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Echocardiographic findings in complete interatrial electrical dissociation in a patient after radiofrequency ablation

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

Atrial fibrillation (AF) is one of the most common arrhythmias which increase the risk of thromboembolism and stroke. Catheter radiofrequency ablation (RFA) is an effective rhythm control method in patients with AF; however, in rare cases, interatrial electrical dissociation may develop.

Aim. To describe a clinical case of complete interatrial electrical dissociation in a patient after radiofrequency ablation for AF, diagnosed during echocardiographic examination.

Materials and methods. A single clinical case of a patient examined and treated at the "Uniclinic" (Zaporizhzhia, Ukraine) is presented. Clinical examination, ECG, and extended echocardiography with speckle-tracking analysis of atrial and ventricular function were performed.

Results. In a 63-year-old patient, one and a half years after RFA, echocardiographic signs of complete interatrial electrical dissociation were detected: Doppler assessment of the mitral inflow revealed the absence of the late diastolic A-wave, and left atrial strain analysis showed the absence of the contractile phase, whereas at the tricuspid valve Doppler imaging demonstrated preserved E and A peaks. Right atrial strain analysis showed preserved reservoir, conduit, and contractile phases. These findings were interpreted as evidence of complete interatrial electrical dissociation.

Conclusions. Complete interatrial electrical dissociation is a rare complication after RFA. Extended echocardiography with speckle-tracking analysis enables diagnosis of this condition. The presence of this complication requires continuation of anticoagulant therapy even in the absence of AF recurrence on ECG.

Keywords: atrial fibrillation, radiofrequency ablation, interatrial electrical dissociation, echocardiography, speckle-tracking.

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Ехокардіографічні знахідки при повній міжпередсердній електричній дисоціації в пацієнта після радіочастотної абляції

В. В. Сиволап, А. О. Богун

Фібриляція передсердь (ФП) – одна з найпоширеніших аритмій, що підвищує ризик тромбоемболій та інсульту. Катетерна радіочастотна абляція (РЧА) є ефективним методом контролю ритму в пацієнтів із ФП, але в рідкісних випадках можливий розвиток міжпередсердної електричної дисоціації.

Мета роботи – описати клінічний випадок повної міжпередсердної електричної дисоціації в пацієнта після радіочастотної абляції з приводу ФП, що діагностована під час ехокардіографічного обстеження.

Матеріали і методи. Описано клінічний випадок пацієнта, який перебував на обстеженні та лікуванні у клініці «Uniclinic» (м. Запоріжжя). Здійснили клінічне обстеження, ехокардіографію, розширену ехокардіографію зі speckle-tracking аналізом передсердної та шлуночкової функцій.

Результати. У 63-річного пацієнта через півтора роки після РЧА виявлено ехокардіографічні ознаки повної міжпередсердної електричної дисоціації: за даними доплерографії мітрального притоку, не визначено пізньодіастолічної хвилі А, а аналіз деформації лівого передсердя показав відсутність контрактильної фази, хоча на тристулковому клапані, за даними доплерографії, визначено збереження піків Е та А, за результатами аналізу деформації правого передсердя, зберігалися три фізіологічні фази (резервуарна, кондуїтна та контрактильна), що визначили як прояв повної електричної міжпередсердної дисоціації.

Висновки. Повна міжпередсердна електрична дисоціація – рідкісне ускладнення після РЧА. Виконання розширеної ехокардіографії зі speckle-tracking аналізом дає змогу діагностувати цей стан. Якщо виявлено ускладнення, доцільно продовжити антикоагулянтну терапію навіть без рецидиву ФП, за даними ЕКГ.

Ключові слова: фібриляція передсердь, радіочастотна абляція, міжпередсердна електрична дисоціація, ехокардіографія, speckle-tracking.

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Atrial fibrillation (AF) remains one of the most prevalent arrhythmias. It increases the risk of thromboembolic events and stroke, the latter of which is responsible for more than 7 million deaths annually worldwide [1]. In this context, recent years have seen more in-depth studies of atrial structure and function, acknowledging their critical role in global cardiac performance and their association with various cardiovascular conditions, particularly AF.

Catheter ablation for pulmonary vein isolation is a therapeutic approach for rhythm control in AF. The primary clinical advantages of ablation are the reduction of arrhythmia-related symptoms and the enhancement of quality of life. It is generally recommended as second-line therapy for patients with symptomatic paroxysmal or persistent AF, where pharmacological treatment has failed or is poorly tolerated [2].

