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Original Research Article

ECHOCARDIOGRAPHIC AND ELECTROCARDIOGRAPHIC FINDINGS AND THEIR CORRELATION WITH CD4 COUNT IN HIV PATIENTS ON ANTIRETROVIRAL THERAPY

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ABSTRACT

Background: Cardiovascular abnormalities are increasingly observed among people living with HIV (PLHIV), especially those with declining CD4 counts. Both traditional and HIV-specific risk factors, as well as the effects of antiretroviral therapy (ART), contribute to early-onset cardiac complications. This study aimed to assess the prevalence of ECG and echocardiographic abnormalities and their correlation with CD4 count in HIV-positive patients.

Materials and Methods: A cross-sectional, hospital-based study was conducted at PESIMSR, Andhra Pradesh, involving 77 HIV-positive adults attending the ART Centre. Clinical data, ECG, 2D echocardiogram, and CD4 counts were analyzed. Patients were categorized into three CD4 groups: <50, 50–100, and 101–200. Statistical analysis was performed using SPSS version 16, with $p < 0.05$ considered significant.

Results: Most participants (40.3%) had CD4 counts between 101–200. The most common comorbidities were anemia (40.3%) and tuberculosis (33.8%), though no significant associations were found with CD4 levels. ST/T wave changes on ECG showed a significant correlation with CD4 ($p = 0.01$), especially in the 50–100 group. Among echocardiographic findings, left ventricular systolic dysfunction (LVEF reduction) significantly correlated with lower CD4 counts ($p = 0.03$). Other abnormalities such as diastolic dysfunction, DCM, and pericardial effusion were more frequent in lower CD4 groups but did not reach statistical significance.

Conclusion: Cardiac abnormalities are common in HIV patients and may occur subclinically. Significant associations were observed between reduced CD4 counts and both ST/T wave changes on ECG and LV systolic dysfunction on echocardiography. Routine cardiovascular evaluation is recommended for timely detection and management of cardiac involvement in HIV care.

Keywords: HIV, CD4 count, Electrocardiogram (ECG), Echocardiography, Cardiovascular complications, Antiretroviral therapy (ART).

INTRODUCTION

A significant number of young people living with HIV were found to have an early beginning of cardiovascular disease. On the other hand, the synergistic interaction of traditional risk factors, such as diabetes mellitus, dyslipidaemia, and family history, significantly raised the risk for cardiovascular disease among people living with HIV by approximately twenty times. HIV-specific risk factors and lower CD4 levels exhibited almost twice the considerably increased risks for cardiovascular disease.[1] Myocarditis has been linked to a number of opportunistic diseases, including HIV itself, as a

potential explanation for the condition. The late stage of HIV infection is typically when dilated cardiomyopathy is discovered, and myocarditis may be the cause that sets off the progression of the condition. There have been reports of AIDS patients suffering from nonbacterial thrombotic endocarditis as well as infective endocarditis.[2]

Recently conducted research indicates that those living with HIV or HIV who are receiving HAART have a greater risk of experiencing cardiac events. Insulin resistance and dyslipidaemia are two of the metabolic side effects that can be caused by protease inhibitors, which are an essential component of the HAART regimen.[3] Diastolic dysfunction, left ventricular systolic dysfunction, pericardial effusion, dilated cardiomyopathy, and coronary artery disease are the most common complications. However, numerous cardiovascular complications have been described, including pulmonary hypertension, systemic hypertension, infective endocarditis, and accelerated atherosclerosis in HIV patients. These complications are the most common.[3]

As the disease progresses, the CD4 count deteriorates, which raises the probability of experiencing cardiovascular complications and ultimately passing away. An echocardiographic screening should be performed on all HIV patients who have low CD4 counts.[4] This will allow for the early detection and management of any issues that could arise. Following heart failure as the most common clinical cardiac diagnosis in HIV-positive patients, pulmonary artery hypertension was the second most common diagnostic overall. On echocardiograms, the most prevalent cardiovascular symptoms seen in HIV-positive patients were reduced fractional shortening, followed by lower ejection fraction from the beginning of the echocardiogram.[4]

