

# Where Are We Going in the World of Cardiac Imaging? Is It the Right Way?

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The world of images has been the most revolutionary medical innovation in recent years and it is not surprising that the editors of the *New England Journal of Medicine* consider medical imaging as one of the ten most important advances in medicine of the past thousand years. (1) If we talk specifically of our field and focus on cardiac imaging, the change in the last 30 years has been truly spectacular. A change that begins with echocardiography, which transforms and “democratizes” diagnosis in cardiology, and is followed by cardiac magnetic resonance, multidetector computed tomography (CT) and fusion techniques.

The question: where are we going in the world of imaging? is very complex to answer, as it not only implies knowing the goal we wish to achieve (it is not difficult to imagine and dream), but also to know by intuition if we really can and should get there. The “vital” model change being imposed by the economic crisis will force science, scientific progress and its incorporation into our clinical practice to adopt very different criteria from those followed in the past years, with economical and profit aspects permeating all our work.

To imagine the near future of imaging techniques is not complex:

## IMAGINING IN ECHOCARDIOGRAPHY

Almost 90% of the scientific bulk and principles of echocardiography have been achieved; therefore, we should not expect revolutionary advances, although it is dangerous to establish such a consideration when we can foresee some new windows that may cast new light.

### Is myocardial deformation immersed in routine?

A huge effort has been done in the past years to understand the usefulness and extend the application of deformation techniques to the study of the heart with ultrasound. However, despite hundreds of publications have supported their use in our routine practice and in very different clinical situations, its actual application in our daily work is minimal. (2) How can we explain this dissociation between the world of publications and the real world of our daily practice? I think the explanation cannot be ascribed to failure of the concepts

and principles of deformation, but in the very weakness of the technique used to obtain reliable data. In order to include myocardial deformation in routine studies, it is essential that in the near future the equipment is standardized, to obtain robust and uniform results regardless the equipment used, and also to have normalized parameters and measurements in different clinical situations. This will be the way to include the Holy Grail of myocardial deformation in daily practice.

### Does contrast echocardiography have a future?

There are three clear indications for using contrast echocardiography in the real world: 1) to enhance a Doppler signal when a good spectrum is difficult to obtain (aortic stenosis is the classic example), 2) to improve visualization of left ventricular endocardial borders and 3) to assess patent foramen ovale, employing in this case agitated saline solution. However, the great application of contrast in ischemic heart disease, myocardial perfusion analysis, has become relegated and this is due to a number of causes which are difficult to define. My personal opinion is that myocardial perfusion assessment by contrast echocardiography is dead and without future.

A new way to implement contrast echocardiography is to calculate intracardiac pressures by analyzing the subharmonic amplitude changes that occur after bubble infusion in the cardiac chambers. Subharmonic amplitude is modified according to the pressure where the bubble is, allowing continuous intracavitary pressure estimation. This new method, called SHAPE (subharmonic pressure estimation aid) is very attractive and must confirm its real efficacy in clinical practice. (3)

### Portable equipment: the practical revolution

They are and will be the most important practical revolution we shall see in the coming years. We will have to be humble and learn to teach other specialists how to establish limits. Indeed, the development of these equipments and their assessment and qualification will give rise to a passionate debate in the near future. We are obliged to get involved and control this training.

### New tools to make life easier

Three-dimensional transesophageal echo invades

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everything; 3D transthoracic echocardiography will continue to be an auxiliary tool, but in my opinion it will not displace standard echocardiography. New probes and new crystals to improve ultrasound to provide better images would be necessary. Also, new quantitative tools for automatic or semi-automatic estimation of most echocardiographic measurements and data processing of stress techniques would help the use of these diagnostic methods.

### COMPUTED TOMOGRAPHY IMAGING

Without any doubt, the revolution is already here. Since the quiet introduction in clinical practice of 4-slice computed tomography in 1988 there has been an exponential technological growth whose first peak, the development of the 64-slice CT scanner, has allowed the expansion of this technique and its incorporation into routine practice. However, there has been great resistance to its application due to radiation issues. In this sense, tomography has been subject to more criticism than other studies the cardiologist requests repeatedly and sometimes, indiscriminately, as nuclear medicine tests. Despite this setback, the change has arrived to stay; the incorporation of the 128-slice dual-source CT scanner or the 320-slice scanner with acquisitions adjusted to reduce radiation dose, allow coronary studies to be performed with less than 1 mSv radiation exposure, less than that of an abdominal X-ray. (4) If we take into account the important limitations of stress tests, (5) the change in diagnostic paradigm is here (anatomy versus function): the ultra-low radiation computed tomography will modify our way of evaluating the coronary patient and even predict risk in the normal population.

Coronary disease screening at last? This is going to be the great revolution in cardiac imaging practice in the next years, which will doubtless modify our clinical approach: the noninvasive inspection of coronary anatomy with computed tomography practically without any radiation cost.