The effectiveness of ablation procedures has steadily improved over recent years, with postoperative complication rates remaining low, typically below 3% according to various studies [3,4]. Interatrial dissociation is an extremely rare complication, most commonly described in isolated clinical case reports rather than in broader complication statistics. This underscores the necessity of raising awareness within the medical community to refine procedural techniques, ensure early detection, and optimize management strategies, including anticoagulant therapy. Limited English-language publications discuss such complications, and no cases have been described in local medical literature.

In this article, we present our clinical observation of complete interatrial dissociation diagnosed using advanced echocardiography and speckle-tracking analysis of both atrial and ventricular function.

Aim

To report a case of complete interatrial dissociation diagnosed using echocardiography – an extremely rare complication following catheter ablation for the treatment of atrial fibrillation.

Materials and methods

We present a single clinical case of complete interatrial dissociation in a patient who was evaluated and treated at the “Uniclinic” (Zaporizhzhia). The clinical evaluation included history-taking, electrocardiography (ECG), and echocardiographic assessment. Echocardiography was performed using a Siemens Acuson Redwood system (Germany) with M-mode, B-mode, Doppler imaging, tissue Doppler imaging, and speckle-tracking analysis in VVI mode, in accordance with the current clinical guidelines.

Results

A 63-year-old male with no significant comorbidities presented to the clinic for a routine transthoracic echocardiographic evaluation and reported no active complaints. His medical history was remarkable for a long-standing history of atrial fibrillation spanning approximately two decades. The patient had been under cardiologist supervision and underwent multiple pharmacological cardioversion procedures using propafenone, sotalol, and amiodarone at different times.

Due to the ineffectiveness of medical treatment, he underwent radiofrequency ablation (RFA) in March 2024, which involved bi-directional isthmus block in both the right and left atria. One month after the procedure, arrhythmia recurred, and electrical cardioversion was performed, restoring normal sinus rhythm. Following this, the arrhythmia remained stable until June 2025 when tachycardia recurred, with a heart rate ranging between 96-150 beats per minute as recorded by 24-hour Holter monitoring. Despite sequential use of antiarrhythmic medications, including amiodarone, verapamil, and sotalol, tachycardia persisted.

In July 2025, the patient complained of worsening symptoms during 3 days including palpitations and a sensation of irregular heartbeats, prompting him to seek medical help at Uniclinic. An ECG recorded atrial flutter with conduction rates of 1:1 and 2:1. The patient underwent electrical cardioversion (one shock, 150 J) while under sedation in the intensive care unit. Sinus rhythm was restored with a heart rate of 60–66 bpm. The patient’s condition improved, and he was discharged on the following medications: sotalol 80 mg, empagliflozin 10 mg, apixaban 5 mg, and ramipril 2.5 mg.

In September 2025, the patient returned for scheduled echocardiography, with no active complaints and no episodes of arrhythmia since discharge. The average heart rate was 60–70 bpm. The echocardiographic findings showed normal left ventricular geometry, with a slight dilation of the cavity (end-diastolic volume by Simpson’s method = 146 mL, indexed end-diastolic volume = 68 mL/m^2). There were no regional wall motion abnormalities, and longitudinal systolic function was preserved, with no regional impairment as demonstrated by speckle-tracking analysis (EndoGLS = -23.8 %). Mild diastolic dysfunction was present, with no elevation in left ventricular end-diastolic pressure (E/e’ = 6.9).

Echocardiographic signs of moderate aortic atherosclerosis were noted, without dilation of the ascending aorta, and mild degenerative aortic regurgitation. Mild mitral regurgitation was present, alongside slight left atrial dilation (LA volume index 35 mL/m^2), and moderate tricuspid regurgitation. Mild right ventricular dilation was noted (basal RV diameter 4.5 cm), with preserved contractility as evidenced by TAPSE 19 mm and peak S’ velocity at 14 cm/s (TDI). EndoGLS of the RV was -28 %. Mild regurgitation was observed at the pulmonary artery valve, with descending limb of the systolic flow curve. No signs of decompensated right heart failure were present, with the inferior vena cava remaining non-dilated and exhibiting adequate inspiratory collapse >50 %. These changes suggested a high likelihood of pulmonary hypertension, Grade I (mild), and the remodeling was considered a manifestation of atrial cardiomyopathy secondary to the patient’s long-standing arrhythmia history.

