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CARDIAC IMAGING IN ARRHYTHMIAS

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Abstract: *Cardiac arrhythmias occur frequently in valvular patients. In valvular patients the role of echocardiography is essential, due to prognostic variations. A common indication of CT coronarography is the evaluation of the coronary arteries, with the highlighting of the light coronary plaques, but also accurately measures the dimensions of the left atrium and the anatomy of the pulmonary veins. In the last years cardiac MRI (magnetic resonance imaging) has been used in the clinic and research media to establish the gold standard measurement for the volumes of heart cavities, their function and tissue structure. All these three methods are essential for the evaluation and treatment of the cardiac patient with important arrhythmia.*

Key words: Arrhythmias, Echocardiography, CT coronarography, Cardiac MR.

1. Anatomoimagistic correlations and the role of echocardiography in understanding AF

Especially in valvular patients the role of echocardiography is essential, due to prognostic variations when they also have atrial fibrillation [1].
There are very many variables that are described with echocardiography, that are essential for the future management of the patient with important arrhythmias. First the function and structure of the left ventricle, and the surrounding pericardium. Second, the valvular apparatus, with the four heart valves. Also, both left and right atrium are important.
Valvular disease is independently associated with atrial fibrillation, and approximately 30% of atrial fibrillation patients have one or more valvular diseases, detected by echocardiography [1]. Atrial fibrillation worsens the prognosis of severe valvular patients, including those who will undergo surgery or minimally invasive surgery for aortic or mitral stenosis or regurgitation [2, 3].
Valvular disease itself increases the risk of stroke, in addition to the risk caused by atrial fibrillation itself [4]; just as in heart failure, valvular disease interacts with atrial fibrillation and is sustained by each other, through volume and pressure overload, tachycariomyopathy, and neurohormonal factors [5,6]. When valvular disease worsens, the onset of supraventricular arrhythmias is a determinant of disease severity and progressivity, thus encouraging valvular surgical intervention (invasive/ minimally invasive) [7]. In the literature, cases with atrial fibrillation have been classified into valvular AF/nonvalvular AF [8], valvular atrial fibrillation being usually associated with rheumatic heart disease (usually mitral stenosis), and the presence of mechanical mitral valve.
The sound is described in physical parameters such as frequency and intensity. Frequency is measured in hertz and multiples (kHz and MHz). The most important part of the echocardiograph is the piezoelectric transducer. [9, 10, 11]. Sound is a wave that travels in straight line. All waves have the following characteristics: frequency, period, wavelength, propagation speed, amplitude and intensity [12].
In addition to echocardiography, imaging modalities also include cardiac CT and nuclear magnetic resonance, necessary for describing the left atrium and pulmonary vein anatomy. These modalities may

provide particularly important information for the treatment and evaluation of atrial fibrillation [13]. If the M, 2D, TDI-tissue Doppler imaging methods can be used in echocardiography, the reproducibility of the measurements, especially the volumetric ones, has certain limitations, and the use of 3D methods has brought improvements, with a higher correlation with the cardiac magnetic resonance standard [14].

2. Coronary CT.

Not only for describing the heart structures involved in the treatment of atrial fibrillation, but also for describing the coronaries and coronary plaque, the CT coronarography is essential. Also, in the case of ventricular malignant arrhythmias, more and more frequently there is the need of excluding the ischemic coronary arteries disease.

A common indication of this is the evaluation of the coronary arteries, with the highlighting of the light coronary plaques, but also accurately measures the dimensions of the left atrium and the anatomy of the pulmonary veins [15, 16]. Image quality may be altered by heart rates greater than 60 / min, or by arrhythmias. Also, the dose of radiation, the possibility of post-contrast allergies and the risk of renal dysfunction should be considered [17]. The cellular atherosclerotic degeneration is first described by Stary [18, 19]. One of the early reports concerning the possible use of Computed Tomography to assess the calcium score was emitted by Guthaner [20] in 1979, and then Agatston [21] (1990) introduced a classified application of the score. The score 1 is means a value of 130–199 HU (Hounsfield units), 2- 200–299 HU, 3- 300–399 HU, and 4 - values higher then 400 HU [20]. Absolute values above 400 ensure the practical ability to recommend catheterization of the left heart [22, 23].

