

ORIGINAL RESEARCH

Relationship between electrocardiogram and findings of serum protein, transaminase and chest CT in male AIDS patients

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Abstract

To investigate the relationship between electrocardiogram (ECG) and findings of serum protein, transaminase and chest computed tomography (CT) in male acquired immune deficiency syndrome (AIDS) patients. 122 male AIDS patients were divided into groups according to serum protein, transaminase detection and chest CT results. ECG detection results of different groups were compared and analyzed. Among 122 male AIDS patients, 75 patients had abnormal ECGs, with a prevalence of 61.48%. According to serum protein detection results, the proportion of male AIDS patients with decreased albumin was the highest, 38.52%. Tachyarrhythmia was significantly more prevalent in the decreased albumin and increased globulin group than in the normal serum protein group ($\chi^2 = 10.710$, $p = 0.001$). The incidence of tachyarrhythmia in the albumin reduction group was significantly higher than in the normal serum protein group ($\chi^2 = 9.387$, $p = 0.002$). Transaminase test results showed 19.67% of patients had elevated glutamic pyruvic transaminase (ALT) and glutamic oxaloacetic transaminase (AST). In the elevated AST group, the tachyarrhythmia incidence was significantly higher ($\chi^2 = 11.484$, $p = 0.001$), and significantly higher in the elevated ALT and AST groups than in the normal transaminase group ($\chi^2 = 9.102$, $p = 0.003$). Chest CT examination showed, 48.36% of patients had pulmonary inflammation. Tachyarrhythmia incidence was significantly higher in the pulmonary inflammation group than in the normal CT examination group ($\chi^2 = 8.437$, $p = 0.004$). As compared to the normal CT group, tachyarrhythmia was significantly more prevalent in the pulmonary tuberculosis group ($\chi^2 = 4.323$, $p = 0.038$). The incidence of abnormal ECG in male AIDS patients is significant. The high incidence of abnormal ECG in male AIDS patients is closely associated with albumin reduction, ALT elevation and pulmonary infection. Electrocardiogram monitoring can provide valuable reference and guidance for clinical diagnosis and treatment.

Keywords

Male; AIDS; Electrocardiogram; Serum protein; Transaminase; Chest CT

1. Introduction

AIDS emerged as an immunodeficiency disease caused by human immunodeficiency virus (HIV) virus infection, which has high infectivity and high mortality. Human life and safety are seriously threatened, and it has become one of the most pressing health problems in society [1]. AIDS is mainly prevalent in the male homosexual population, so the proportion of males is significantly higher than that of females, with a ratio of 10:1 [2]. AIDS patients suffer mainly from opportunistic infections due to immune deficiency [3]. Whether patients are infected or suffering from other conditions, their cardiovascular system, cardiac function will be damaged in varying degrees. Dilated cardiomyopathy, myocarditis, and endocarditis are clinically recognized heart function impairments [4]. ECG

monitoring is convenient and rapid for early cardiac function injury examination in AIDS patients. Despite the fact that ECG changes are earlier than morphological changes of heart, early clinical interventions based on ECG changes have critical clinical significance for preventing and treating cardiac function injuries. Clinical studies on cardiac function impairment and their ECG changes are scarce at present [3]. Considering this, this study examined male AIDS patients, aimed to investigate the relationship between electrocardiographic findings and serum protein, transaminase, and chest CT findings. Male AIDS patients admitted to our hospital between January 2020 and July 2022 were studied and reported.

2. Materials and methods

2.1 Clinical data

A total of 122 male AIDS patients admitted to our hospital from January 2020 to July 2022 were selected as study subjects. Patients ranged in age from 19 to 72 years, with an average age of (44.04 ± 12.63) years. Table 1 and Fig. 1 detail clinical data.

TABLE 1. Clinical data table of study subjects.

