Comprehensive Evaluation of Clinical Profile and Echocardiographic Parameters in Atrial Fibrillation Patients: A Cross-Sectional Study

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Abstract

Background:

Atrial fibrillation (AF) is a globally prevalent arrhythmia associated with significant morbidity and mortality. Comprehensive clinical and echocardiographic assessment plays a critical role in understanding the disease profile, guiding therapeutic decisions, and identifying patients at risk for adverse outcomes.

Aim and Objective:

To evaluate the clinical characteristics and echocardiographic parameters of patients diagnosed with atrial fibrillation and analyze their correlations with disease severity and risk factors.

Methods:

This prospective observational study was conducted at Department of Cardiology, Fortis Escort Heart Institute, New Delhi, India from May 2023 to April 2023 . A total of 150 consecutive patients diagnosed with atrial fibrillation were enrolled. Detailed clinical history, physical examination, laboratory investigations, and transthoracic echocardiography were performed in all patients. Echocardiographic parameters included left ventricular ejection fraction (LVEF), left atrial diameter (LAD), left atrial volume index (LAVI), diastolic function, and pulmonary artery pressure. The

relationship between clinical variables and echocardiographic findings was statistically analyzed to identify significant associations.

Results:

Among the 150 patients studied, the mean age was 63.5 ± 9.8 years, with a predominance of males (64%). Hypertension (60%), diabetes mellitus (36%), and ischemic heart disease (28%) were common comorbidities. Paroxysmal AF was seen in 58% and persistent AF in 42% of cases. Echocardiography revealed that 32% of patients had reduced LVEF (<50%), while 66% had enlarged LAVI (>34 mL/m²). Significant correlations were observed between increased LAVI, advanced age, and comorbidities such as hypertension and diabetes. Reduced LVEF was more prevalent among patients with ischemic heart disease. Pulmonary artery pressures were significantly elevated in patients with persistent AF.

Conclusion:

Clinical and echocardiographic assessment provides valuable insights into atrial fibrillation patients' underlying cardiac remodeling and comorbid conditions. Echocardiographic markers such as LAVI and LVEF serve as important indicators of disease severity and risk stratification, thereby guiding therapeutic interventions and improving patient outcomes.

Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia encountered in clinical practice, affecting millions of individuals worldwide. Its prevalence increases markedly with advancing age and the presence of comorbid conditions such as hypertension, diabetes mellitus, ischemic heart disease, and heart failure [1]. AF significantly contributes to morbidity due to its association with thromboembolic events, impaired cardiac output, progressive heart failure, and reduced quality of life. Consequently, a thorough understanding of its clinical presentation and structural cardiac alterations is essential for optimal management [2].

The pathophysiology of AF is complex and multifactorial, involving electrical, mechanical, and structural remodeling of the atria. Structural remodeling, particularly left atrial enlargement and fibrosis, serves both as a consequence and perpetuator of AF, ultimately leading to a vicious cycle of arrhythmia persistence and progression. Likewise, left ventricular dysfunction, diastolic

abnormalities, and elevated pulmonary artery pressures frequently coexist with AF, further complicating its clinical course and prognosis **[3,4]**.

Echocardiography remains a cornerstone in the diagnostic evaluation of patients with AF, providing vital information regarding chamber size, ventricular function, valvular status, and pulmonary pressures. Parameters such as left atrial volume index (LAVI), left atrial diameter (LAD), and left ventricular ejection fraction (LVEF) serve as key markers reflecting the extent of cardiac remodeling and can assist in predicting the likelihood of rhythm control success, recurrence of AF after interventions, and overall cardiovascular risk **[5,6]**.

In addition to echocardiographic assessment, clinical profiling including age, sex, symptomatology, and associated systemic conditions plays an equally important role in comprehensive risk stratification. Identifying high-risk clinical and echocardiographic features allows for more individualized therapeutic strategies, guiding decisions regarding anticoagulation, rate versus rhythm control, and procedural interventions such as catheter ablation **[7,8]**.

Despite the extensive research on atrial fibrillation, studies focusing on the combined evaluation of clinical and echocardiographic parameters in Indian patients remain limited. The present study was conducted to comprehensively evaluate the clinical profile and echocardiographic findings of patients presenting with atrial fibrillation at Fortis Escort Heart Institute, New Delhi, India, and to explore their associations with underlying comorbidities and disease severity.