The objective of this study was to ascertain the frequency of cardiac problems among HIV patients and to investigate the relationship between CD4 count and these issues. In addition to determining whether or not there is a correlation between cardiac problems in HIV patients and CD 4 count, the purpose of this study was to evaluate the degree to which CD 4 count can serve as a predictive indication of the course of disease in HIV patients.[5-7] One third of HIV-positive patients exhibited cardiovascular symptoms, with males being more likely to be affected than females. In patients with a low CD4 count, there is an increased presentation of cardiovascular symptoms. In patients with a decreased CD4 count, there was a higher prevalence of pericardial effusion as well as hypertension in the pulmonary arteries.[8]

Aim & Objectives

- To correlate the electrocardiographic and 2D Echo findings with CD4 count of HIV infected patients.
- To identify risk factors for cardiovascular disease among people living with HIV.

MATERIALS AND METHODS

This hospital-based, cross-sectional study was conducted in the Department of General Medicine at PES Institute of Medical Sciences & Research (PESIMSR), Kuppam, Andhra Pradesh. The study population included HIV-positive patients attending the Antiretroviral Therapy (ART) Centre at PESIMSR. A total of 77 HIV-positive patients, aged over 18 years, were included in the study over a period of 18 months.

The inclusion criteria comprised patients aged above 18 years who were either on antiretroviral therapy or treatment-naive individuals living with HIV. Patients with a history of valvular heart disease, congenital heart disease, rheumatic heart disease, thyroid disorders, hypertension, or pregnancy were excluded from the study.

All participants were evaluated using a structured proforma, which captured socio-demographic details, personal and family history, co-infections, and comorbidities such as hypertension, diabetes mellitus, ischemic heart disease, thyroid abnormalities, COPD, bronchial asthma, and cardiac conditions. A thorough clinical examination and systemic assessment were conducted for all patients. Key investigations included CD4 count, 12-lead electrocardiogram (ECG), two-dimensional echocardiogram, complete hemogram, thyroid-stimulating hormone (TSH), HbA1c, fasting lipid profile, erythrocyte sedimentation rate (ESR), renal function tests, urine analysis, ultrasound of the abdomen and pelvis, and chest X-ray in the posteroanterior (PA) view.

After obtaining written informed consent, each patient underwent a comprehensive medical history review and clinical examination. Blood samples were collected to assess CD4 counts, based on which participants were categorized into five groups: <49, 50–100, 101–300, 301–500, and >500. All patients were subjected to a standard 12-lead ECG and 2D echocardiographic examination. ECGs were analyzed for findings such as low voltage complexes, electrical alternans, ST elevation, heart blocks, QT interval prolongation, QRS prolongation, atrial fibrillation (AF), ventricular tachycardia (VT), and other arrhythmias. Echocardiograms were evaluated for cardiovascular abnormalities such as reduced ejection fraction, reduced fractional shortening, cardiomyopathy, pericardial effusion or disease, valvular lesions, and signs of infective endocarditis.

Data entry was performed using Microsoft Excel and statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 16. Descriptive statistics were employed to summarize categorical variables as frequencies and percentages, while quantitative variables were expressed as means with standard deviation (mean ± SD). Statistical comparisons between groups were made using the Chi-square test for categorical variables. A p-value of less than 0.05 was considered statistically significant,

adhering to the standard assumptions of each statistical test.