Item	Case	Proportion (%)
Occupation		
Farmer	42	34.43
Worker	64	52.46
Student	4	3.28
Other occupation	12	9.84
Education		
Junior high school and below	43	35.25
High school	62	50.82
High school and above	17	13.93
Sexual partner history		
Yes	30	24.59
No	92	75.41

2.1.1 Inclusion criteria

(1) Patients who meet the relevant diagnostic criteria for AIDS in the Chinese Guidelines for the Diagnosis and Treatment of AIDS; (2) Patients who cooperated with clinical examinations; (3) Patients who signed the informed consent form.

2.1.2 Exclusion criteria

(1) Patients with incomplete ECG data; (2) Patients with missing serum protein, transaminase, chest CT examination results; (3) Patients with abnormal renal function.

2.2 Test method

2.2.1 Electrocardiogram test method

This study involved ECG examinations performed by an electrocardiographer with 5 years' experience and a mastery of operating procedures for electrocardiography-related equipment. Cardsoft synchronous 12-lead electrocardiograph (General Electric Company, USA) was used.

2.2.2 Detection method for serum protein and transaminase

Under fasting conditions, 3 mL of venous blood was drawn from the study subjects in the morning and centrifuged (model: Beckman AU5831 automatic biochemical analysis system; manufacturer: Beckman Coulter USA Co., Ltd.) to separate serum. The centrifuge was set at the following parameters: rotation speed: 2000 r/min, time: 10 min. Serum was stored at $-30\text{ }^{\circ}\text{C}$. At the time of testing, patient's blood specimen was withdrawn and separated if it was found to be hemolyzed. Serum protein was detected by serum protein electrophoresis and transaminases were detected by rate nephelometry.

2.2.3 Chest CT examination

GE Revolution EVO 64-slice CT scanner (USA) was used. Associated parameters were set as follows: voltage: 120 kV, current: 230 mAs, interslice: 5 mm, slice thickness: 5 mm. Patients were asked to remain supine on the CT scanner and a plain CT scan was performed. Contrast agent were injected according to the patient's weight for an enhanced scan.

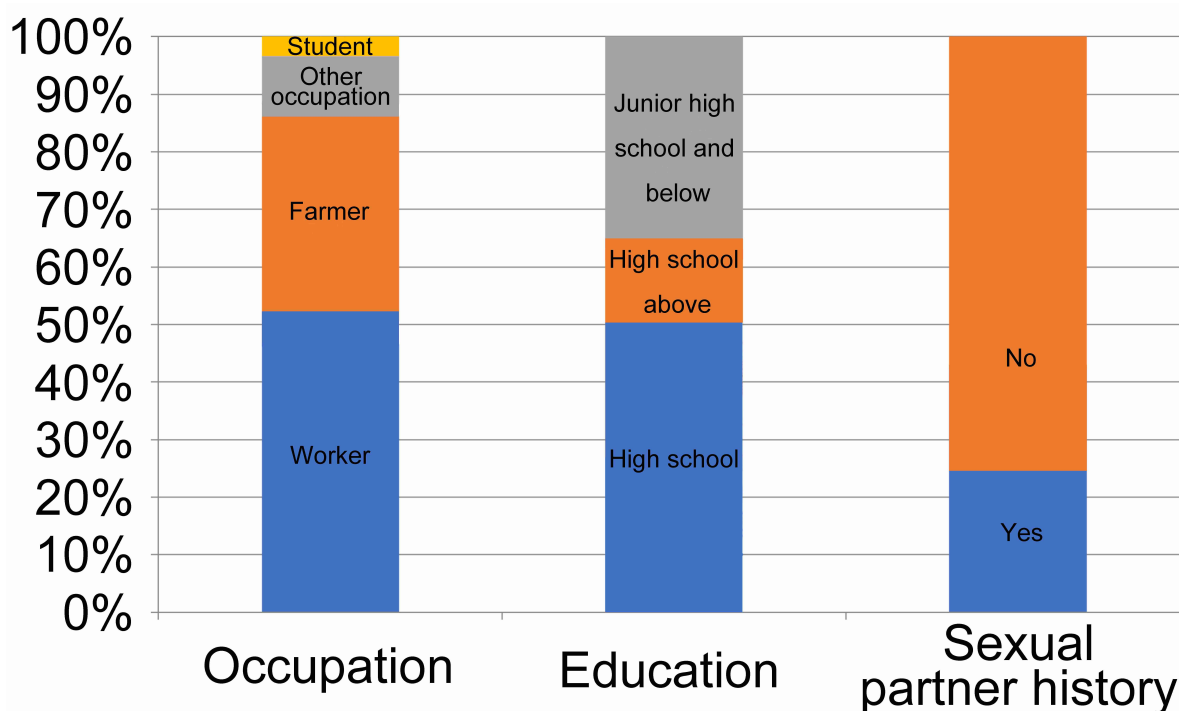


FIGURE 1. Clinical data of study subjects.

