Editorial

Cardiovascular Computed Tomography and Magnetic Resonance: History and Growing Impact in Brazil and in the World

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Growth in Brazil and in the World

Cardiovascular computed tomography and magnetic resonance are an important topic within the area of cardiovascular imaging in Brazil and in the world. In the *Arquivos Brasileiros de Cardiologia* this is not different, and despite the increased focus in clinical study, these two topics have grown in impact and scientific publications in recent years.

It is notorious the expansion of the national technological park with entrance of countless devices capable of performing advanced studies using cardiovascular tomography and magnetic resonance with increasing impetus for opening more centers specialized in these methods.

When we perform a systematic review using EndNote as a search tool and select only PubMed as a database with the words "magnetic resonance" and "computed tomography", in the *Arquivos Brasileiros de Cardiologia* alone we observe a total of 182 studies (Figure 1).

In parallel, when we perform a search on PubMed using the word "cardiac" and the MeSH (Medical Subject Headings) terms "computed tomography" and "magnetic resonance imaging", we find a sum of publications close to 45 thousand articles (44,711 articles) (Figure 2).

These graphics turn out to be merely illustrative, but are without doubt markers of the impact of these methods in Brazil (Figure 1) and in the world (Figure 2). It is easy to identify that after the year 2000 and in the last decade there has been a large insertion of these methods in the scientific scenario and we believe that this reflects also in the clinical scenario.

History in the *Arquivos Brasileiros de Cardiologia*

The first studies published in the *Arquivos Brasileiros de Cardiologia* were basically clinical studies and case reports in which the methods were able to contribute to a better diagnosis[1-4]. The first original articles emerged with the use of magnetic resonance imaging in the study by Kalil Filho et al[5,6] in the year of 1995. At that same year, guided by Pinto et al[7], emerged the first Brazilian consensus for the use of cardiac magnetic resonance imaging in clinical cardiology. Computed tomography had its first original study published in 1997, by Kalil et al[8]. One of the pioneering studies in the path of the evaluation of the current calcium score was performed by Feldman et al[9].

Relationship with International Societies

We currently have two international societies dedicated specifically to these methods. The SCMR (Society for Cardiovascular Magnetic Resonance) was the first society to be founded and by the year 2000, it was already organizing the process of credentialing for those dedicated to cardiovascular magnetic resonance[10]. The SCCT (Society of Cardiovascular Computed Tomography) was founded shortly after, following the advances of the method, and in 2009, made available its guidelines for better practice of the method[11,12]. In Brazil, the *Arquivos Brasileiros de Cardiologia* had a fundamental role in the publication of our first guideline[13], which was updated this year (2014) and is currently undergoing editing for future publication.

Scientific and Educational Organization in Brazil

In the early days of the organization in Brazil, a study group of cardiovascular magnetic resonance and computed tomography called GERT was formed and played a key role in the diffusion of knowledge throughout Brazil. A group of physicians dedicated to cardiovascular computed tomography and magnetic resonance created in Brazil the National Meeting of Cardiac Radiology (*Encontro Nacional de Radiologia Cardíaca*, ENRC), which will be on its eighth consecutive year in 2015. This group is composed of radiologists and cardiologists supported by SCMR and SCCT, along with national societies, to enhance the methods in Brazil and discuss the experiences in national territory. Similarly, SBC's Department of Cardiovascular Imaging (DIC), bringing together specialists in nuclear medicine, echocardiography, vascular ultrasound, and cardiovascular magnetic resonance and computed tomography, gathers annually in a meeting with almost 2 thousand participants and maintains the role of diffusing knowledge in the areas of cardiovascular magnetic resonance and computed tomography started with GERT.

We still have only a few training centers of experts in the field, mostly in the Rio-São Paulo hub, but in the last 5 years