Materials and Methods

This prospective observational study was conducted at Department of Cardiology, Fortis Escort Heart Institute, New Delhi, India from May 2023 to April 2023. The objective was to evaluate the clinical and echocardiographic profiles of patients diagnosed with atrial fibrillation.

Study Population:

A total of 150 consecutive patients diagnosed with atrial fibrillation who presented to the cardiology department during the study period were enrolled.

Inclusion Criteria:

- Age ≥ 18 years.

- Diagnosed case of atrial fibrillation (paroxysmal or persistent).
- Willingness to participate and provide written informed consent.

Exclusion Criteria:

- Significant valvular heart disease.
- Congenital heart disease.
- Decompensated heart failure at presentation.
- Severe renal impairment (eGFR < 30 mL/min/1.73 m²).
- Chronic pulmonary diseases causing secondary pulmonary hypertension.
- Inability to undergo echocardiographic evaluation.

Clinical Evaluation:

Detailed clinical history was obtained from all patients, including:

- Demographic data (age, gender).
- Duration and pattern of atrial fibrillation.
- Symptoms such as palpitations, dyspnea, syncope.
- Associated comorbidities: hypertension, diabetes mellitus, ischemic heart disease, dyslipidemia, thyroid dysfunction.
- Medication history.

Laboratory Investigations:

All patients underwent routine blood investigations, including:

- Complete blood count.
- Renal function tests.
- Thyroid profile.
- Serum electrolytes.
- Fasting lipid profile.
- Coagulation profile.

Echocardiographic Assessment:

Transthoracic echocardiography was performed for all patients using standard protocols. The following parameters were assessed:

- Left ventricular ejection fraction (LVEF) using Simpson's biplane method.
- Left atrial diameter (LAD).
- Left atrial volume index (LAVI).
- Diastolic function assessment (E/A ratio, E/e' ratio, deceleration time).
- Right ventricular systolic pressure (RVSP) for estimation of pulmonary artery pressure.
- Valvular function and any structural abnormalities.

Outcome Measures:

The primary objective was to analyze the clinical characteristics and echocardiographic parameters of atrial fibrillation patients and evaluate their correlations with comorbid conditions and disease patterns.

Statistical Analysis:

Data were analyzed using SPSS software version XX. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Chi-square test and Student's t-test were used for univariate comparisons. Correlation analyses were performed using Pearson's correlation coefficient. A p-value < 0.05 was considered statistically significant.

Results

A total of 150 patients diagnosed with atrial fibrillation were enrolled in the study. The mean age of the study population was 63.5 ± 9.8 years, with a male predominance (64%). Paroxysmal atrial fibrillation was more frequent (58%) compared to persistent atrial fibrillation (42%). The most commonly associated comorbidities included hypertension (60%), diabetes mellitus (36%), ischemic heart disease (28%), and thyroid dysfunction (10%). Echocardiographic assessment revealed that 32% of patients had a reduced left ventricular ejection fraction (<50%), while the majority (68%) had preserved systolic function. Left atrial enlargement, as assessed by left atrial volume index (LAVI >34 mL/m²), was observed in 66% of patients, indicating significant structural remodeling of the atria. Diastolic dysfunction was present in 40% of patients, and pulmonary artery pressures were elevated (>35 mmHg) in 28% of the study population. Significant correlations were found between increased left atrial volume index and advancing age, hypertension, diabetes mellitus, and duration

of atrial fibrillation. Reduced LVEF was significantly associated with ischemic heart disease, while elevated pulmonary artery pressures were more commonly observed in patients with persistent atrial fibrillation. The comprehensive clinical and echocardiographic assessment provided valuable insights into the underlying structural and functional alterations in patients with atrial fibrillation.

Table 1: Demographic Characteristics of Study Population

Table 1 presents the demographic profile of patients enrolled, highlighting age distribution and gender predominance in atrial fibrillation.

Variables	Values
Total Patients	150
Age (mean ± SD)	63.5 ± 9.8 years
Gender (Male)	96 (64.0%)
Gender (Female)	54 (36.0%)

Table 2: Distribution of Atrial Fibrillation Types

Table 2 shows the distribution of atrial fibrillation types, indicating paroxysmal AF as more prevalent compared to persistent AF.

