

Special article

Update on Cardiac Imaging Techniques 2014



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ABSTRACT

In this article, we review the contributions of the most important imaging techniques used in cardiology, reported in 2014. Echocardiography remains the cornerstone for diagnosing and monitoring valvular heart disease, and there has been a continuing effort to improve quantification of this condition and obtain prognostic parameters for follow-up. The study of regional myocardial function is anchored in the diagnosis of subclinical ventricular dysfunction, and 3-dimensional transesophageal echocardiography has become the perfect ally in interventional procedures for structural heart disease. Cardiac magnetic resonance imaging and cardiac computed tomography are the focus of most publications on cardiac imaging in ischemic heart disease, reflecting their consolidated use in clinical practice. Nuclear medicine excels in the study of myocardial viability after interventional treatment of acute coronary syndromes and its performance is validated in the diagnosis of ischemic heart disease.

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Novedades en imagen cardiaca 2014

RESUMEN

En este artículo se realiza una revisión de las aportaciones de las técnicas de imagen más relevantes a la cardiología que se han publicado durante este año. El ecocardiograma sigue siendo la piedra angular en el diagnóstico y el seguimiento de las valvulopatías, con un esfuerzo continuo para mejorar su cuantificación y obtener parámetros pronósticos de seguimiento. El estudio de la función miocárdica regional se afianza en el diagnóstico de la disfunción ventricular subclínica, y el ecocardiograma transesofágico tridimensional se ha convertido en el perfecto aliado del intervencionismo en las cardiopatías estructurales. La cardi resonancia y la tomografía computarizada cardiaca acaparan la mayoría de las publicaciones en imagen cardiaca relativas a la cardiopatía isquémica, reflejo de unas técnicas más que consolidadas en la práctica clínica. La medicina nuclear destaca en el estudio de la viabilidad miocárdica tras el intervencionismo en el síndrome coronario agudo y refuerza su rendimiento en el diagnóstico de la cardiopatía isquémica.

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ECHOCARDIOGRAPHY

Developments in Echocardiography

There have been no important technological advances in echocardiography, but some striking developments have emerged in software applications for fusing transesophageal echocardiography (TEE) and X-ray fluoroscopy images to facilitate minimally-invasive treatment of structural heart disease.¹ In addition, systems to measure cardiac contractility based on new algorithms

have led to improvements in ultrasound wave analysis, optimizing lateral resolution.²

Contrast Myocardial Perfusion and Stress Echocardiography

Recent evidence has further supported the use of myocardial contrast echocardiography to study perfusion.³ In a multicenter study,⁴ the use of dipyridamole with this technique showed higher sensitivity but lower specificity than single-photon emission computed tomography (SPECT) for the detection of significant coronary artery disease in a population with a high incidence of risk factors and an intermediate-high prevalence of this condition.

Published documents on the appropriate use of stress techniques and recent guidelines from the European Society of

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Abbreviations

Cardiac CT: cardiac computed tomography
 CMR: cardiac magnetic resonance
 EF: ejection fraction
 SPECT: single-photon emission computed tomography
 TEE: transesophageal echocardiography

Cardiology have indicated that these tests play an important role and are preferred over conventional stress testing.^{5–7} Individuals with pretest probability < 15% or > 85% do not require noninvasive testing.

Recent studies have confirmed the improved yield of images obtained at peak stress.⁸ In an attempt to standardize ischemia grading with different techniques, a working group designed the ISCHEMIA⁹ study to determine the equivalence of the results of various tests in predicting ischemic events. In patients with left bundle branch block, the yield of stress echocardiography was shown to be lower than that of dobutamine stress cardiac magnetic resonance (CMR) imaging.¹⁰ In valvular disease, such as myxomatous mitral valve regurgitation¹¹ or aortic regurgitation,¹² and in hypertrophic cardiomyopathy,¹³ stress echocardiography has continued to show considerable value.