3. Cardiac magnetic resonance imaging

Magnetic resonance is based on the physical property of the nucleus that has an odd number of protons and/or neutrons [24].

In the last years MRI has been used in the clinic and research media to establish the gold standard measurement for the volumes of heart cavities, their function and tissue structure [25]. Furthermore, contrast assessment with gadolinium-containing agents has revolutionized myocardial fibrosis assessment. However, it is an expensive method, and it is not available in all healthcare institutions and some patients cannot be evaluated because of specific neuropsychiatric conditions. The presence of intracardiac implants or other devices had a contraindication to the method, but more and more MR compatible devices are being developed [26, 27]. Administration of gadolinium-based contrast in patients with renal dysfunction may result in systemic nephrogenic fibrosis [28, 29].

Imaging principles and techniques for identifying the substrate of ventricular arrhythmias using the MR.

Malignant ventricular arrhythmias are the electrical expression of the scar tissue from cardiomyopathies and determine the sudden death of these patients. At present, alteration of the ejection fraction remains the major criterion for the implantation of intracardiac defibrillators, for preventing of sudden cardiac death. In the recent years, however, more advanced techniques, such as nuclear imaging, magnetic resonance (MR), and computerized tomography (CT), have allowed a closer analysis of the ventricular arrhythmic substrate, and it seems that it may be useful in further assessing the risk of sudden cardiac death. The typical anatomic substrate that can be analysed by complementary high-performance imaging methods is tissue with perfusion anomalies, the scar area and its margin, and the sympathetic denervation area [30].

The pathophysiology of ventricular arrhythmias is complicated and influenced by a number of factors. Classically, it is considered to be the result of the interaction between the anatomical substrate and the incidental triggers, which leads to electrical destabilization, by increasing the automatism, the induced extrasystoles, triggered activity, and the re-entry [31].

In over 75% of cases of sudden cardiac death, in the western population, coronary artery atherosclerotic obstruction is responsible [32].

Perfusion abnormalities due to coronary obstructions induce ischemia in acute syndromes, or in chronic stable cases, in both cases, changes in perfusion determine different stages of ischaemia or reperfusion that will determine triggered activity and re-entry [32]. Nuclear imaging and cardiac MR are excellent tools for assessment of myocardial perfusion and may be used to assess the contribution of ischaemia in ventricular malignant arrhythmias. After the myocardial infarction, that usually occur in the setting of an acute coronary syndrome, a scar area develops, encircled by the border area, which contains some healthy tissue and nonviable fibrous cells. Thus, those mixed tissues contain the foundation of the re-entry area: the heterogeneous prolonged conduction zone, at the border of the scar tissue, and the non-leading scar tissue [32, 33]. Cardiac MRI with late gadolinium contrast is the preferred method of visualizing scar areas and

border areas; also, myocardial infarction not only causes the loss of myocytes, but also the destruction of sympathetic nerve endings, which are highly sensitive to ischemia [34].

4. CT or MRI?

Several authors in the literature address the question whether CT or MRI is the best method of discovering the coronary obstructions, that eventually end in determining sudden cardiac death/ other major comorbidities, via an arrhythmogenic pathway. In a very important review from 2011, Konstantin Nikolaou [35], concluded the following facts. The two techniques are being developed as complementary tools for describing the ischaemic heart disease and the level of coronary obstructions. The level of precision seems to be similar, if the CT includes calculation of calcium score and description of coronary arteries, or if the MR scan applies stress imaging, and both methods become more and more available. More because of the negative predictive value, and that is the case when these methods are combined, the ischemic heart disease can be excluded, if the proper criteria for patient examination with these imagistic tools were used. It is not the aim of these techniques to diminish the use of invasive examinations, when these are clearly indicated, but to reduce the number of invasive catheterisation protocols that do not end up with stenting the coronary arteries. Beside this problem, it is also of great importance to remember that arrhythmias occur also in a various number of conditions, that are not of ischemic nature, thus it is very important to examine the patients with important arrhythmias with several imagistic tools.

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