Realtime Three-dimensional Echocardiography – A New Diagnostic Tool for Mitral Valve Assessment

a report by

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Mitral valve disease is a common disease that requires an accurate evaluation in order to decide when and how the problem should be treated. Realtime three-dimensional echocardiography (RT3-D) is a new technique that allows us to visualise the mitral valvular anatomy in any desired space orientation. This review will focus on two specific subject areas in which our research team has been working: the accuracy of RT3-D for the evaluation of rheumatic mitral stenosis and the usefulness of RT3-D for the assessment of mitral valve prolapse.

Mitral Stenosis

Rheumatic mitral valve stenosis remains an important public health concern in developed countries. To define the best therapeutic strategy in patients with rheumatic mitral valve stenosis, clinical data and accurate measurements of mitral valve area (MVA) are necessary. Doppler-based methods are heavily influenced by haemodynamic variables, left ventricular hypertrophy and associated valvular disease. Direct measurements of the MVA could traditionally only be performed using a planimetry traced on two-dimensional (2-D) echo images. However, this method has multiple limitations, the major one being the correct image plane orientation.[1,2] RT3-D provides a unique 'en-face' view of the complete mitral valve apparatus[3,4] and has been shown to improve the accuracy of 2-D echo MVA planimetry.[5] Until now, 3-D echocardiography was not routinely performed due to the cumbersome nature of older platforms, prolonged data acquisition and offline processing time. With the advent of the new transthoracic 3-D matrix array probes that allow RT3-D rendering, many of the above limitations can be avoided. Compared with all other echo-Doppler methods, RT3-D has the best agreement with the invasively determined MVA, the usual gold standard. Furthermore, RT3-D provides a similar interobserver variability compared with the pressure half-time method and shows a better interobserver agreement than 2-D echo for the assessment of the pre-valvuloplasty Wilkins score.[5,6] RT3-D has also been shown to be superior in evaluating the MVA in one of the most difficult scenarios for the classical non-invasive methods: the immediate post-valvuloplasty period. Directly following a percutaneous mitral valvuloplasty, the pressure half-time method has been shown to have a poor agreement with invasive data.[7] There are various reasons for this inaccuracy, including the development of an atrial septal defect in many patients after the valvuloplasty, and the fact that the pressure half-time method assumes that left atrial and left ventricular compliances remain stable. This assumption is not valid in the immediate period following a percutaneous valvuloplasty because rapid changes in the left atrial pressure and left ventricular filling occur in this setting, affecting the compliance of both the left atrium and left ventricle. The RT3-D MVA assessment shows a better agreement with the invasively derived MVA before and in the immediate post-valvuloplasty period.[8] Thus, we can conclude that RT3-D is a feasible and accurate technique for measuring MVA in patients with rheumatic mitral valve stenosis and that it is still useful under the conditions in which other non-invasive methods fail.

Mitral Valve Prolapse

Accurate assessment of the scallops involved in a mitral prolapse is important, especially in those patients who are potential candidates for surgery, because this information may be crucial in order to evaluate their chances of valvular repair. Offline 3-D echocardiographic reconstruction of the mitral valve has been performed for many years with excellent results.[9] It has shown that both transthoracic and transesophageal approaches are useful methods in locating the prolapsing scallops of the mitral valve in order to guide the surgeon in his or her valvular reconstruction.[10,11] Nevertheless, 3-D echocardiography has not been routinely performed due to its low cost-effectiveness ratio and the fact that it is time-consuming. With the advent of the new transthoracic 3-D probes that allow RT3-D rendering, these kinds of studies could easily be performed in a short time. RT3-D has been shown to be an accurate method for studying mitral prolapse, able to determine from a transthoracic approach which scallops are involved in the prolapse. This information is particularly relevant for patients who are potential candidates for surgical repair.[12] New diagnostic echocardiographic signs for the evaluation of mitral valve prolapse – such as the 'mitral eversion' and the 'pseudo-cleft'[13] – are currently being described. The 'mitral eversion' is defined as an image of negative relief of the mitral leaflets in systole respect to the annulus, observed from the left ventricle in a modified apical three-chamber view (conventional three-chamber view slightly tilted to include as much of the mitral annulus as possible). A normal mitral valve produces a positive relief with tent shape in this perspective. 'Mitral eversion' has been shown to be an accurate marker to diagnose prolapse of all the scallops in both leaflets. On the other hand, 'pseudo-cleft' (defined as a line along the leaflet from the free border to the annulus, appearing either as valvular discontinuity or as clear relief in its surface, in the paraesternal short axis view or in an apical view of the mitral valve) is a sign that represents the border between normal and prolapsing scallops.

In conclusion, RT3-D echocardiography allows us to perform a more complete evaluation of the mitral valve structures from different points of view. Furthermore, using this new diagnostic method, the surgeon can directly understand what is happening at the level of the mitral valve from a dynamic point of view. ■

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