that contribute to a high atherogenic index [20]. To measure total lipid levels, the atherogenic index of plasma, a reliable biomarker of dyslipidemia and AS, has been employed [21]. It is also thought to be a metabolic syndrome and coronary syndrome biomarker [22]. It has been shown in earlier research to be positively connected with the risk of cardiovascular disease [23]. Interestingly, some research suggests that AIP may have a stronger correlation with the risk of cardiovascular and cerebrovascular conditions compared to alternative values of single lipoprotein cholesterol [24]. Few studies, meanwhile, have looked at the connection between AIP and functional results in AIS. The AIP, which was determined by dividing the total cholesterol by the log10 of the HDL-C ratio, has recently been identified as a novel dyslipidemia measure that is more stable than conventional lipid counts alone [25]. Additionally, the logarithmic conversion value of TG/HDL-C utilized to generate AIP, which was used to characterize the clinical prediction effect, could more closely fit the statistical model believed to be an ecological distribution than the unconverted variables could [26]. Past studies have shown that AIP levels are positively associated with both the stability of plaque and the severity of coronary artery lesions [27]. This suggests that patients with high AIP levels are more vulnerable to the rapid development and rupture of coronary plaques, which increases the risk of unanticipated recurrent revascularization. Second, several studies have shown a strong correlation between high levels of AIP and insulin resistance, which is connected to a higher risk of cardiovascular incidents [28]. Thirdly, obese patients had a higher likelihood of having a high AIP level [29], and exhibited higher rates of metabolic syndrome, diabetes, and hypertension [30].

It was discovered that patients with ischemia had higher CRI levels, and that CRI-II levels, but not CRI-I, were connected with the degree of ischemia. The existence and severity of ischemia were both co-independently predicted by CRI-II, and the prediction of ischemia severity by CRI-II threshold values increased gradually [31]. Prior research has shown how CRI derived from lipid profiles can be used to predict cardiovascular disease. Zhang et al. [32] revealed that the risk of ischemic stroke is correlated with CRI-I, a measure of coronary plaque production, in both men and women. Dai et al. [33] found that there is a positive connection between CRI-I and CRI-II and aortic calcification. Afsin et al. [34] demonstrated that sluggish coronary flow can be independently predicted by CRI-II. Despite this, the results show that CRI is a useful screening method for CAD prediction. Gradual threshold values were provided by CRI-II to differentiate between ischemia severity. Beyond just determining whether ischemia is present, CRI-II can be a cheap and simple screening tool for predicting the severity of ischemia [35].

Conclusion

Alongside monitoring conventional lipid parameters, clinicians should also incorporate easily calculated indices such as AIP, AC, and CRI-I&II, which offer a more comprehensive reflection of complex lipid metabolism. For AF patients with optimally managed LDL-C levels, the simple index, which may be acquired from a standard lipid profile, may provide additional predictive information.

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