Special attention was given to the Doppler flow patterns at the atrioventricular valves. At the level of the mitral valve, a prominent E-wave peak was observed, while the A-wave peak was absent. Instead, short peaks corresponding to the f-wave on the ECG were recorded *(Fig. 1)*. A characteristic diastolic “fluttering” of the valve

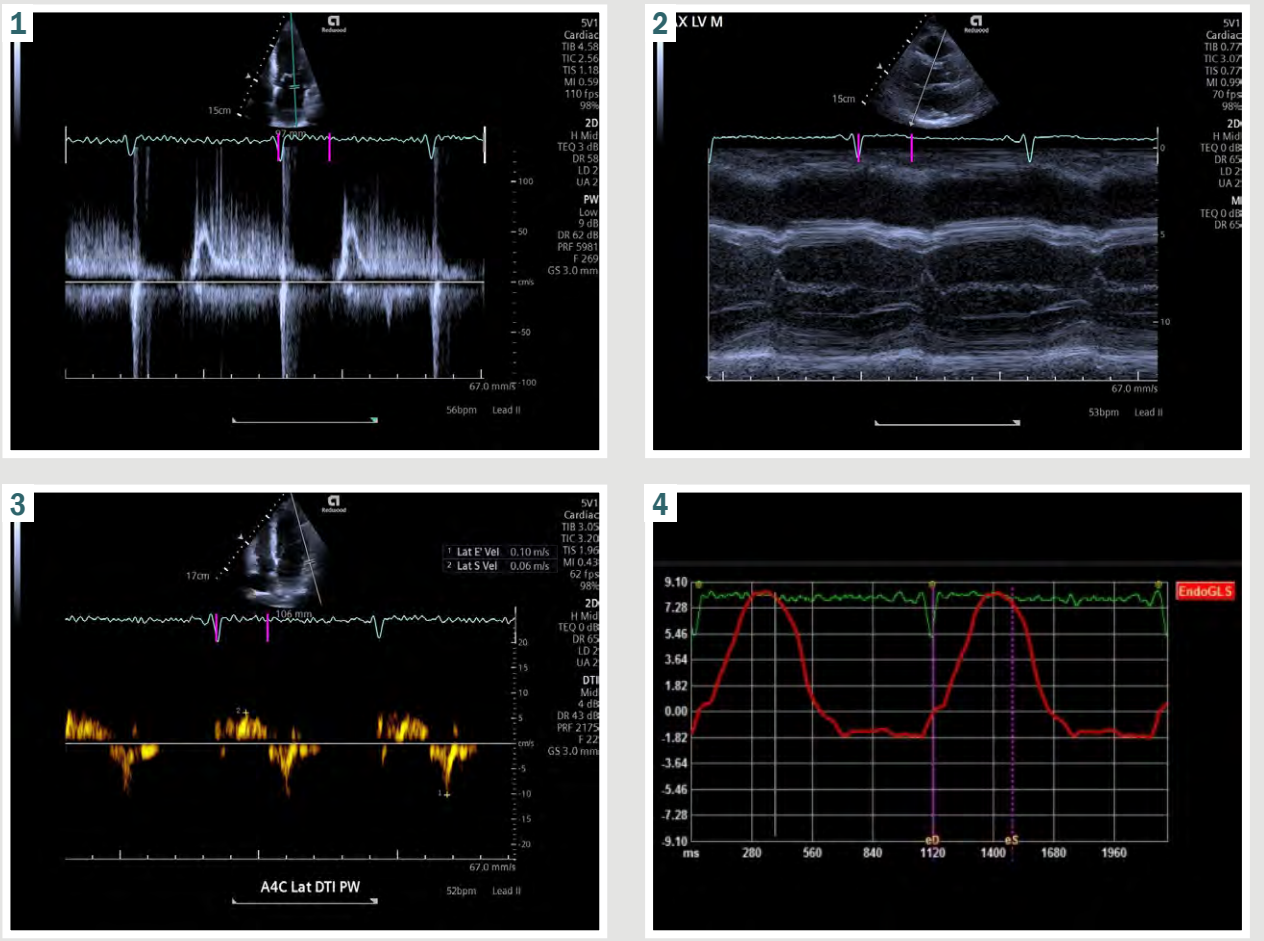

Fig. 1. Doppler flow imaging of the mitral valve. The E-wave peak is observed, and the A-wave peak is absent, with short peaks instead, corresponding to the f-wave on the ECG.

