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Update: Acute Coronary Syndromes (VIII)

Imaging Techniques in the Evaluation of Post-infarction Function and Scar

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ABSTRACT

Imaging techniques are essential in the clinical evaluation of patients with a myocardial infarction. They are of value for both initial assessment of the ischemic injury and for detection of the subgroup of patients at higher risk of developing cardiovascular events during follow-up. Echocardiography remains the technique of choice for the initial evaluation, owing to its bedside capability to determine strong predictors, such as ventricular volumes, global and regional systolic function, and valvular regurgitation. New techniques for evaluating ventricular mechanics, mainly assessment of ventricular deformation, are revealing important aspects of post-infarction ventricular adaptation. The main alternative to echocardiography is cardiac magnetic resonance imaging. This technique is highly accurate for determining ventricular volumes and ventricular function and has the additional advantage of being able to characterize the myocardium and demonstrate changes associated with the ischemic insult such as necrosis/fibrosis, edema, microvascular obstruction, and intramyocardial hemorrhage. These features not only allow detection and quantification of the infarct size, but also reveal additional characteristics of the scar tissue with prognostic value.

Técnicas de imagen en la evaluación de la función y cicatriz tras el infarto

Palabras clave:
Infarto de miocardio
Técnicas de imagen
Función ventricular
Cicatriz

RESUMEN

Las pruebas de imagen resultan esenciales en la valoración clínica de los pacientes que han sufrido un infarto de miocardio. Permiten no solo evaluar el daño isquémico inicial, sino además detectar subgrupos de pacientes con mayor riesgo de eventos en la evolución. La ecocardiografía sigue siendo el test inicial de elección, capaz de facilitar a pie de cama predictores potentes como los volúmenes ventriculares, la función ventricular general y segmentaria o la presencia de regurgitación valvular. Nuevas técnicas de estudio de la mecánica ventricular, fundamentalmente de la deformación miocárdica, están mostrando aspectos relevantes de la adaptación ventricular tras el infarto. La principal técnica alternativa a la ecocardiografía es la cardiorresonancia magnética, cuya principal ventaja es, aparte de su exactitud en la determinación de los volúmenes y la función ventriculares, la capacidad de caracterizar el miocardio y demostrar procesos que el daño isquémico conlleva, como necrosis/fibrosis, edema, obstrucción microvascular o hemorragia intramiocárdica. Esto no solo permite detectar y cuantificar el tamaño del infarto, sino que pone de manifiesto ciertas características del tejido infartado con valor pronóstico adicional.

INTRODUCTION

The incidence of acute coronary syndrome in Spain remains high, with around 116 000 new events in 2013, and it is expected to increase in the coming decades.[1] Imaging techniques are of great value for establishing a prompt diagnosis in myocardial infarction and for prognostic stratification, enabling identification of patient subgroups at a higher risk of complications during their clinical course. Determination of systolic function and ventricular volumes

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Abbreviations

CMR: cardiac magnetic resonance
LGE: late gadolinium enhancement
LV: left ventricle
LVEF: left ventricular ejection fraction
MDCT: multidetector computed tomography
RV: right ventricle
SPECT: single photon emission computed tomography
TTE: transthoracic echocardiography

is the cornerstone for predicting events following a myocardial infarction. To evaluate these parameters, transthoracic echocardiography (TTE) remains the test of choice because of its speed and availability, and cardiac magnetic resonance (CMR) is being increasingly used owing to its excellent reproducibility and accuracy. Alternative modalities, such as nuclear techniques and multidetector computed tomography (MDCT), are also available for this purpose. Another important prognostic factor is the size of the infarct, which can be measured with TTE, nuclear techniques, MDCT or, more accurately, with CMR. In addition, capabilities related to myocardial characterization such as determination of the presence of edema, intramyocardial bleeding, and microvascular obstruction by CMR have emerged over the last few years and have shown prognostic relevance.

The aim of this review is to update evidence on the current use of imaging techniques, particularly CMR, to assess ventricular function and the myocardial scar following infarction (Table). Detailed coverage of residual ischemia detection, another important aspect in post-infarction risk stratification, is beyond the scope of this article.

EVALUATION OF POST-INFARCTION VENTRICULAR FUNCTION AND VENTRICULAR REMODELING

Left Ventricular Systolic Function

The left ventricular ejection fraction (LVEF), a powerful predictor of cardiovascular events, is the most widely used parameter in clinical practice to assess the changes occurring in cardiac function after a myocardial infarction.[2] However, it is important to keep in mind that both global and regional systolic function can be misleading in the acute phase due to myocardial stunning in noninfarcted segments or compensatory hypercontractility at distant sites. Transthoracic echocardiography is the technique of choice for first-line post-infarction evaluation of ventricular volumes and systolic function.[3] Simpson's modified biplanar method is currently recommended, in particular for patients with changes in regional contractility.[4] Evaluation of regional contractile function is useful for establishing the diagnosis of an acute coronary syndrome and also has prognostic implications. The wall motion score index, which reflects the extent of contractile dysfunction by estimating the motion index of the 17 left ventricular (LV) segments, has proven to be a predictor of mortality and hospitalization for heart failure following an infarction, regardless of the LVEF.[5]

Although TTE is widely available, 10% of studies have been estimated to have image quality limitations that hamper interpretation of their findings.[6] The use of echocardiographic contrast agents improves visualization of the endocardial border and accuracy in the evaluation of global and regional systolic function.[7,8] In the past, implementation of these agents in acute coronary syndromes was considered contraindicated, but current recommendations allow their use in this context with proper monitoring.[9] Another developing echocardiographic technique that has shown increasing clinical utility in daily practice is 3-dimensional echocardiography, particularly in real time. Although a good acoustic window is still required to obtain high-quality

Table
Role of Imaging Techniques in Assessment Following Myocardial Infarction

	Ventricular function	Ventricular mechanics	Scar characterization
TTE	Technique of choice for the initial assessment because of availability, safety profile, portability, and low cost	Most widely used technique	Estimation of the scar by myocardial thinning and echogenicity, and regional contractility
	Evaluation of global and regional systolic and diastolic function	Myocardial velocity by tissue Doppler, with a prognostic impact on calculation of LV filling pressure	Quantification of viability using low-dose dobutamine
	Additional importance of ventricular remodeling on systolic function	Myocardial deformation (strain and strain rate) by tissue Doppler and speckle tracking	Possibility to determine microvascular obstruction
Nuclear cardiology	Reproducible and non-operator-dependent for assessing systolic function	Currently, no techniques are clinical useful	Quantification of infarct and viability
	Superior to TTE for assessing volumes and RV function		Possibility to determine area at risk
CMR	Reference technique for noninvasive assessment of volumes, mass, biventricular function	Little clinical application	Most accurate quantification of infarct size and transmurality
	High reproducibility	Determination of deformation through tagging	Quantification of viability
			Prognostic impact of scar characteristics: microvascular obstruction, hemorrhage, area at risk
MDCT	Accurate	Currently, no techniques are clinically useful	Feasible to quantify size of the infarct
	Superior to TTE for quantifying volumes and RV function		

CMR, cardiac magnetic resonance; LV, left ventricle; MDCT, multidetector computed tomography; RV, right ventricle; TTE, transthoracic echocardiography.