2.3 Outcome measures

According to serum protein, transaminase and chest CT, the patients were divided into groups. ECGs from different groups were compared and analyzed.

2.4 Statistical analysis

IBM SPSS Statistics 25.00 (IBM, Armonk, NY, USA) was used for data processing. Enumeration data was tested using percentage (%) and χ^2 . $\bar{x} \pm s$ and t were applied to measurement data that meet the normal distribution characteristics. $p < 0.05$ indicated significant difference.

3. Results

3.1 Relationship between electrocardiogram and serum protein in male AIDS patients

In the serum protein detection results, 38.52% of male AIDS patients had decreased albumin, which was the highest proportion. Tachyarrhythmia was the main ECG abnormality in patients. Tachyarrhythmia was significantly more prevalent in the decreased albumin and increased globulin group compared to the normal serum protein group ($\chi^2 = 10.710$, $p = 0.001$). The incidence of tachyarrhythmia in the albumin reduction group was significantly higher than in the normal serum protein group ($\chi^2 = 9.387$, $p = 0.002$). Table 2 and Fig. 2 show the results.

3.2 Relationship between electrocardiogram and transaminases in male AIDS patients

Transaminase test results showed that among the abnormal transaminase groups, patients with elevated ALT and AST accounted for the highest proportion (19.67%). Tachyarrhythmia was the main ECG abnormality in patients. In the elevated AST group, the tachyarrhythmia incidence was significantly higher than in the normal transaminase group ($\chi^2 = 11.484$, $p = 0.001$). Tachyarrhythmia incidence was significantly higher in the elevated ALT and AST group than in the normal transaminase group ($\chi^2 = 9.102$, $p = 0.003$). Table 3 and Fig. 3 show the results.

3.3 Relationship between electrocardiogram and chest CT findings in male AIDS patients

According to chest CT examination, among male AIDS patients, those with pulmonary inflammation accounted for the highest proportion (48.36%). Tachyarrhythmia was the main ECG abnormality in patients. Tachyarrhythmia incidence was significantly higher in pulmonary inflammation group than in the normal CT group ($\chi^2 = 8.437$, $p = 0.004$). As compared to the normal CT group, tachyarrhythmia was significantly more prevalent in the pulmonary tuberculosis group ($\chi^2 = 4.323$, $p = 0.038$). Table 4 and Fig. 4 show the results.

4. Discussion

HIV infection reduces AIDS patients' immune capacity. Long-term HIV infection involves multiple systems and organs. There is higher likelihood of digestive system, respiratory system damage in patients [4]. Clinical studies indicate that AIDS patients can suffer cardiac function injuries. Case reports describing patients with cardiac injuries have gradually raised concerns among clinical workers [5]. ECG has become a more clinical mature examination method for detecting cardiac function in patients, which can identify and predict myocardial injury-related problems [6]. Cardiac function impairment in AIDS patients is rarely studied clinically, while studies of ECG abnormalities are even rarer. An investigation into electrocardiographic abnormalities in AIDS patients explored the incidence and associated factors. AIDS patients have been found to have a high incidence of electrocardiographic abnormalities, which are related to factors such as age, cluster of differentiation 4 (CD4) cell count, viral load, and inflammatory markers [7]. However, the study did not include serum protein, transaminases, and chest CT examinations [7]. A review article [8] noted that AIDS patients have a higher incidence of cardiovascular disease, and ECG abnormalities are one of the common cardiovascular manifestations. Electrocardiographic changes are related to risk factors for cardiac disease (e.g., inflammation, dyslipidemia, etc.), which stresses the importance of preventing and managing cardiovascular disease among AIDS patients [8]. However, a detailed discussion of the relationship between serum protein, transaminases, and chest CT findings was not provided in this review. AIDS patients were also studied for predictors of cardiovascular disease [9]. A number of factors have been found to be associated with cardiovascular lesions in AIDS patients, including age, hypertension, antiretroviral therapy history, viral load, and inflammatory markers. A specific relationship between ECG, serum protein, transaminases, and chest CT examinations was not addressed. To provide clinical references and references for AIDS prevention and treatment, this study analyzed the ECG findings of male AIDS patients, and compared the relationship between abnormal ECG findings and serum protein, transaminase, chest CT findings.

