Editorial Comment

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Three-dimensional Echocardiography: Is It Ready for Prime Time?

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Echocardiography has undergone numerous improvements and additions of new modalities of ultrasound investigation since its first clinical application in the 50s. Better understanding of sound and ultrasound physics is a result of intensive scientific research in recent centuries. In this way, are of historical importance the contributions of researchers from diverse nationalities at different moments in human history, such as:

1 - The measurement of the sound speed by French Franciscan Friar Marin Mersenne (1588-1648);

2 - The need for knowing the propagation medium for sound transmission, observation of the English physicist Robert Boyle (1627-1691);

3 - The observation of sound reflection from the analysis of bat flight reported by the Italian mathematician Abbe Lazare Spallanzi (1727-1799);

4 - The description of variation of the sound frequency from sound emitters, as mentioned by the Austrian physicist Christian Johan Doppler in 1842;

5 - The description of piezoelectric phenomenon in 1880 by the couple Pierre and Marie Curie, which was the reason for nomination and receipt of the Nobel Prize.

Following the discoveries of physics, the various modalities of echocardiography brought new possibilities of diagnostic investigation and a better understanding on heart physiology and pathophysiology of heart disease. Thus, it was observed the introduction of M-mode echocardiography in the 50s and 60s, with important contribution of Edler, Schmmit and Effert, and two-dimensional echocardiography with the brilliant contribution of Eggleton and Feigenbaum, in the 60s and 70s. Even in the 70s and early 80s the use of pulsed Doppler was started for observing the heart flow, with the publication of important manuscripts from Holen, Hatle and Colleagues. Also in the 70s, the first description of transesophageal cardiac investigation in modoplanar mode was elaborated. In the 80s, the first studies on flow mapping with color Doppler was started, which would revolutionize the investigation of congenital heart diseases and valve diseases.

With respect to three-dimensional echocardiography, the initial three-dimensional description of the human structure was performed in 1961, based on ultrasound investigation of the human eye by Baum and Greenwood[1]. The first description of three-dimensional cardiac imaging was performed in 1974 by Dekker and colleagues by using a mechanical arm for the acquisition of images[2]. At that time, the interest was on the possibility to measure the ventricular volumes. In 1976, Moritz, Shreve, and colleagues described the three-dimensional acquisition by employing an acoustic locator. In 1977, Raab described in Boulder, Colorado, USA, the possibility of acquiring three-dimensional echocardiographic images electromechanically by freehand scanning.

In 1980, it is launched in Germany the three-dimensional echocardiographic rotational acquisition and, in 1981, in the U.S., Pearlmann and colleagues reported the acquisition of images by fanlike acquisition. The study on mitral valve and subvalvular mitral apparatus has gained great advance to its knowledge from series of studies in Boston, Ma, USA, by Levine and colleagues[3]. In the 90s, the three-dimensional transesophageal echocardiography was described by investigations in three different centers: at the *TuftsUniversity - New England Medical Center,* Boston, Ma, USA, by Pandian and colleagues; at the *Erasmus Thorax Center,* Roterdan, Netherlands, by Chen and colleagues, and at the *Alabama University,* Alabama, USA, by Nanda and colleagues. In the early 21st century, real-time three-dimensional echocardiography was described

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from matrix digital technology, and this was considered a huge step forward for application and inclusion in the clinical practice three-dimensional echocardiography. In this context, it has been extremely significant the contribution from Lang and colleagues, University of Chicago, Il, USA[4]. Today, there is the possibility of investigating cardiac mechanics as three-dimensional echocardiographic study by using the speckle tracking technique.

The current recommendations (2012) from the associated committee of the *European Association of Echocardiography* (EAE) and the *American Society of Echocardiography* (ASE)[4] on the use of three-dimensional echocardiography in clinical practice follow the expertise accumulated in the last decades with the method. Thus, three-dimensional echocardiography is currently recommended for use in clinical practice for:

1 - Measurement of left ventricular volumes;
2 - Measurement of ejection fraction of the left ventricle;
3 - Analysis of the anatomy of the mitral valve;
4 - Quantification of mitral valve stenosis;
5 - Guide hemodynamic percutaneous procedures.