### MOLECULAR IMAGING

Molecular imaging enables the noninvasive visualization and characterization of biological processes at the cellular and molecular level. Normally, these studies must be performed in combination with anatomical positioning and evaluation requiring multimodal fusion methods. There are numerous alternatives of cardiovascular imaging that provide images with metabolic information on myocardial intermediate metabolism. (6) PET with FDG (fluoro-2-deoxyglucose) gives an in vivo approximation of glucose use by the myocardium, as well as myocardial fatty acid metabolism, which may have important diagnostic, prognostic and therapeutic implications in the coronary patient. Likewise, SPECT with labeled tracers as 15-iodophenyl-pentadecanoic acid (IPPA) allows evaluation of fatty acid oxidative metabolism. A very

promising aspect of molecular imaging is the identification of vascular inflammatory phenomena. Many clinical studies have demonstrated that F-FDG PET has the potential ability of providing molecular images of inflammation to detect unstable plaques. (7) It has also been shown that human heart angiogenesis images can be obtained by PET studies with F-galacto-RGD tracers. (8)

Imaging studies of cardiac neuroreceptors is a very important area of molecular imaging. (9) We are able to assess presynaptic and postsynaptic function using the noradrenaline analogue C-hydroxyephedrine as tracer in PET studies or meta-iodo-benzylguanidine for SPECT tests. There is already clinical work showing a clear association between the severity of neuroreceptor dysfunction and risk of sudden death. A very attractive area is also the use of this type of information to select patients at high risk of arrhythmia who could benefit from pacemaker implantation.

### LET US RETURN TO REALITY: A HARD CONCLUSION

Imaging in Cardiology has experienced an extraordinary leap in the last 30 years that has been translated into an enormous increase in costs. The numbers are heady: in the United States, the expense of cardiac imaging services represents nearly 10% of all medical costs. Only between 2000 and 2006 the cost of imaging techniques has doubled and, in the last 25 years, the number of requested diagnostic tests has multiplied by 20. It is possible that this is due not to the bad use, but the abuse in the request of studies.

In this context there is the additional radiation issue. It is calculated that approximately 2% of cancers are attributable to medical diagnostic radiation and there is a clear conscience in drastically reducing the exposure of patients to radiation studies, specifically those of nuclear medicine.

It is difficult to know where we will arrive with cardiac imaging in the next years, even though we know where we wish to go. Certainly, CT and cardiac NMR are modifying our real current practice, but the new multimodal techniques as CT-PET, CT-SPECT, PET-NMR, cardiac NMR-SPECT, cardiac NMR-TC and special contrast agents as iron nanoparticles (MPI) have appeared in the horizon, adding a great scientific attraction for us professionals dedicated to cardiac imaging. However, all these techniques will have to prove that they increase patient clinical information, as well as an adequate cost-effectiveness. (10) It is not only a question of acquiring beautiful images or that equipment companies induce us to use new and amazing imaging technologies. We must be much stricter in introducing new imaging methods. The crisis and the economical model change must modify our appraisal of scientific progress. The world is radically changing by the pressure of a crisis that can remodel what we thought was developed and ready to be cooked and become true. The words of the cardiologist Bernard Lown, Nobel Peace Prize, become actual: Frequently,

medical technology is not scientifically assessed; it is often applied without knowledge of the cost-benefit data and relies more on the needs of the market than on the needs of the patient. Undoubtedly, this hard true comment encourages reflection....Do we need in our practice all the information provided by the new sophisticated imaging techniques? To introduce a new imaging technique in our practice, we should demand, at least, some of the following conditions:

-That it improves patient diagnosis, taking into account that the level of improvement has consequences on the prognostic evaluation or treatment. Hence, it must not be only an academic diagnostic improvement.

-That the acquired information represents a decrease in the cost of patient diagnosis.

-That the technique substitutes another more aggressive method or that uses more radiation.

Are these conditions always met? It is clear they are not.

It is obvious that the scientific world must not abandon the search of new diagnostic alternatives and we must continue to advance in our knowledge to benefit the patient. The question is whether in the severe crisis we find ourselves, which includes the healthcare system, it is the moment to change. Must the search and expansion of these advances go in the same direction? or, on the contrary, must we look for other ways more in accordance with the change in model that seems to irrevocably get nearer? Difficult answer.

To conclude and to try help you find your answer, I quote these surprising and provocative words of Lauer in an editorial of the New England Journal of Medicine. They are worth reading. (11)

*"We need to adopt a new paradigm for our approach to imaging. Instead of investing so many resources in performing so many procedures, we should take a step back and design and execute desperately needed large-scale, randomized trials to figure out which procedures yield net benefits. This approach would require leadership and courage on the part of our profession, our opinion leaders, and the research enterprise, but were we to insist that all, or nearly all, procedures be studied in well-designed trials, we could answer many critical clinical questions within a short time. Because*

*we will continue to be uncertain of the magnitude of harm, an accurate understanding of the magnitude of benefit is a moral imperative."*

I hope this will allow us to consider, think and draw some practical consequence in our commitment with cardiac imaging.

#### Conflicts of interest

None declared.

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