4.1 Relationship between abnormal electrocardiogram and serum protein in male AIDS patients

This study showed that male AIDS patients with decreased albumin had the highest percentage (38.52%). Tachyarrhythmia was the main ECG abnormality in patients. Patients with decreased albumin, patients with decreased albumin and increased globulin had a higher incidence of tachyarrhythmia than those with normal serum protein. This suggests that an abnormal ECG in male AIDS patients is associated with decreased albumin.

TABLE 2. Relationship between electrocardiogram and serum protein in male AIDS patients (%).

Group	N	Composition ratio	Abnormal electrocardiogram		Tachyarrhythmia		Bradyarrhythmia		Left atrioventricular hypertrophy		Right atrioventricular hypertrophy		ST-T change		Other	
			n	%	n	%	n	%	n	%	n	%	n	%	n	%
Normal serum protein group	44	36.07	20	45.45	4	9.09	9	20.45	3	6.82	0	0.00	5	11.36	3	6.82
Decreased albumin and increased globulin group	26	21.31	18	69.23	11	42.31*	4	15.38	4	15.38	0	0.00	5	19.23	5	19.23
Decreased albumin group	47	38.52	36	76.60	17	36.17*	6	16.67	2	6.25	4	8.33	6	12.50	8	17.02
Increased globulin group	5	4.10	1	20.00	0	0.00	1	20.00	0	0.00	0	0.00	0	0.00	1	20.00
Total	122	100.00	75	61.48	32	24.59	19	15.57	9	7.34	4	3.28	16	13.11	17	13.93

Note: *Compared with normal serum protein group, $p < 0.05$, significant difference.

ST-T: Segment T-Terminal.

TABLE 3. Relationship between electrocardiogram and transaminases in male AIDS patients (%).

Group	N	Composition ratio	Abnormal electrocardiogram		Tachyarrhythmia		Bradyarrhythmia		Left atrioventricular hypertrophy		Right atrioventricular hypertrophy		ST-T change		Other		
			n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Normal transaminase group	80	65.57	41	51.25	13	16.25	13	16.25	5	6.25	4	5.00	8	10.00	8	10.00	
Elevated group	ALT	4	3.28	2	50.00	0	0.00	0	0.00	0	0.00	0	0.00	1	25.00	1	25.00
Elevated group	AST	14	11.48	12	85.71	8	57.14*	3	21.43	2	14.29	0	0.00	3	21.43	4	28.57
Elevated and AST group	ALT	24	19.67	20	83.33	11	45.83*	3	12.5	2	8.33	0	0.00	4	16.67	3	12.50
Total		122	100.00	75	61.48	32	24.59	19	15.57	9	7.34	4	3.28	16	13.11	17	13.93

Note: *Compared with the normal transaminase group, $p < 0.05$, significant difference.
 ALT: glutamic pyruvic transaminase; AST: glutamic oxaloacetic transaminase; ST-T: Segment T-Terminal.

TABLE 4. Relationship between electrocardiogram and chest CT findings in male AIDS patients.