Fig. 2. M-mode imaging, parasternal position, long axis of the left ventricle, beam through the mitral valve leaflets. Diastolic "fluttering" of the mitral valve leaflets is observed.

Fig. 3. TDI imaging mode, sample volume at the lateral mitral valve annulus. S' and e' peaks are recorded, while the a' peak is absent.

Fig. 4. Speckle-tracking analysis of left atrial deformation. The reservoir phase is observed, with the absence of the contractile phase of left atrial contraction, corresponding to the lack of active late diastolic contraction of the left atrium.

leaflets, typical of atrial fibrillation, was observed *(Fig. 2)*. When analyzing the tissue Doppler curve of the lateral mitral annulus, both S' and e' peaks were clearly recorded, while the a' peak was absent *(Fig. 3)*. Upon analyzing the left atrial strain, a single peak of early diastolic deformation was recorded, corresponding to the reservoir strain value. This was followed by a conductive phase without contraction. The reservoir strain value was found to be reduced, measuring 7.7 % *(Fig. 4)*.

At the tricuspid valve, Doppler interrogation demonstrated distinct E-wave (early diastolic filling) and A-wave (late diastolic filling corresponding to atrial systole) components *(Fig. 5)*. On tissue Doppler imaging of the lateral tricuspid annulus, the S', e', and a' waves were clearly identified *(Fig. 6)*. Analysis of right atrial strain curves revealed all three physiological phases – reservoir, conduit, and contractile – with a preserved reservoir strain value of 25 % *(Fig. 7)*.

On the simultaneous ECG recording, both a P wave preceding each QRS complex and f waves were observed concurrently *(Fig. 8)*.

These findings were interpreted as evidence of complete interatrial electrical dissociation, wherein the right atrium was controlled by rhythm of the sinus node, while the left atrium exhibited independent fibrillatory electrical activity.

Discussion

The phenomenon of interatrial block has been extensively described in the literature, primarily diagnosed by electrocardiography and recognized as a predictor of atrial tachyarrhythmias, including AF. Within the medical community, this condition is commonly referred to as Bayés syndrome [5,6].

However, complete interatrial dissociation is often excluded from standard classifications of interatrial block and is defined as a condition in which the right and left atria exhibit independent electrical rhythms. This phenomenon is exceedingly rare and has been described only in isolated clinical case reports, first documented by Deitz and colleagues in 1957 [7].