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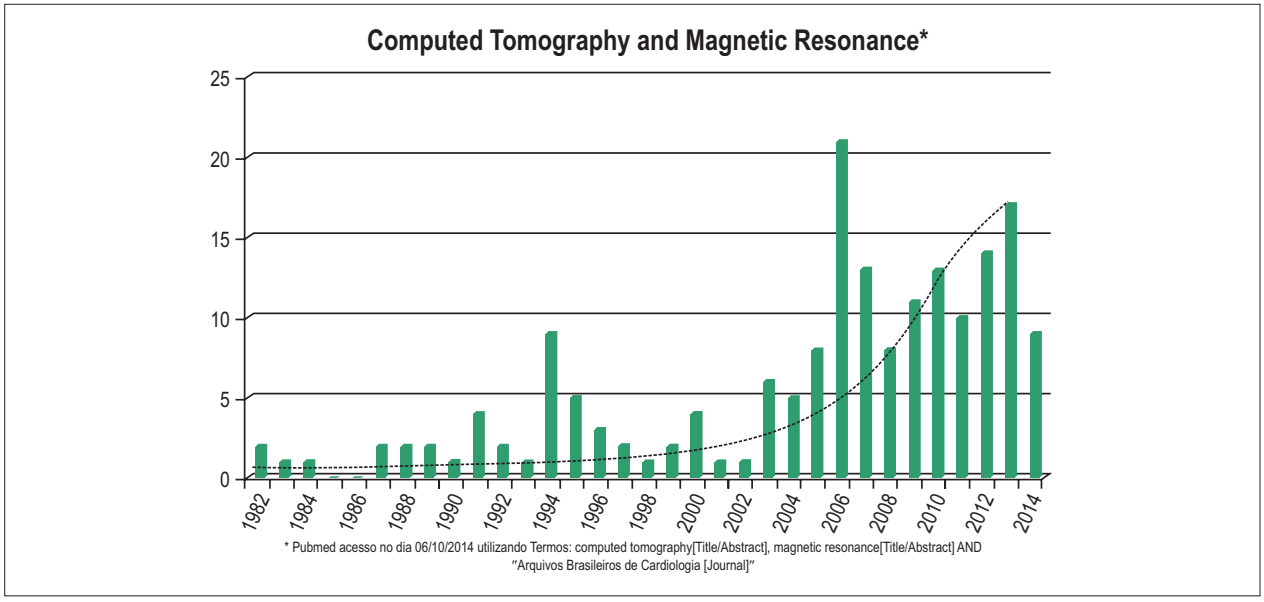

Figure 1 – *Number of publications in the Arquivos Brasileiros de Cardiologia with exclusive focus on cardiovascular computed tomography and magnetic resonance.*

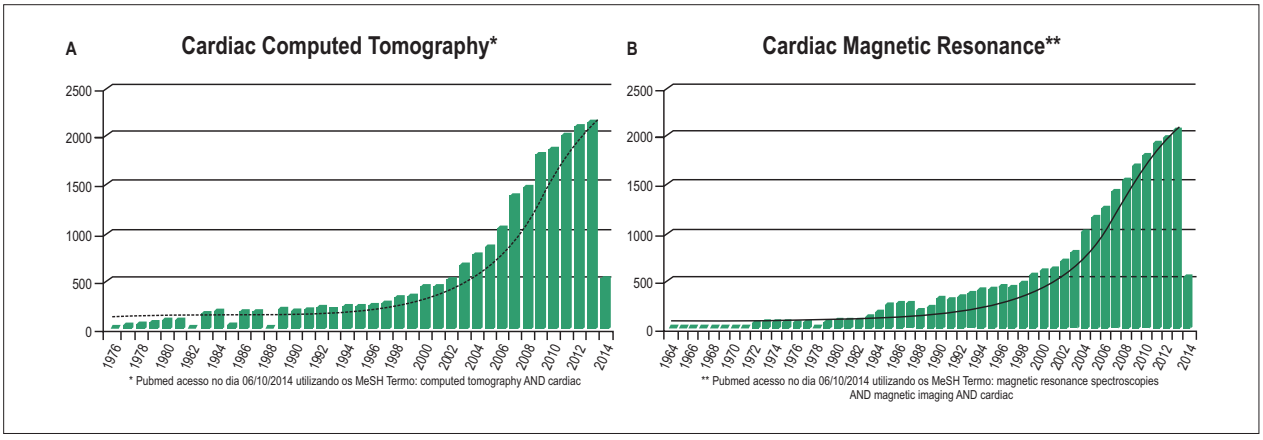

Figure 2 – *Number of publications in PubMed with exclusive focus on cardiovascular computed tomography and magnetic resonance.*

an increasing number of private institutions and university hospitals are strengthening teaching and research in the area. Many who are currently in charge of the specialized centers in Brazil sought their expertises in international centers and we believe that in the near future this reality will no longer be true, since we will have large groups throughout the country.

Worldwide Impact of the Latest Publications by Brazilians

The increasing group of people involved in cardiovascular imaging in Brazil and in the world culminated in an explosion of publications dedicated to standardization and proper use of the method over the last years[14-31].

Some pioneering work of great international impact has been elaborated by Brazilians and we managed, through this editorial, to draw attention to each one in their area.

- Computed Tomography

Assessment of the coronaries – The study conducted by Miller et al[32] had one of the highest scientific impact and collaboration of three Brazilians, one of which was the principal investigator, and also had the largest number of patients included in the study by a Brazilian center. Published in *The New England Journal of Medicine*, the authors concluded that computed tomography can identify the presence and severity of coronary artery disease with good accuracy, but when positive, could not replace conventional coronary angiography. Recently, tomography showed its value in patients with acute coronary syndrome[33].