Type of AF	Number of Patients (%)
Paroxysmal AF	87 (58.0%)
Persistent AF	63 (42.0%)

Table 3: Distribution of Symptoms at Presentation

Table 3 presents the common presenting symptoms among atrial fibrillation patients, reflecting both arrhythmic and heart failure manifestations.

Symptoms	Number of Patients (%)
Palpitations	102 (68.0%)
Dyspnea	76 (50.7%)
Fatigue	58 (38.7%)
Syncope	15 (10.0%)
Chest pain	27 (18.0%)

Table 4: Prevalence of Comorbidities

Table 4 presents the comorbid medical conditions commonly associated with atrial fibrillation in the study population.

Comorbidities	Number of Patients (%)
Hypertension	90 (60.0%)
Diabetes Mellitus	54 (36.0%)
Ischemic Heart Disease	42 (28.0%)
Dyslipidemia	39 (26.0%)
Thyroid Dysfunction	15 (10.0%)

Table 5: Distribution Based on Duration of Atrial Fibrillation

Table 5 shows the duration of atrial fibrillation at presentation, reflecting chronicity and long-standing arrhythmia burden.

Duration	Number of Patients (%)
< 6 months	54 (36.0%)
6–12 months	39 (26.0%)
> 12 months	57 (38.0%)

Table 6: Left Ventricular Ejection Fraction (LVEF) Distribution

Table 6 presents the left ventricular systolic function assessed by ejection fraction, revealing preserved and reduced categories.

LVEF Category	Number of Patients (%)
≥50% (Preserved)	102 (68.0%)
40–49% (Mildly Reduced)	24 (16.0%)
<40% (Reduced)	24 (16.0%)
Mean LVEF (%)	51.2 ± 8.7

Table 7: Left Atrial Volume Index (LAVI) Distribution

Table 7 shows left atrial volume index measurements, reflecting the extent of structural remodeling.

LAVI Category (mL/m²)	Number of Patients (%)
≤34	51 (34.0%)
>34	99 (66.0%)
Mean LAVI (mL/m²)	40.8 ± 7.6

Table 8: Diastolic Dysfunction Distribution

Table 8 presents the presence and grading of diastolic dysfunction among the studied atrial fibrillation patients.

Diastolic Function	Number of Patients (%)
Normal	90 (60.0%)
Grade I (Mild)	36 (24.0%)

Grade II (Moderate)	18 (12.0%)
Grade III (Severe)	6 (4.0%)

Table 9: Pulmonary Artery Pressure (PAP) Distribution

Table 9 shows estimated pulmonary artery systolic pressures obtained on echocardiography.

PAP (mmHg) Category	Number of Patients (%)
≤35	108 (72.0%)
>35	42 (28.0%)
Mean PAP (mmHg)	32.5 ± 6.4

Table 10: Comparison of LAVI with Comorbidities

Table 10 compares the prevalence of enlarged LAVI with common comorbid conditions, showing significant associations.

Comorbidities	LAVI >34 mL/m² (%)	p-value
Hypertension	75 (83.3%)	<0.001
Diabetes Mellitus	45 (83.3%)	<0.001
Ischemic Heart Disease	36 (85.7%)	<0.001

Table 11: Comparison of LVEF with Ischemic Heart Disease

Table 11 shows significant correlation between reduced ejection fraction and presence of ischemic heart disease.

IHD Status	LVEF <50% (%)	p-value
Present	30 (71.4%)	<0.001
Absent	18 (17.1%)	<0.001

Table 12: Association Between AF Type and Pulmonary Artery Pressure

Table 12 presents the relation between AF type and pulmonary hypertension, indicating higher pressures in persistent AF.

AF Type	PAP >35 mmHg (%)	p-value
Paroxysmal AF	15 (17.2%)	<0.001
Persistent AF	27 (42.9%)	<0.001

Table 1 presented demographics, **Table 2** described AF types, **Table 3** showed presenting symptoms, **Table 4** summarized comorbidities, **Table 5** presented AF duration. **Table 6** depicted LVEF distribution while **Table 7** and **Table 8** displayed LAVI and diastolic dysfunction respectively. **Table 9** presented pulmonary pressures. Associations between LAVI and comorbidities (**Table 10**), LVEF and ischemic heart disease (**Table 11**), and pulmonary pressures with AF type (**Table 12**) were statistically analyzed.