Group	N	Composition ratio	Abnormal electrocardiogram		Tachyarrhythmia		Bradyarrhythmia		Left atrioventricular hypertrophy		Right atrioventricular hypertrophy		ST-T change		Other	
			n	%	n	%	n	%	n	%	n	%	n	%	n	%
Normal CT group	35	28.69	15	42.86	3	8.57	5	14.29	1	2.86	0	0.00	5	14.29	4	11.43
Pulmonary inflammation group	59	48.36	41	69.49	21	35.59*	7	11.86	5	8.47	4	6.78	7	11.86	9	15.25
Tuberculosis group	12	9.84	7	58.33	4	33.33*	2	16.67	1	8.33	0	0.00	4	33.33	2	16.67
Pulmonary tuberculosis + pneumonitis group	16	13.11	12	75.00	4	25.00	5	31.25	2	12.5	0	0.00	0	0.00	2	12.50
Total	122	100.00	75	61.48	32	24.59	19	15.57	9	7.34	4	3.28	16	13.11	17	13.93

Note: *Compared with normal CT group, $p < 0.05$, significant difference.
 CT: computed tomography, ST-T: Segment T-Terminal.

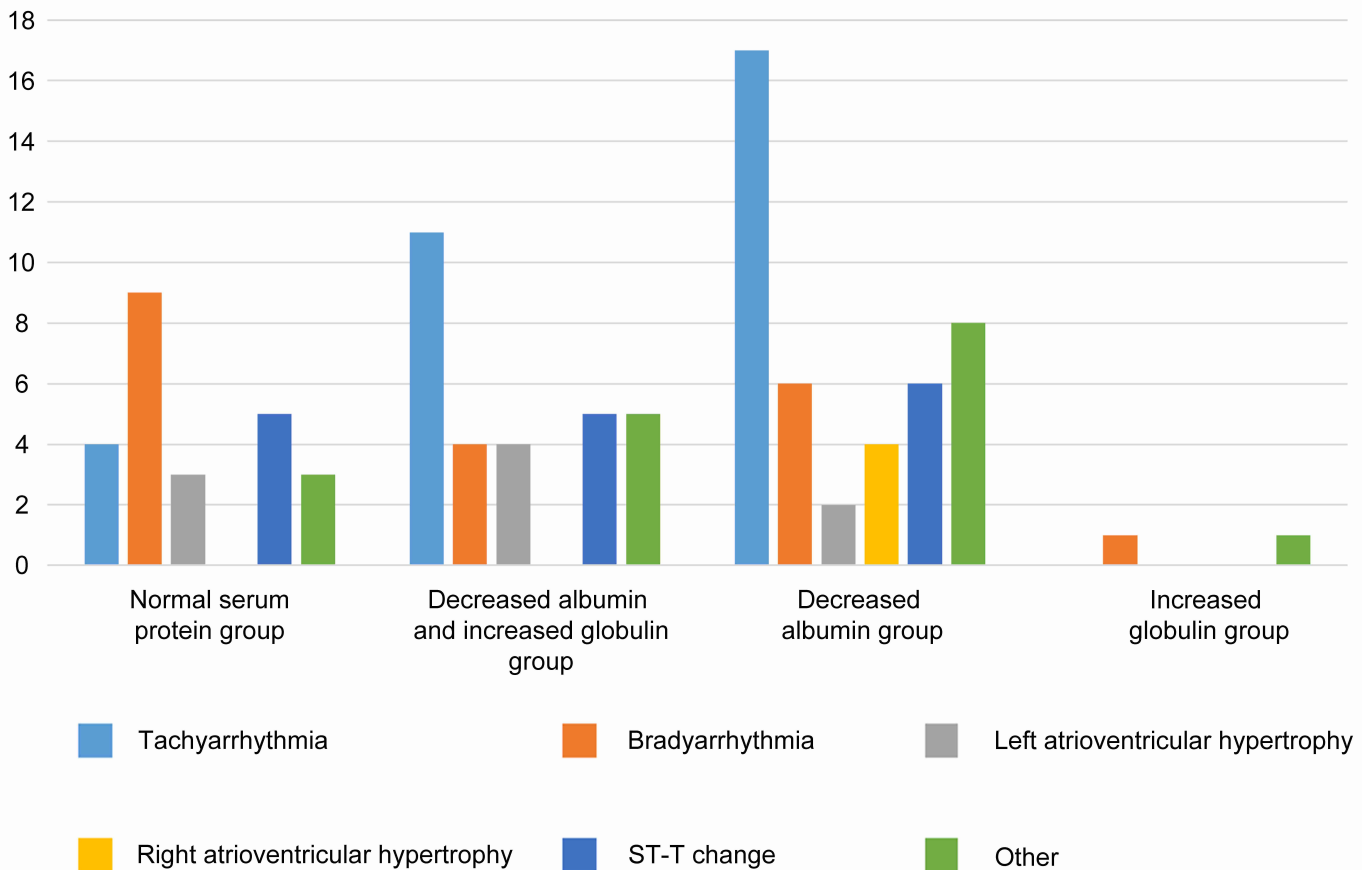


FIGURE 2. Relationship between ECG and serum protein in male AIDS patients. ST-T: Segment T-Terminal.

Albumin levels decrease in AIDS patients for two important reasons [9–11]. Long-term HIV infection damages liver function, resulting in decreased albumin levels. Patients suffer from digestive system damage, which leads to poor protein absorption of proteins, and ultimately lower albumin levels. Albumin plays a key role in maintaining blood volume and regulating plasma colloid osmotic pressure. Albumin levels decreased, and blood volume tended to decrease. Osmotic imbalances can lead to blood extravasation. Only by strengthening cardiac fluctuations, enhancing myocardial function and other means can the human body effectively respond to this situation. Then, the clinical ECG showed a tachyarrhythmia (tachycardia).

4.2 Relationship between abnormal electrocardiogram and transaminase in male AIDS patients

Among male AIDS patients, patients with elevated ALT and AST accounted for the highest proportion (19.67%) of abnormal transaminase groups. Tachyarrhythmia was the main ECG abnormality in patients. Patients with elevated AST (elevated AST group, elevated ALT and AST group) had a higher incidence of tachyarrhythmia than those with normal transaminases. This noted that abnormal ECG in male AIDS patients is associated with elevated AST.