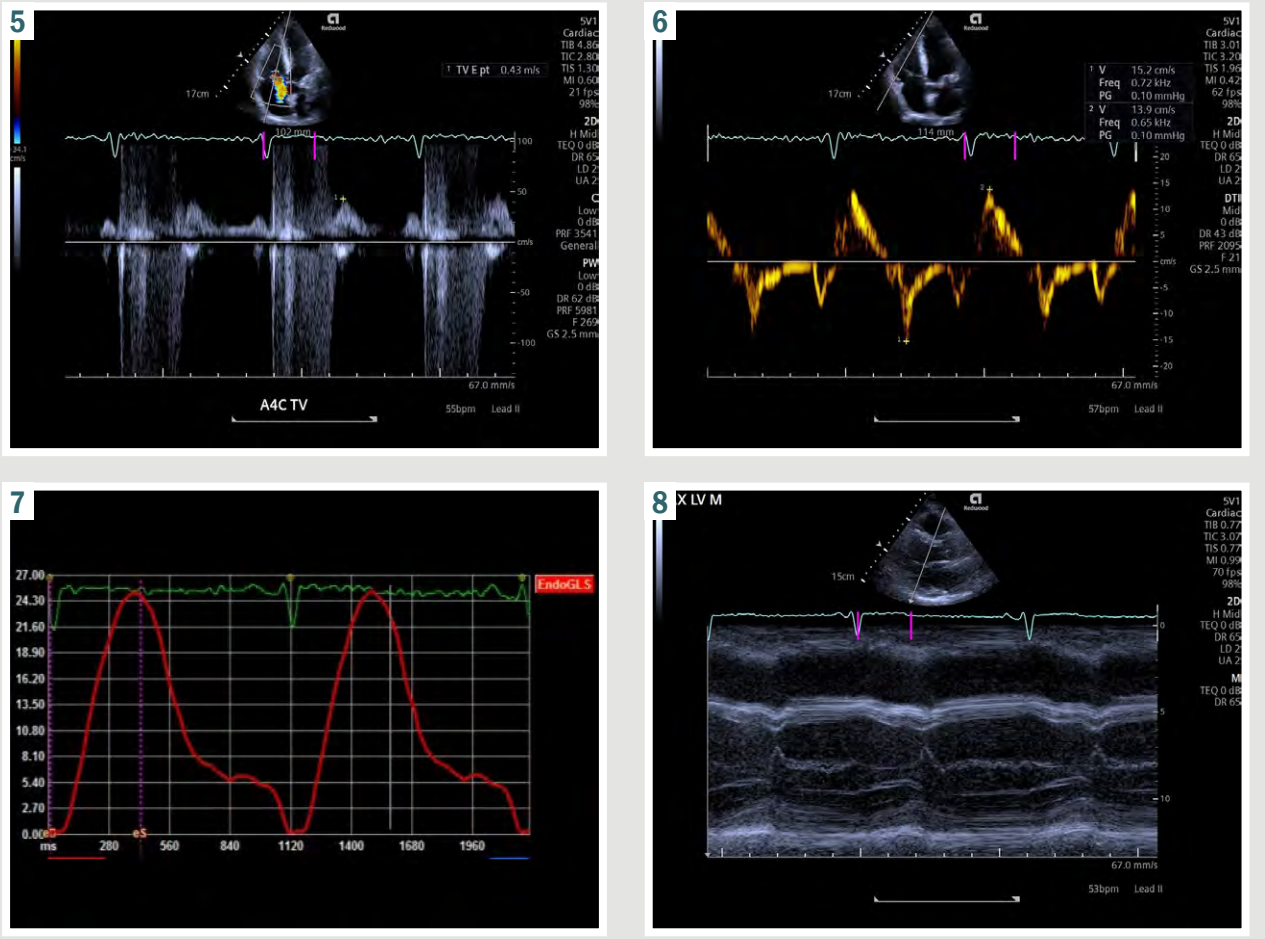

Fig. 5. Doppler flow imaging of the tricuspid valve. Both the E-wave and A-wave peaks are observed.

Fig. 6. TDI imaging mode, sample volume at the lateral tricuspid valve annulus. S', e', and a' peaks are recorded.

Fig. 7. Speckle-tracking analysis of right atrial deformation. The reservoir, conduit, and contractile phases of right atrial contraction are sequentially observed.

Fig. 8. The simultaneous ECG recording during echocardiography, both a P wave (yellow arrow) preceding each QRS complex and f waves (white arrow) were observed concurrently.

According to M. S. Kushakovsky's classification, this condition corresponds to third-degree interatrial block – a state of complete electrical dissociation between the atria. Historically, complete interatrial dissociation was observed in critically ill or terminal patients with congestive heart failure or digitalis toxicity [7,8]. In recent years, however, the number of reports describing its occurrence following RFA has increased, coinciding with the broader adoption of RFA as an effective treatment for supraventricular arrhythmias. According to the latest European Society of Cardiology (ESC) guidelines, RFA has a Class I level of recommendation for symptomatic patients with paroxysmal AF and a Class IIb recommendation for those with persistent AF [1].

In a large international cohort study conducted in 2024, the incidence of major complications following RFA for AF was analyzed. Among 33,879 procedures, the overall rate of severe complications (n = 271) was low, with the following events reported: cardiac tamponade (6.8 ‰), stroke (0.97 ‰), cardiac arrest (0.41 ‰), atrioesophageal fistula (0.21 ‰), and death (0.21 ‰) [4].

The present case represents an exceptionally rare complication, previously reported only in isolated individual cases.