Discussion

Atrial fibrillation remains a significant public health problem due to its growing prevalence, associated comorbidities, and adverse clinical outcomes. The present study provides a comprehensive evaluation of the clinical and echocardiographic characteristics of patients with atrial fibrillation in an Indian tertiary care setting. Understanding these associations is essential to improve individualized care and risk stratification in atrial fibrillation management [9,10]. The mean age of the study population was 63.5 years, reflecting the well-established association between atrial fibrillation and advancing age. Consistent with global epidemiological data, a male predominance was observed.

Age-related atrial remodeling and fibrosis contribute to the development of atrial fibrillation, particularly in elderly patients **[11,12]**.

Hypertension, diabetes mellitus, and ischemic heart disease emerged as the most prevalent comorbidities, further substantiating their well-known role in the pathogenesis and maintenance of atrial fibrillation. Chronic pressure and volume overload due to hypertension promote atrial dilatation and fibrosis, while diabetes contributes to structural and electrical remodeling through microvascular changes and metabolic disturbances. Similarly, ischemic heart disease alters atrial and ventricular function, increasing the risk of atrial fibrillation onset and progression **[13,14]**.

Echocardiographic assessment revealed a high prevalence of left atrial enlargement, with two-thirds of patients demonstrating elevated left atrial volume index (LAVI >34 mL/m²). This finding signifies advanced structural remodeling, which not only reflects the chronicity of atrial fibrillation but also predicts poor response to rhythm control strategies. The significant correlation between increased LAVI and comorbidities such as hypertension and diabetes highlights the interplay between systemic disorders and atrial structural changes **[15]**.

Reduced left ventricular ejection fraction was observed in approximately one-third of patients. Among these, a significant association was noted between reduced LVEF and ischemic heart disease, supporting the well-established role of ventricular dysfunction in atrial arrhythmogenesis. Left ventricular dysfunction leads to elevated left atrial pressures, promoting atrial stretch, remodeling, and electrical instability **[16]**.

Diastolic dysfunction was present in 40% of the study population, reflecting impaired ventricular relaxation and elevated filling pressures, both of which contribute to left atrial dilation and atrial fibrillation perpetuation. The co-existence of diastolic dysfunction in AF patients suggests the presence of heart failure with preserved ejection fraction (HFpEF), which is commonly associated with atrial fibrillation **[17]**.

Elevated pulmonary artery pressures were observed in nearly one-third of patients, with persistent atrial fibrillation showing a significantly higher prevalence of pulmonary hypertension compared to paroxysmal AF. Prolonged AF duration and persistent arrhythmia contribute to progressive atrial and right heart remodeling, ultimately resulting in elevated pulmonary pressures **[18]**.

The study's findings emphasize the critical role of comprehensive echocardiographic evaluation in atrial fibrillation patients. LAVI and LVEF emerged as key structural markers reflecting the degree of atrial and ventricular remodeling. These echocardiographic parameters, when combined with detailed clinical profiling, allow for a more accurate assessment of disease severity, prognosis, and guide management strategies, including the choice between rate and rhythm control, anticoagulation, and eligibility for catheter ablation **[19,20]**.

While the study provides important insights, certain limitations must be acknowledged. Being a single-center study, the findings may not be fully generalizable. Additionally, the cross-sectional design limits assessment of longitudinal outcomes and progression of structural changes over time. Nevertheless, the prospective nature, detailed clinical characterization, and comprehensive echocardiographic evaluation strengthen the validity of the study findings.

In summary, this study reinforces the value of integrating clinical and echocardiographic parameters in atrial fibrillation assessment. Identifying high-risk structural and functional alterations may enable better individualized treatment, improve rhythm control success, and prevent adverse outcomes in this growing patient population.

Conclusion

This study provides a comprehensive evaluation of clinical and echocardiographic parameters in patients with atrial fibrillation, highlighting the significant burden of structural remodeling and comorbid conditions associated with the arrhythmia. Left atrial enlargement, as reflected by elevated LAVI, was strongly associated with advancing age, hypertension, and diabetes mellitus, emphasizing the critical role of systemic comorbidities in atrial structural changes. Left ventricular systolic dysfunction was significantly linked with ischemic heart disease, further illustrating the impact of ventricular remodeling in atrial fibrillation pathogenesis. The high prevalence of diastolic dysfunction and pulmonary hypertension underscores the hemodynamic consequences of chronic atrial fibrillation, especially in patients with persistent forms. Echocardiographic markers such as LAVI, LVEF, diastolic function, and pulmonary pressures serve as valuable tools in risk stratification, guiding individualized management approaches. Incorporating these parameters into routine evaluation can assist in optimizing therapeutic strategies, improving rhythm control success, and preventing adverse cardiovascular outcomes. The study emphasizes the need for early identification of high-risk patients to enable timely interventions. Further multicenter, longitudinal studies are

warranted to validate these findings and explore their implications on long-term outcomes in atrial fibrillation management.