RESULTS

The majority of the participants (33.8%) were in the 41–50 years age group, followed by 31.2% in the 31–40 years group. The least number of participants (6.5%) were aged above 61 years. Out of 77 HIV-infected patients, 51.9% were male and 48.1% were females. Out of the 77 HIV patients, 61.0% had a normal BMI, while 23.4% were underweight, indicating a significant proportion with possible nutritional deficiencies. Additionally, 15.6% were overweight. Substance use was common among the study participants, with 46.8% reporting alcohol consumption and 28.6% having a history of smoking.
The majority of participants (40.3%) had a CD4 count between 101–200, followed by 39.0% in the 50–100 range. A smaller proportion (20.8%) had a CD4 count below 50.
About 23.4% of patients were on ART for less than 6 months, while 13.0% had been receiving treatment for 25–60 months.
The most common comorbidity observed among the HIV patients was anemia, present in 40.3% of cases, followed by pulmonary tuberculosis affecting 33.8%. Diabetes mellitus in 5.2% and Hypertension in 3.9%. Other comorbidities like ischemic heart disease, and COPD were each reported in 2.6% of patients. Notably, no patients had a known history of valvular, congenital, or rheumatic heart disease, nor any thyroid disorders.
Among the lipid profile abnormalities observed in the study population, decreased HDL levels were the most common, seen in 62.3% of patients. Elevated LDL was noted in 20.8%, while increased triglyceride levels were present in 18.2%. Abnormal total cholesterol was seen in 16.9% of cases.
Among the 77 HIV patients evaluated, tachycardia was observed in 31.2% of patients, while bradycardia was noted in 2.6%. The majority (66.2%) had a normal heart rate. Conduction abnormalities were present in 19.4% of the patients. ST/T wave abnormalities were seen in 27.2% of patients. Prolonged QT intervals were identified in 5.2% of the study subjects.
Left ventricular (LV) systolic dysfunction, based on reduced ejection fraction (LVEF), was noted in 31.2% of patients, while LV diastolic dysfunction was present in 27.2%. Valvular regurgitation (including mitral, aortic, pulmonary, and tricuspid) was observed in 32.5% of patients. Dilated cardiomyopathy was found in 12.9% of the subjects. Pulmonary hypertension was present in 16.8%. Regional wall motion abnormalities were observed in 7.7% of patients. Pericardial effusion was detected in 7.8%.

Table 1: Correlation Between Age, gender and CD4 Count in HIV Patients

			CD4 count			Total
			<50	50-100	101-200	
Age Group	18-30 years	n	2	1	4	7
		%	28.6%	14.3%	57.1%	100%
	31-40 years	n	3	12	9	24
		%	12.5%	50.0%	37.5%	100%
	41-50 years	n	6	11	9	26
		%	23.1%	42.3%	34.6%	100%
	51-60 years	n	4	5	6	15
		%	26.7%	33.3%	40.0%	100%
	>61 years	n	1	1	3	5
		%	20.0%	20.0%	60.0%	100%
Gender	Male	n	8	16	16	40
		%	20.0%	40.0%	40.0%	100%
	Female	n	8	14	15	37
		%	21.6%	37.8%	40.5%	100%

The majority of patients (40.3%) had CD4 counts between 101–200, indicating moderate immunosuppression. CD4 <50 was most common in the 41–60 years age group. Younger (18–30) and older (>61) patients had higher CD4 >100 levels. Among both males and females, around 40% had CD4 counts between 101–200, with slightly more females having CD4 <50.

Table 2: Correlation Between Comorbid Conditions and CD4 Count in HIV Patients

		CD4 count			Total	P value
		<50	50-100	101-200		
Hypertension	n	1	1	1	3	0.76
	%	33.3%	33.3%	33.3%	100%	
Diabetes mellitus	n	1	1	2	4	0.24
	%	25.0%	25.0%	50.0%	100%	
Ischemic heart disease	n	0	1	1	2	0.76
	%	0.0%	50.0%	50.0%	100%	
COPD	n	1	1	0	2	0.42
	%	50.0%	50.0%	0.0%	100%	
Anemia	n	7	13	11	31	0.78

	%	22.6%	41.9%	35.5%	100%	
Pulmonary tuberculosis	n	5	14	7	26	0.13
	%	19.2%	53.8%	26.9%	100%	

Comorbidities such as hypertension, diabetes, IHD, COPD, anemia, and pulmonary tuberculosis showed no statistically significant association with CD4 count ($p > 0.05$ for all). While TB and COPD were more frequent in patients with CD4 <100, and anemia was common across all groups, these trends lacked significant correlation.