Assessment of myocardial perfusion – The studies by Cury et al[34] , first published in *Radiology*, brought a new proposal for the use of computed tomography in the evaluation of myocardial ischemia. With simple protocols and easy clinical applicability, it managed to demonstrate that myocardial perfusion on

computed tomography has good correlation with SPECT and with conventional coronary angiography in identifying stenosis of native vessels[35] or with stent[36]. The first multicenter study validating this new technique to detect myocardial ischemia was recently published by Rochitte et al[37]. This study reported high accuracy for detecting meaningful stenoses associated with perfusion defects in the same territory evaluated by tomography when compared with the combination of invasive catheterization with SPECT scintigraphy, and with a lower cost of radiation dose. Thus, this new method is able to diagnose hemodynamically meaningful stenoses or those associate with a reduction of myocardial blood flow.

Evaluation of volumes and function – The quantification of ventricular volumes and function has been validated against other methods of great clinical applicability[38,39], but recently the use of these measurements demonstrated a great potential for detection of cardiovascular risk and mortality[40].

Evaluation of focal fibrosis – In studies by Shiozaki et al[41,42] we can observe that, in addition to the ability to detect focal fibrosis, tomography can be used to predict ventricular arrhythmias. This field is of great importance because some patients are unable to undergo magnetic resonance and can benefit with this new technique.

Evaluation of interstitial fibrosis – In quantifying interstitial fibrosis by computed tomography, the studies by Nacif et al[43,44] were pioneers and open a potential for evaluating subclinical myocardial damage not previously possible in the context of cardiomyopathies.

Epidemiological impact – The studies by Bittencourt et al[45,46] demonstrated the prognostic potential of computed tomography in symptomatic patients with nonobstructive and obstructive coronary disease. However, Prazeres et al[47] were able to summarize in an unique way the potential of the technique for use in the emergency room, with potential of cost reduction for low-probability patients.

- Magnetic Resonance

Assessment of the coronaries –Evaluation of the coronary arteries by magnetic resonance is currently limited to the characterization of the origin or evaluation of the proximal thirds of the main vessels. Recently, new techniques and use of specific vascular contrast created a new horizon for implementation of this method which is free of ionizing radiation. Nacif et al[48] demonstrated that the intravenous contrast medium *Gadofosveset trisodium* had a slightly better performance than the contrast media routinely used.

Assessment of myocardial perfusion – Since the initial studies on the characterization of microvascular obstruction by Rochitte et al[49] in 1998, until the clinical applicability of the evaluation of myocardial ischemia by Cury et al[50] in 2006, and the use of multimodal (combined) resonance techniques for characterization of coronary artery disease by de Mello et al[51] in 2012, we are able to observe the current maturity of the method in the country.

Evaluation of volumes and function – After years using indexing and morphological, volumetric and functional values of international studies, we can say that in a pioneer way, Macedo et al[52] were able to demonstrate in a Brazilian population different morphological and volumetric standards for men and women. Nacif et al[53] demonstrated that there are several ways to quantify atrial volume and that all correlate with one another.

Evaluation of iron deposits – The studies by Fernandes et al[54-56] are of great importance for standardization and evaluation of patients with hepatic and myocardial iron storage.

Evaluation of focal fibrosis – In this topic of publications, there are countless contributions by Brazilians in the impact of the method worldwide, but without a doubt one of the most discussed was the study by Azevedo et al[57] who were able to demonstrate the importance of detection and quantification of delayed myocardial enhancement in patients who underwent aortic valve replacement with great implication in left ventricular functional improvement and evaluation of mortality.

Evaluation of interstitial fibrosis – The studies by Mongeon et al[58,] Coelho-Filho et al[59], Nacif et al[44], Sibley et al[60] and Liu et al[61] were pioneers in the evaluation of interstitial fibrosis by techniques of T1 map and quantification of extracellular volume.

Epidemiological impact – Without a doubt, magnetic resonance is one of the best methods for quantification of myocardial fibrosis. When present, myocardial fibrosis is associated with increased mortality and worse prognosis[62]. In Brazil, in addition to the diseases commonly evaluated in the world, we have Chagas disease that was very well studied by Rochitte et al[63,64]. Now, one of the studies with a major impact on clinical decision using the method was in the risk reclassification using stressor agents[65].

Impact of the Latest Publications in the *Arquivos Brasileiros de Cardiologia*

The *Arquivos Brasileiros de Cardiologia* function as a national thermometer and a main scientific channel reflecting this explosion of publications. The article by Duarte[66], published in 2010, clearly demonstrates the growth of computed tomography and its impact on the detection of coronary artery disease. Over the past decade, we observed an increasing number of review articles[67-75] and original articles[47,52,76-90], which reinforces the impact of tomography and magnetic resonance in current cardiovascular imaging.

Finally, it is not possible to include all studies by Brazilian authors due to the increasing number of publications in the area, but we are sure that we are entering a new era of cardiovascular imaging. The great development of technology applied to medicine causes computed tomography and magnetic resonance to grow increasingly, changing day-to-day the impact on clinical practice.

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