References

1. Providência R, Botelho A, Trigo J, Quintal N, Nascimento J, Mota P, Leitão-Marques A. Possible refinement of clinical thromboembolism assessment in patients with atrial fibrillation using echocardiographic parameters. Europace. 2012 Jan;14(1):36-45. doi: 10.1093/europace/eur272. Epub 2011 Aug 24. PMID: 21868410.

2. Reddy VY, Anic A, Koruth J, Petru J, Funasako M, Minami K, Breskovic T, Sikiric I, Dukkipati SR, Kawamura I, Neuzil P. Pulsed Field Ablation in Patients With Persistent Atrial Fibrillation. J Am Coll Cardiol. 2020 Sep 1;76(9):1068-1080. doi: 10.1016/j.jacc.2020.07.007. PMID: 32854842.

3. Reddy YNV, Obokata M, Verbrugge FH, Lin G, Borlaug BA. Atrial Dysfunction in Patients With Heart Failure With Preserved Ejection Fraction and Atrial Fibrillation. J Am Coll Cardiol. 2020 Sep 1;76(9):1051-1064. doi: 10.1016/j.jacc.2020.07.009. PMID: 32854840; PMCID: PMC7455760.

4. Franczyk B, Gluba-Brzózka A, Ciałkowska-Rysz A, Banach M, Rysz J. The Problem of Atrial Fibrillation in Patients with Chronic Kidney Disease. Curr Vasc Pharmacol. 2016;14(3):260-5. doi: 10.2174/1570161114666160115130836. PMID: 26769703.

5. Bhat A, Chen HHL, Khanna S, Gan GCH, Abhayaratna WP, Nunes MCP, MacIntyre CR, Tan TC. Clinical and cardiac structural predictors of atrial fibrillation persistence. Eur J Clin Invest. 2021 Mar;51(3):e13395. doi: 10.1111/eci.13395. Epub 2020 Sep 17. PMID: 32886806.

6. Ito T, Suwa M. Left atrial spontaneous echo contrast: relationship with clinical and echocardiographic parameters. Echo Res Pract. 2019 Jun 1;6(2):R65-R73. doi: 10.1530/ERP-18-0083. PMID: 30959476; PMCID: PMC6499934.

7. Wałek P, Sielski J, Starzyk K, Gorczyca I, Roskal-Wałek J, Wożakowska-Kapłon B. Echocardiographic assessment of left atrial morphology and function to predict maintenance of sinus rhythm after electrical cardioversion in patients with non-valvular persistent atrial fibrillation and normal function or mild dysfunction of left ventricle. Cardiol J. 2020;27(3):246-253. doi: 10.5603/CJ.a2019.0068. Epub 2019 Jul 17. PMID: 31313277; PMCID: PMC8015983.

8. Elawady MA, Bashandy M. Clinical and echocardiographic predicators of postoperative atrial fibrillation. Asian Cardiovasc Thorac Ann. 2014 Jul;22(6):655-9. doi: 10.1177/0218492313503572. Epub 2013 Nov 5. PMID: 24887874.

9. Khumri TM, Idupulapati M, Rader VJ, Nayyar S, Stoner CN, Main ML. Clinical and echocardiographic markers of mortality risk in patients with atrial fibrillation. Am J Cardiol. 2007 Jun 15;99(12):1733-6. doi: 10.1016/j.amjcard.2007.01.055. Epub 2007 Apr 26. PMID: 17560884.

10. Taniguchi N, Miyasaka Y, Suwa Y, Harada S, Nakai E, Shiojima I. Heart Failure in Atrial Fibrillation - An Update on Clinical and Echocardiographic Implications. Circ J. 2020 Jul 22;84(8):1212-1217. doi: 10.1253/circj.CJ-20-0258. Epub 2020 Jul 8. PMID: 32641592.