Table 3: Correlation Between Lipid Profile Abnormalities and CD4 Count in HIV Patients

		CD4 count			Total	P value
		<50	50-100	101-200		
Total cholesterol (>200 mg/dl)	n	1	7	5	13	0.33
	%	7.7%	53.8%	38.5%	100%	
HDL (male <40mg/dl, female <50mg/dl)	n	11	17	20	48	0.68
	%	22.9%	35.4%	41.7%	100%	
LDL (>100mg/dl)	n	1	8	7	16	0.25
	%	6.3%	50.0%	43.8%	100%	
Triglycerides (>150mg/dl)	n	2	6	6	14	0.80
	%	14.3%	42.9%	42.9%	100%	

Dyslipidemia parameters showed no significant correlation with CD4 count. Total cholesterol >200 mg/dL and elevated LDL were most common in the CD4 50–100 group (53.8% and 50.0%, respectively), while low HDL was more frequent in CD4 >100 (41.7%). High triglycerides were equally seen in CD4 50–100 and >100 groups (42.9%), but rare in CD4 <50 (14.3%). All associations were statistically non-significant ($p > 0.05$).

Table 4: Correlation Between Electrocardiographic (ECG) Abnormalities and CD4 Count in HIV Patients

			CD4 count			Total	P value
			<50	50-100	101-200		
Rate	Bradycardia	n	0	1	1	2	0.36
		%	0.0%	50.0%	50.0%	100%	
	Tachycardia	n	3	12	9	24	
		%	12.5%	50.0%	37.5%	100%	
Conduction abnormalities		n	2	8	5	15	0.42
		%	13.3%	53.3%	33.3%	100%	
ST/T wave abnormality		n	4	14	3	21	0.01
		%	19.0%	66.6%	14.2%	100%	
QT prolonged		n	1	0	3	4	0.22
		%	25.0%	0.0%	75.0%	100%	

Among ECG findings, ST/T wave abnormalities showed a statistically significant association with CD4 count ($p = 0.01$), most commonly seen in patients with CD4 50–100 (66.6%). Other abnormalities—including bradycardia, tachycardia, conduction defects, and QT prolongation—were more frequent in lower CD4 groups but did not reach statistical significance ($p > 0.05$).

Table 5: Correlation between Echocardiographic Abnormalities and CD4 Count in HIV Patients

LV diastolic dysfunction	**n**	**6**	**10**	**5**	**21**	**0.34**
	%	**28.5%**	**47.6%**	**23.8%**	**100%**	
Valvular regurgitation (MR,AR,PR,TR)	n	6	10	9	25	0.95
	%	24.0%	40.0%	36.0%	100%	
LV Systolic dysfunction (Reduced LVEF)	n	9	9	6	24	0.03
	%	37.5%	37.5%	25.0%	100%	
Dilated cardiomyopathy	n	4	6	0	10	0.28
	%	40.0%	60.0%	0.0%	100%	
Pulmonary hypertension	n	3	6	4	13	0.91
	%	23.0%	46.1%	30.7%	100%	
Regional wall motion abnormality	n	3	2	1	6	0.41
	%	50.0%	33.3%	16.6%	100%	
Pericardial effusion	n	1	5	1	7	0.37
	%	14.2%	71.4%	14.2%	100%	

Among echocardiographic findings, LV systolic dysfunction (reduced LVEF) showed a statistically significant association with CD4 count ($p = 0.03$), being most frequent in CD4 <100 groups. Other abnormalities like diastolic dysfunction, valvular regurgitation, DCM, PAH, RWMA, and pericardial effusion were more common in lower CD4 strata but lacked statistical significance ($p > 0.05$), indicating a trend without strong correlation.

DISCUSSION

In this study, we aimed to evaluate the correlation between electrocardiographic and echocardiographic findings with CD4 counts in HIV-infected patients and to identify cardiovascular risk factors among people living with HIV. Cardiovascular involvement in HIV is increasingly recognized due to both direct viral effects and long-term immune suppression, which may lead to subclinical or overt cardiac dysfunction. With the advent of antiretroviral therapy (ART), patients are living longer, thereby increasing the relevance of non-infectious complications such as cardiac manifestations.