AST increases in AIDS patients mainly due to three factors [12–14]. First, patients' liver function is impaired under HIV exposure due to long-term HIV infection. Second, AIDS

patients' immune capacity is reduced, resulting in a reduced ability to resist viruses and bacteria, which may lead to liver involvement. Third, it is also affected by long-term oral drug treatment in AIDS patients. The incidence of drug-induced liver injury is higher, and liver burden is heavier. An elevated AST increases the antigen supply and antibody precipitation reaction. It is believed that the immune coincidence formed as a result of this dual action will precipitate on the cell wall of myocardial vascular, which in turn will adversely affect the heart's blood supply and cause impaired cardiac function. At this time, the electrocardiogram showed a tachyarrhythmia.

4.3 Relationship between ECG and chest CT findings in male AIDS patients

Among male AIDS patients, chest CT examination revealed the greatest percentage of patients with pulmonary inflammation (48.36%). Tachyarrhythmia dominated the ECG abnormalities in patients. It was found that the incidence of tachyarrhythmia in patients with pulmonary inflammation and pulmonary tuberculosis was higher than that in normal CT examinations. This suggests that abnormal ECG in male AIDS patients is associated with pulmonary infection.

AIDS patients are prone to pulmonary infections, especially due to their low immune capacity. It increases the risk of tuberculosis infection, and pulmonary tuberculosis is still prevalent [15]. A pulmonary infection compromises oxygenation function, which affects the cardiovascular system, increases heart rate, resulting into tachyarrhythmias on electrocardiograms

