A new technique offers improved diagnostic precision and a route to personalized therapy for a common arrhythmia that affects more than 10 million people in Europe

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A multidisciplinary study led by scientists at the Centro Nacional de Investigaciones Cardiovasculares (CNIC) presents a new method for assessing the structural and electrophysiological changes, called atrial remodeling, produced in the heart of patients with atrial fibrillation, one of the most frequent forms of cardiac arrhythmia. The new diagnostic method is based on the simultaneous assessment of electrical and mechanical (contractile) activity in the heart atria during atrial fibrillation. The study is published in *Nature Communications*.

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Study leader David Filgueiras explained that, until now, “this was an unmet challenge,” because, on the one hand, “the available technology did not allow the integration of both types of information to provide a more complete evaluation,” and on the other hand, “during atrial fibrillation, the contractile movements of the atria are of low intensity, and measuring them is technically challenging.”

Atrial fibrillation is an irregular and often very fast heartbeat that can cause the formation of blood clots in the heart, increasing the risk of stroke, heart failure, and related complications. Atrial fibrillation condition affects an estimated 10 million people in Europe, and around 700,000 in Spain.

Atrial fibrillation is currently classified according to the length of time that the patient has been in arrhythmia. Nevertheless, explained Dr. Filgueiras, who leads the Advanced Development in Arrhythmia Mechanisms and Therapy group at the CNIC and is a cardiologist at the Instituto de Investigación Sanitaria del Hospital Clínico San Carlos (IdISSC), “this temporal classification provides no information about a patient’s extent of atrial remodeling, an especially important parameter in the first months of the condition, when the underlying disease processes can progress at different rates.”

According to Dr. Filgueiras, “the importance of this new diagnostic method is its ability to provide a personalized assessment of an individual patient’s degree of atrial remodeling, independently of the clinical classification based on temporal criteria”.

The three first authors on the study are Daniel Enríquez Vázquez, of the Complejo Hospitalario Universitario in A Coruña and a member of the Spanish cardiovascular research network (CIBERCV), and CNIC scientists Jorge G. Quintanilla and Alba García Escolano. Dr. Enríquez Vázquez highlighted that “on a clinical level, the results show that electromechanical dissociation in patients with atrial fibrillation is a solid indicator of disease progression and of the need to take urgent steps to return these patients to normal rhythm in an efficient and stable manner.”

The team led by Dr. Filgueiras worked in partnership with colleagues at the Hospital Clínico San Carlos, the Hospital Universitario Central de Asturias, the Hospital de la Santa Creu i Sant Pau, the Complejo Hospitalario Universitario de A Coruña, the Universidad Complutense de Madrid, the Universidad Politécnica de Madrid, the Universidad Autónoma de Barcelona, the University of Connecticut, and the CIBERCV. Over the past 10 years, this team of national and international experts worked together to integrate electrical and mechanical cardiac data to enable a personalized characterization of the status of the pathological changes associated with the progression of atrial fibrillation.

This diverse team was able to achieve this through the use of a multidisciplinary approach.

In the first phase, engineers and physicists devised the most appropriate strategy for integrating the electrical and mechanical data. The solution they found was to measure mechanical activity by Doppler imaging—a noninvasive method that provides information on atrial tissue movements—and electrical activity by surface electrocardiography.

Both of these approaches are easy to implement in the clinic because they are noninvasive and can be conducted during a transthoracic ultrasound examination, a routine study of the shape and functioning of the heart and some of its internal structures.

The second phase involved experts in biology, biotechnology, biochemistry, and biomedical engineering working together with the CNIC Proteomics Unit and clinical cardiologists. Experimental studies conducted in this phase correlated the information obtained with the new approach with underlying pathological changes in atrial tissue. This information was used to develop new advanced mapping techniques and computer simulations to reveal the mechanisms underlying electrical and mechanical remodeling during the progression of atrial fibrillation.

The final phase was a multicenter prospective study of 83 patients at an early stage in the development of atrial fibrillation, to determine the prognostic value of simultaneous the electrical and mechanical assessment of the atria in patients with this type of arrhythmia.

The experimental and clinical findings revealed an imbalance between electrical and mechanical (contractile) activation in the atria at early stages of the disease. This causes the two parameters to become dissociated, so that the contractile activation cannot keep up with the electrical activation, a phenomenon the investigators call atrial electromechanical dissociation. The pace of this dissociation is specific to each individual patient, although in the absence of restoration of a normal rhythm it is usually observed within the first 2-3 months after an uninterrupted atrial fibrillation episode.

A key advantage of the new approach is that atrial electromechanical dissociation is identified before the appearance of overt clinical signs of structural atrial remodeling. “The use of this new diagnostic approach allows early characterization of the underlying remodeling in patients with atrial fibrillation,” said Dr. Filgueiras. “The study shows that it is possible to integrate electrical and mechanical data from the atria of patients with atrial fibrillation to obtain personalized prognostic information about the clinical progression of the disease.”

Nicasio Pérez Castellano, of the IdISSC, and David Calvo Cuervo, of Hospital Central de Asturias and currently a member of the IdISSC emphasized that, “in addition to the results obtained, a major strength of this new approach is its noninvasive character, which will greatly ease the management of patients with atrial fibrillation.”

Julián Pérez Villacastín, a clinical collaborator on the study at Hospital Clínico San Carlos, CIBERCV and currently president of the Spanish Society of Cardiology, added that, “this research and its clinical implementation will allow an increasingly personalized management of patients with atrial fibrillation.” This is especially important given the growing prevalence of this disease, which affects more than 700,000 people in Spain and more than 10 million across Europe.

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