In our study, the majority of HIV-positive patients were middle-aged adults, with the highest representation in the 41–50 years age group (33.8%), followed by 31–40 years (31.2%). This age distribution aligns with findings from studies by Sharath Madhyastha et al,[9] and Sakthivel et al,[10] where the predominant age groups were 41–50 and 45–54 years, respectively. The gender distribution in our study was nearly equal (51.9% male, 48.1% female), which is comparable to findings by Sakthivel et al. and Bang et al., but contrasts with studies such as Marwadi et al,[11] and Kumar et al,[12] which showed a male predominance. Most of our patients (63.6%) had been on ART for 6–24 months, indicating relatively recent therapy initiation, whereas Bang et al,[13] reported a longer average ART duration (7.29 years). BMI and socioeconomic data were not assessed in detail in our study but were key factors in studies like Nsagha et al,[14] and Cookey et al,[15] which highlighted trends toward underweight or overweight status among HIV patients. Overall, our demographic findings are consistent with national and international studies showing that HIV predominantly affects adults in their most productive years, with a slight male predominance.

In this study, the majority of HIV-positive patients had moderate to severe immunosuppression, with 40.3% having CD4 counts between 101–200, 39.0% between 50–100, and 20.8% with CD4 <50. This is comparable to studies by Sharma et al.16 and Marwadi et al,[11] which also reported a high proportion of patients with CD4 counts <200 cells/μL, emphasizing significant immunosuppression in these populations. Singh et al,[17] and Kumar et al,[12] highlighted that lower CD4 counts were strongly associated with echocardiographic abnormalities, a finding echoed in our study. Patients with longer ART duration (25–60 months) in our study showed higher CD4 counts, consistent with observations by Nsagha et al,[14] and Bang et al,[13] supporting the role of sustained ART in immune recovery. While younger patients in our cohort tended to have higher CD4 counts, no statistically significant age correlation was observed—similar to findings by Saxena et al,[19] Mean or median CD4 counts reported in other studies—such as Marbaniang et al,[18] (378 cells/μL) and Nsagha et al,[14] (421.5 ± 279.9 cells/μL)—were higher than in our study, likely due to differences in ART duration and baseline disease burden. Overall, our findings align with existing literature that underscores a strong inverse relationship between low CD4 counts and cardiovascular involvement.

In this study, anemia (40.3%) emerged as the most common comorbidity among HIV-positive patients, followed by pulmonary tuberculosis (33.8%), both of which were more prevalent in individuals with CD4 counts <100 cells/μL, although no statistically significant correlation was observed. These findings are consistent with Gaikwad et al., who also reported tuberculosis (27.3%) and anemia (26%) as leading comorbidities, particularly in immunosuppressed individuals. Unlike studies by Marbaniang et al,[18] Sakthivel et al,[10] and Nsagha et al,[14] where non-communicable comorbidities such as hypertension, diabetes, dyslipidemia, and metabolic syndrome were prominent, our cohort had lower rates of these conditions (all 2.6%), likely due to differences in population demographics, ART duration, and exclusion criteria. Sharath Madhyastha et al,[9] and Gaikwad et al,[20] excluded patients with pre-existing cardiovascular disease, as in our study, but still observed metabolic abnormalities and borderline dyslipidemia, suggesting the potential for subclinical risk even in the absence of overt disease. Overall, our findings reflect the continuing burden of communicable comorbidities like TB and anemia in HIV patients with low CD4 counts, while studies from more urban or better-resourced settings are increasingly documenting a transition toward non-communicable diseases in long-term ART-treated populations.