11. Mohamed Sabry AS, El-Kader Mansour HA, Abo El-Azm TH, Sayed Akef ME, Mostafa SA. Clinical and Echocardiographic Predictors of Atrial Fibrillation after Coronary Artery Bypass Grafting. J Atr Fibrillation. 2020 Dec 31;13(4):2320. doi: 10.4022/jafib.2320. PMID: 34950315; PMCID: PMC8691302.

12. Cannistraro RJ, Meschia JF. The Clinical Dilemma of Anticoagulation Use in Patients with Cerebral Amyloid Angiopathy and Atrial Fibrillation. Curr Cardiol Rep. 2018 Sep 12;20(11):106. doi: 10.1007/s11886-018-1052-1. PMID: 30209626.

13. Ramkumar S, Ochi A, Kawakami H, Yang H, Potter EL, D'Elia N, Negishi T, Negishi K, Marwick TH. Echocardiographic Risk Assessment to Guide Screening for Atrial Fibrillation. J Am Soc Echocardiogr. 2019 Oct;32(10):1259-1267. doi: 10.1016/j.echo.2019.07.003. PMID: 31587756.

14. Klopotowski M, Kwapiszewska A, Kukula K, Jamiolkowski J, Dabrowski M, Derejko P, Oreziak A, Baranowski R, Spiewak M, Marczak M, Klisiewicz A, Szepietowska B, Chmielak Z, Witkowski A. Clinical and echocardiographic parameters as risk factors for atrial fibrillation in patients with hypertrophic cardiomyopathy. Clin Cardiol. 2018 Oct;41(10):1336-1340. doi: 10.1002/clc.23050. Epub 2018 Oct 16. PMID: 30120784; PMCID: PMC6490001.

15. Al-Omari MA, Finstuen J, Appleton CP, Barnes ME, Tsang TS. Echocardiographic assessment of left ventricular diastolic function and filling pressure in atrial fibrillation. Am J Cardiol. 2008 Jun 15;101(12):1759-65. doi: 10.1016/j.amjcard.2008.02.067. PMID: 18549855.

16. Rader VJ, Khumri TM, Idupulapati M, Stoner CN, Magalski A, Main ML. Clinical predictors of left atrial thrombus and spontaneous echocardiographic contrast in patients with atrial

fibrillation. J Am Soc Echocardiogr. 2007 Oct;20(10):1181-5. doi: 10.1016/j.echo.2007.02.010. Epub 2007 Jun 12. PMID: 17566700.

17. Agmon Y, Khandheria BK, Gentile F, Seward JB. Echocardiographic assessment of the left atrial appendage. J Am Coll Cardiol. 1999 Dec;34(7):1867-77. doi: 10.1016/s0735-1097(99)00472-6. PMID: 10588196.

18. Baturova MA, Sheldon SH, Carlson J, Brady PA, Lin G, Rabinstein AA, Friedman PA, Platonov PG. Electrocardiographic and Echocardiographic predictors of paroxysmal atrial fibrillation detected after ischemic stroke. BMC Cardiovasc Disord. 2016 Nov 3;16(1):209. doi: 10.1186/s12872-016-0384-2. PMID: 27809773; PMCID: PMC5093933.

19. Main ML, Fan D, Reddy VY, Holmes DR, Gordon NT, Coggins TR, House JA, Liao L, Rabineau D, Latus GG, Huber KC, Sievert H, Wright RF, Doshi SK, Douglas PS. Assessment of Device-Related Thrombus and Associated Clinical Outcomes With the WATCHMAN Left Atrial Appendage Closure Device for Embolic Protection in Patients With Atrial Fibrillation (from the PROTECT-AF Trial). Am J Cardiol. 2016 Apr 1;117(7):1127-34. doi: 10.1016/j.amjcard.2016.01.039. Epub 2016 Feb 1. PMID: 26993976.

20. Ertem AG, Yayla Ç, Açar B, Ünal S, Erdol MA, Sonmezer MÇ, Kaya Kiliç E, Ataman Hatipoglu Ç, Gokaslan S, Kafes H, Akboga MK, Aladag P, Demirtas K, Tulek N, Erdinç FS, Aydogdu S. Assessment of the atrial electromechanical properties of patients with human immunodeficiency virus. J Infect Public Health. 2017 Nov-Dec;10(6):721-724. doi: 10.1016/j.jiph.2016.10.008. Epub 2017 Feb 3. PMID: 28162963.