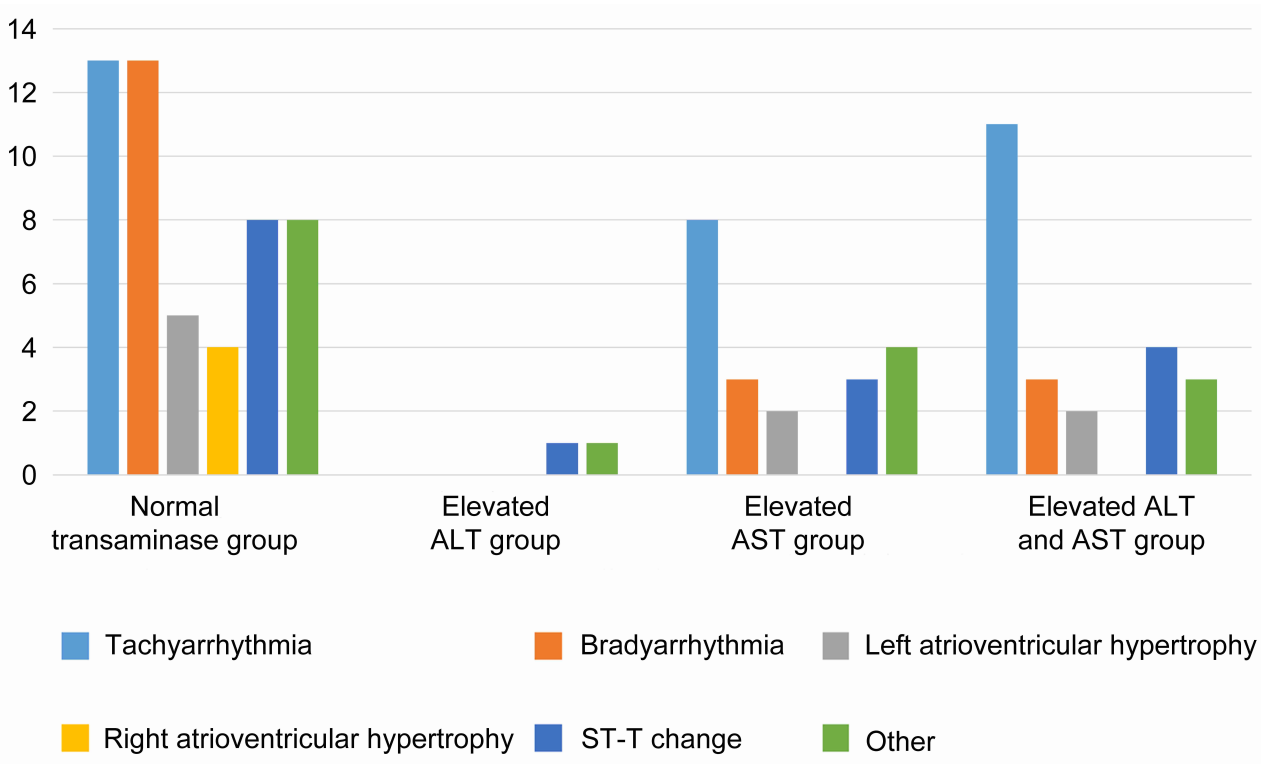


FIGURE 3. Relationship between electrocardiogram and transaminase in male AIDS patients. ALT: glutamic pyruvic transaminase; AST: glutamic oxaloacetic transaminase; ST-T: Segment T-Terminal.