In this study, ECG abnormalities were observed in a substantial proportion of patients, with tachycardia (31.2%), ST/T wave changes (27.2%), conduction abnormalities (19.4%), and QT interval prolongation (5.2%). Notably, ST/T wave abnormalities showed a statistically significant association with CD4 count ($p = 0.01$), being most prevalent among patients with CD4 counts between 50–100 cells/μL, suggesting early myocardial involvement in moderate immunosuppression. These findings are consistent with previous studies such as Gaikwad et al,[20] who reported a strong inverse relationship between ECG abnormalities and CD4 count ($p < 0.001$), and Bang et al,[13] who found significant associations between QTc prolongation, LBBB, and CD4 <200. Similarly, Sharath Madhyastha et al,[9] and Sharma et al,[16] reported sinus tachycardia and low voltage complexes more frequently in patients with lower CD4 counts, although statistical significance was not consistently demonstrated. Marwadi et al,[11] also documented a high prevalence of sinus tachycardia, low voltage complexes, and QTc prolongation, particularly in patients with advanced immunosuppression. While not all ECG abnormalities in our study reached statistical significance, the trend of more frequent abnormalities

in patients with lower CD4 levels aligns with the broader literature.

In this study, echocardiographic abnormalities were prevalent, with left ventricular systolic dysfunction (31.2%) and diastolic dysfunction (27.2%) being the most common findings, reflecting significant compromise in both contractile and relaxation functions. Valvular regurgitation was observed in 32.5% of cases, while dilated cardiomyopathy (12.9%), pulmonary hypertension (16.8%), regional wall motion abnormalities (7.7%), and pericardial effusion (7.8%) were also noted. Although statistical significance with CD4 count was not established for all parameters, a clear trend emerged—patients with lower CD4 counts, particularly <100 cells/µL, had more frequent and severe cardiac abnormalities. These results are consistent with multiple studies, including Singh et al,[17] Sharma et al,[16] Gaikwad et al,[20] and Marwadi et al,[11] all of which reported a strong inverse relationship between CD4 count and echocardiographic abnormalities, particularly systolic dysfunction, DCM, and pericardial effusion. Studies such as Bang et al,[13] and Saxena et al,[19] also found statistically significant associations between low CD4 levels and reduced ejection fraction, LVDD, and DCM. Our findings, while not all statistically significant, align with the broader evidence that cardiac dysfunction in HIV patients—often subclinical—correlates with the degree of immunosuppression and underscores the need for routine echocardiographic screening, especially in patients with CD4 <200 cells/µL.

This study highlights the high prevalence of cardiovascular involvement—both electrical (ECG) and structural (2D Echo)—among HIV-positive patients, with a partial but clinically meaningful correlation with CD4 count. ST/T wave changes on ECG showed a statistically significant association with CD4 levels, particularly in the 50–100 range, pointing to early myocardial involvement in moderate immunosuppression. Although echocardiographic abnormalities such as LV systolic and diastolic dysfunction, valvular regurgitation, and dilated cardiomyopathy were not statistically correlated with CD4 count in this dataset, they were notably more common in patients with CD4 <200, echoing trends seen in studies by Singh,[17] Sharma,[16] Gaikwad,[20] and Marwadi,[11] among others. These studies consistently show that advancing immunosuppression—especially CD4 <100 or <50—is associated with increased risk and severity of cardiac abnormalities, including pericardial effusion, pulmonary hypertension, and heart failure. While some studies, such as Saxena et al,[19] suggest that cardiac involvement may also occur independently of CD4 count—likely due to chronic inflammation or direct viral effects—most agree on the value of routine cardiovascular screening in HIV care.

CONCLUSION

This study highlights that HIV patients commonly had moderate immunosuppression, with most having CD4 counts between 50–200. While comorbidities like anemia and tuberculosis were prevalent, no statistically significant correlation was found between most comorbid conditions and CD4 count. Notably, ST/T wave abnormalities on ECG are significantly associated with lower CD4 levels, indicating possible early cardiac involvement in moderately immunosuppressed patients. Although trends suggested better immune status with longer ART duration and normal BMI, these were not always statistically significant. Overall, the findings underscore the importance of regular cardiovascular evaluation and holistic care in HIV patients, beyond just immunological monitoring.

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