Three-dimensional echocardiography is currently considered promising, being the subject of active research in the following [4] clinical situations:

1 - Measurement of left ventricular mass;
2 - Measurement of the right ventricle volumes;
3 - Measurement of ejection fraction of the right ventricle;
4 - Measurement of left ventricular dyssynchrony;
5 - Analysis of the left ventricle shape;
6 - Measurement of the left atrium volumes;
7 - Quantification of mitral valve regurgitation;
8 - Analysis of the aortic valve anatomy;
9 - Quantification of aortic valve stenosis;
10 - Analysis of heart valve prostheses.

According to the same recommendation[4], the three-dimensional echocardiography currently presents areas not yet fully studied, as follows:

1 - Analysis of the tricuspid valve anatomy;
2 - Quantification of tricuspid valve regurgitation;
3 - Quantification of tricuspid valve stenosis;
4 - Analysis of the pulmonary valve anatomy;
5 - Quantification of pulmonary valve regurgitation;
6 - Quantification of pulmonary valve stenosis;
7 - Quantification of aortic valve regurgitation;
8 - Measurement of the right atrium volumes;
9 - Analysis of the right ventricle shape;
10 - Infectious endocarditis.

The authors of this paper[4] state the three-dimensional echocardiography should be performed additionally and complementary to two-dimensional echocardiography, allowing the addition of volumetric additional information. They also state the possibilities of application of this technique are not yet totally exhausted due to the constant evolution of computer programs used in three-dimensional echocardiography.

The article by Albuquerque and colleagues[5], *Real-Time Three-Dimensional Transesophageal Echocardiography: Valve Prostheses Evaluation,* published in this issue of the Brazilian Journal of Echocardiography and Cardiovascular Imaging, reports a real-time three-dimensional transesophageal echocardiographic study conducted in Recife-PE, in the period from March 2009 to July 2012, on 208 patients with heart valve prostheses. In this elegant investigation, it has been performed the description of the experience of the Echocardiography Laboratory, Emergency Heart Hospital, University of Pernambuco (PROCAPE / UPE), as well as the comparison between the two-dimensional and three-dimensional transesophageal echocardiographic findings.

The authors considered that the three-dimensional transesophageal echocardiographic investigation added information about the possible mechanism involved in the dysfunction of heart valve prostheses, especially those at mitral position. I fully agree with the authors' conclusions. Congratulations to the group for the academic initiative, conduct of the study, quality of the scientific method employed, beauty and precision of the obtained images, and the development of important center for echocardiographic and cardiac investigation in the region. This surely results from the excellence of the group, coordinated by the grandmaster *(conductor)* of Cardiology in Latin America, our dear Professor.José Maria Del Castilho, a friend of many journeys, responsible for training countless Hispanic cardiologists *(cardiologists)*.

Three-Dimensional Echocardiography: *Is it ready for prime time?* Three-dimensional echocardiography: Is it ready for daily clinical use? When the color flow mapping was launched, there were serious doubts about the possibility of its application within different clinical settings; however, it became a clinical technique of huge application, as observed: *2D Echoand Doppler color flow mapping were not initially perceived to be major diagnostic advances that both have subsequently proved to be,* by Professor Stephen P. Saunders, *Duke University Medical Center,* Durham, NC, USA. With respect to three-dimensional echocardiography, we believe to be in a similar path, the path of any new technique that passes through the stages of innovation, development, dissemination and evaluation, following thus the first clinical trials and the observation of clinical application extent. As early and late supporters of the technique, it may be observed the abandonment of the technique as an obsolete or not beneficial technique, or its acceptance as a beneficial and established technique.

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