Interventional Procedures

The role of imaging techniques, particularly 3-dimensional (D) TEE, is evident in the management of patients undergoing percutaneous treatment of structural heart disease and atrial appendage closure.¹⁴ A new system has been reported for percutaneous suture ligation of the atrial appendage (LARIAT device), requiring precise 2D and 3D-TEE guidance.¹⁵

In addition, a new nomenclature system based on simple anatomic relationships has been described to define the location of paravalvular leaks; this system is easier to accommodate to the fluoroscopic view than the nomenclature based on the surgeon's view.¹⁶ In patients with severe aortic stenosis undergoing percutaneous device implantation, preprocedure measurement of the aortic annulus by a new 3D echocardiography method provides results similar to those obtained by cardiac computed tomography (CT) study and predicts the development of paravalvular regurgitation with similar precision.¹⁷

Two excellent reviews by Faletta et al^{18,19} have described the contribution of echocardiography in general and the 3D technique in particular before and during MitraClip implantation. It may also be possible to introduce the use of 3D-TEE in other settings, such as pulmonary vein ablation.²⁰

Valvular Heart Disease

Low-gradient severe aortic stenosis with preserved ejection fraction (EF) is a controversial condition. One prospective study including 260 patients reported that this condition has a poor prognosis and that valve replacement is associated with greater survival than medical treatment.²¹ By contrast, in another large series,²² survival was greater in low-gradient aortic stenosis than in high-gradient cases, and there was a gradual increase in the gradient over time, which could indicate that the low-gradient form is less severe. In a comparative study, echocardiography underestimated the aortic valve area compared with CMR imaging in patients with low-gradient stenosis but not in those with normal gradient, which casts doubt on the assumption that this entity is always a more advanced form of the disease.²³

There are concerns about indexing aortic valve area by body surface area, as this system increases the prevalence of severe aortic stenosis cases by including patients with less advanced disease, without improving the diagnostic accuracy for valvular disease-related events.²⁴ This is especially important in obese patients because indexing by body surface area could clearly overestimate the severity of aortic valve stenosis.²⁵

A new score to predict the outcome of mitral valvuloplasty that incorporates mitral valve area ≤ 1 cm², maximum leaflet displacement at diastole ≤ 12 mm, commissural area ratio ≥ 1.25 , and subvalvular involvement has been validated in a large patient sample and has shown better predictive capacity than the Wilkins score.²⁶

Mitral regurgitation is common following a non-ST-elevation myocardial infarction, and a long-term prospective study has shown that the presence and grade of regurgitation are both associated with a poorer prognosis. In part, this effect may be explained by negative ventricular remodeling and a higher incidence of atrial fibrillation.²⁷

Measurement of aortic regurgitation by 2D and 3D echocardiography has been compared with CMR as the reference technique. Three dimensional echocardiography showed a better correlation and Kappa index of agreement, less dispersion, and narrower confidence limits than 2D echocardiography.²⁸

To estimate the severity of tricuspid regurgitation, 3D echocardiography was more accurate than 2D for determining the effective regurgitant orifice area and the regurgitant volume (especially in eccentric jets) by evaluation of the proximal isovelocity surface area (PISA), using quantitative Doppler and 3D planimetry as reference²⁹ (Figure 1).

The association between dopamine agonist use for treating pituitary tumors and valvular disease has been called into question following a multicenter study conducted in the United Kingdom³⁰ that found no clinically significant association between the dose of this drug and age-adjusted valvular disease.

Aortic Disease

The aortic dilatation patterns and growth rates in patients with bicuspid aortic valve were compared with those of patients with Marfan syndrome or degenerative aortic disease. In patients with bicuspid aortic valve, dilatation of the tubular aorta was the most common pattern and exhibited the fastest growth (similar to Marfan syndrome), regardless of the valve morphology. In comparison with Marfan syndrome patients, a larger percentage of patients with bicuspid valve did not show progression of aortic dilatation. Dilatation of the sinuses was uncommon and was related with the valve morphology. Baseline aortic diameter was not proportional to the rate of progression, which implies that systematic follow-up is needed in this condition.³¹

In a registry of 1850 patients with a transient ischemic attack, the incidence of recurrent vascular events was related to the presence and severity of aortic atheroma detected by TEE, which supports systematic screening of this factor to optimize risk stratification in these patients.³²

Ventricular Function

Despite the growing interest in applying ventricular deformation parameters in clinical practice, one of the main limitations is that the normal values and the effect of various demographic, hemodynamic, and technical factors on these parameters is unknown. Recent publication of reference values obtained by 2D³³ and 3D³⁴ speckle tracking may foster the implementation of these parameters in routine practice. The continuing development

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