To understand the mechanism of interatrial dissociation, it is essential to review the anatomy of the interatrial conduction pathways. Under normal conditions, electrical communication between the atria occurs through several routes, with the Bachmann's bundle playing a predominant role according to published data. Bachmann's bundle constitutes a branch of the anterior interatrial tract, connecting the sinoatrial and atrioventricular nodes. It originates from the sinus node, courses anteriorly, and gives off a secondary branch near the superior vena cava, forming the Bachmann's bundle, which extends subepicardially across the interatrial groove. It is separated from the right atrial wall by adipose tissue, forming the limbus of the fossa ovalis. The bundle lacks a fibrous sheath and consists of atrial myocardial fibers. Its right and left extensions run along both atrial appendages and merge with the atrial musculature. The main trunk of Bachmann's bundle is relatively broad, measuring approximately

4 mm in width and 9 mm in height [9]. Two additional physiological interatrial conduction pathways have been described: one passing through the interatrial septum near the fossa ovalis, and another located adjacent to the proximal portion of the coronary sinus [10]. It is highly probable that thermal injury to Bachmann's bundle and adjacent interatrial conduction fibers during the ablation procedure resulted in the complete electrical dissociation observed in this case.

Gautam S. et al. described a case of transient interatrial dissociation in a 58-year-old man following catheter ablation [11]. After the first RFA, the patient maintained sinus rhythm for two weeks, but atrial tachycardia recurred, prompting a second ablation. Sinus rhythm was again restored, but after three weeks the arrhythmia recurred, necessitating a third RFA session. During this final procedure, bidirectional interatrial block was demonstrated electrophysiologically, with complete left atrial isolation and dissociated electrical activity within the left atrium. Subsequent echocardiography during sinus rhythm demonstrated absence of a discernible A-wave on the transmitral Doppler flow curve – findings identical to those observed in our case. Interatrial conduction gradually recovered within two months, as evidenced by the reappearance of the A-wave on follow-up Doppler assessment [11].

Shashank J. et al. reported interatrial block documented during electrophysiological study and subsequent RFA in a patient with prior ablations and surgical atrial septal defect repair [12]. After left atrial flutter ablation, sinus rhythm persisted within the left atrium without evidence of left atrial standstill, suggesting a functional rather than fixed anatomical block. Similarly, B. Kovacs and J. J. Liang described cases in which simultaneous sinus rhythm in the right atrium and left atrial flutter were recorded during ablation [13], while L. Franchin et al. reported that radiofrequency stimulation applied to the left atrial ridge successfully terminated the arrhythmia and restored interatrial conduction [14].

Another case of complete interatrial dissociation was reported in a 60-year-old man with pulmonary hypertension secondary to idiopathic pulmonary fibrosis, where the left atrium exhibited sinus rhythm and the right atrium fibrillated, as demonstrated by ECG and echocardiographic assessment [15].

It is noteworthy that surgical isolation of the left atrium was among the first procedural strategies proposed for chronic AF management [16]. In these early operations, the left atrium remained in fibrillation while sinus rhythm was preserved in the remaining cardiac chambers. However, this approach was abandoned due to the persistent thromboembolic risk originating from the fibrillating left atrium.

In the present study, strain analysis of both atria using speckle-tracking echocardiography significantly enhanced the diagnostic value of standard echocardiographic evaluation. The atria function as reservoirs during left ventricular systole, conduits during early diastolic left ventricular filling, and active contractile chambers during late diastole. Under normal sinus rhythm, three strain phases are recognized: reservoir phase, peaking at the end of left ventricular systole (corresponding to aortic valve closure); conduit phase, reflecting passive blood transfer from atria to ventricles during early diastole; contractile phase, corresponding to active atrial contraction in late diastole. Current recommendations emphasize the clinical importance of left atrial reservoir strain as an early indicator of functional impairment and fibrosis [17]. In our case, differentiated strain analysis of the left and right atria provided valuable diagnostic insight, enabling the identification of complete interatrial electrical dissociation.

Conclusions

Complete interatrial dissociation following radiofrequency catheter ablation for atrial fibrillation can be reliably identified by echocardiographic assessment utilizing atrial strain analysis (speckle-tracking imaging), which enhances the diagnostic accuracy and functional evaluation of atrial performance. The presence of this complication necessitates continuation of anticoagulant therapy, given the increased risk of thrombus formation within the left atrium due to the absence of the contractile phase associated with atrial fibrillation.

Ethical approval
The research programme was reviewed and approved by the Bioethics Commission of Zaporizhzhia State Medical and Pharmaceutical University (Protocol No. 10 dated 18 September 2025). The document was prepared on the basis of the "General Principles of Animal Experiments" (III National Congress on Bioethics, Kyiv, 2007) and brought into line with the "European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes" (Strasbourg, 1986), Directive 86/609/EEC and the Law of Ukraine "On the Protection of Animals from Cruel Treatment" No. 3447-IV of 21 February 2006.

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