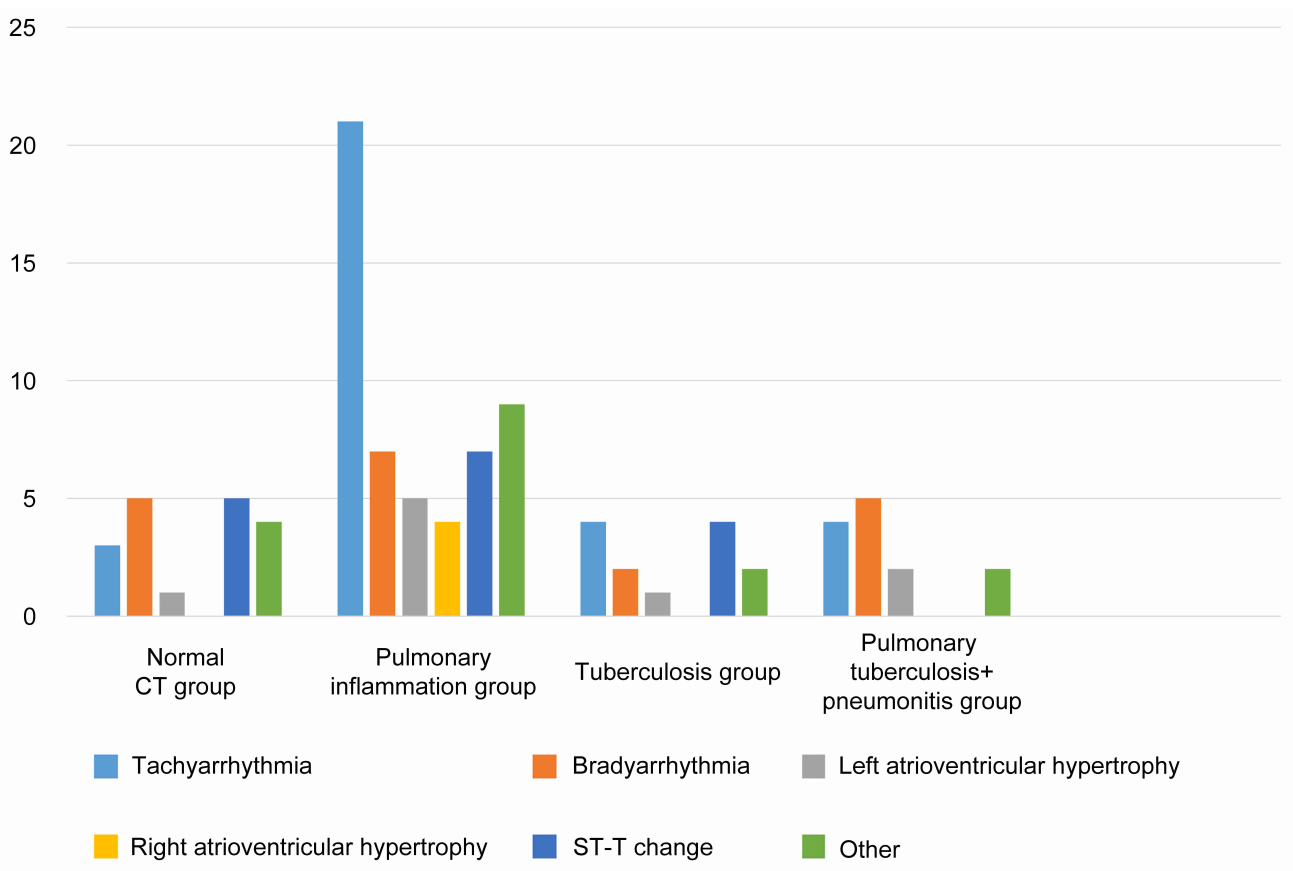


FIGURE 4. Relationship between ECG and chest CT findings in male AIDS patients. CT: computed tomography; ST-T: Segment T-Terminal.

[16]. Pulmonary hypertension can be triggered by varying degrees of pulmonary vascular injury in patients with pulmonary inflammation and pulmonary tuberculosis. Then, it leads to an increase in right heart load, right heart system injury, and right atrioventricular hypertrophy on the ECG.

5. Conclusions

In summary, the high incidence of abnormal ECG in male AIDS patients is closely associated with albumin reduction, ALT elevation and pulmonary infection. Electrocardiogram monitoring can provide valuable reference and guidance for clinical diagnosis and treatment.

Besides being limited in sample size and source of cases, this study has some other limitations. Healthy controls should be included in the study design to determine whether the conclusions drawn from the study are relevant due to AIDS itself or to other factors. Further research should be conducted on a broader range of subjects to provide a more comprehensive and objective conclusion, which points to the clinical prevention and treatment of AIDS.

AVAILABILITY OF DATA AND MATERIALS

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be obtained from the corresponding author upon request.

AUTHOR CONTRIBUTIONS

HL—designed the study and carried them out; prepared the manuscript for publication and reviewed the draft of the manuscript. HL, PD, LYZ, ZYS and PPZ—supervised the data collection, analyzed the data, interpreted the data. All authors have read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Ethics Committee of Hangzhou Xixi Hospital (Approval No. 2021 (Department) Ethics No. 20). Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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