NEW PERSPECTIVES IN EXPLORING CARDIAC PATIENT IMAGING - CARDIAC CT

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REZUMAT

Boli cardiovasculare ocupă primul loc între cauzele de morbiditate și mortalitate, atât în țările dezvoltate, cât și în cele în curs de dezvoltare. Drept urmare, diagnosticarea acestor boli, în special stabilirea unui diagnostic precoce și neînvațat, cu costuri cât mai mici cu putîntă, ocupă un loc principal în managementul pacienților cardiovasculați. Pe lângă tehnicile invasive cunoscute (cateterismul Seldinger), există în prezent posibilitatea diagnosticării bolilor cardiovasculare, și în special a patologiei coronariene, prin metode neînvațate, cum ar fi angioînvațarea cu computer tomograf (angio CT).

Cuvinte cheie: neînvațat, angioînvațarea CT, patologie coronariană

ABSTRACT

The major cause of morbidity and mortality, both in developed and developing countries, is represented by cardiovascular diseases. Consequently, diagnosing such diseases, especially the early and noninvasive diagnosis, with expenses as small as possible, takes front position in the management of cardiovascular patients. Along with known invasive techniques (Seldinger catheterism), presently there is also available the possibility of diagnosing cardiovascular pathology and especially coronary pathology by means of noninvasive methods such as CT angiocoronarography.

Key Words: noninvasive, CT angiocoronarography, coronary pathology

As it is well known, cardiovascular diseases hold first position as far as morbidity and mortality in developed and developing countries are concerned. Thus, one could sense an urgent need of exploring an increasing number of cardiovascular patients in the shortest time possible, with as little costs as possible and by potential noninvasive means. These objectives lead to advanced investigation devices and imagistic study techniques, highlighting mainly exploration of the heart by computer tomography (CT) and by magnetic resonance as well.

The great obstacle in the acquisition of images necessary for establishing a diagnosis of cardiovascular disease was the fact that an organ had to be examined in permanent motion, with small caliber vessels, these being also in motion (the coronary arteries).

With the emergence of multislice CTs, fast image acquisition has become possible in order to diagnose cardiovascular pathology.

The first images acquisitioned for the purpose of diagnosing coronary pathology were achieved with the help of EBCT (electron-beam CT). The highly sophisticated and voluminous equipment, as well as the reduced spatial resolution caused the use of this method to be discontinued. However, this method allowed the identification of coronary arteries calcifications as well as their visualization, although with a reduced resolution.

The rise and development of multislice-multi-detector CTs has brought along an immense progress in image acquisition velocity, tube rotation/spin velocity, volume scanned on time unit, acquisitioned slice thickness. After EBCT, the first trials of acquisition, reconstruction and diagnosis of coronary pathology have been made on CT-4 multislice, but the very long acquisition time (approx. 40 sec.) and thus the very long apnea, as well as the low image resolution prompted further research in this area, revealing the possibility of visualizing coronary arteries, nevertheless in better technical conditions. With the emergence of CT-16 multislice there has been a big improvement in acquisition of images necessary for diagnosing coronary pathology. Still the scanning time is long.
which allows its use for patients who are able to perform a blocked inhaling for about 25-30 sec. The time and space resolution were also satisfactory, but an improvement was still required.

The “Big-Bang” was produced along with the advent of CT 64-multislice which features a series of technical characteristics necessary for noninvasive coronaryography: tube spin velocity of 330 ms (3 times/sec), slice thickness of 0.6 mm, scan time of approximately 12-15 s depending on the scanned area, pulsed ECG scan and synchronized ECG scan with retrospective reconstruction of images and a spatial resolution under 0.4 mm (Figs. 1,2).

Currently, CT-64 multislice is an international standard for imagistic exploration of the heart. The range of imagistic exploration of the heart and big intrathoracic vessels holds a series of examination protocols that allow the possibility of identifying the following:

- Coronary calcifications;
- Valvular calcifications;
- Assessment of coronary arteries and stenosis quantification;
- By-pass assessment;
- Stent patency assessment’
- Left ventricular function assessment (ejection fraction, telediastolic volume, telesystolic volume, ventricular septum, parietal kinetics variations/ modifications);
- Emerging malformations of coronary arteries;
- Cardiac malformations;
- Valvular prosthesis functional condition.

One of the most important functions provided by CT 64 – multislice is the noninvasive assessment of coronary arteries, respectively the presence or absence of coronary stenoses, with the possibility of quantification the degree of stenosis. (Figs. 3-7)
Figure 3. 3D Multiplanar Reconstruction (MPR).

Figure 4. Occlusion of left anterior descending artery.

Figure 5. Severe stenosis of diagonal branch.

Figure 6. Occlusion of right coronary artery.
The scanning protocol comprises a native examination for identifying the presence of coronary calcifications and the angiocoronarography itself. In order to obtain flawless images, patient beta blocking is necessary, the cardiac frequency requiring values between 60-70 beats/min, with an ideal value below 60 beats/min. In the scanning protocol, ECG synchronizing and ECG pulsing are activated, which cause reduction of radiation dose to the equivalent of an angiocoronarography by means of Seldinger technique.

After the acquisition of primary data, the retrospective ECG reconstructions are performed at 60-70% of the cardiac cycle, according to the rate/frequency. For evaluation of the parietal kinetics and left ventricle performance multi-phase reconstructions are performed, achieving 2500-3000 images at the end of the process.

Primary reconstructions are transferred to the post processing station where the soft designed for cardiac exploring allows isolation of the coronary arteries, their expansion on the longitudinal axis with the possibility of spinning around this axis, and also tracking the axial sections by the coronary artery under study. These facilities allow detection of eccentric atheroma plaques, as well as the effect of these plaques upon the vascular diameter (percentage quantification of coronary stenoses for area and diameter). One can also perform the calculation of Agatson calcium scoring, predictive factor for the virtual emergence of any coronary events. As mentioned before, assessment of the left ventricle function and performances are also available.

Besides the reconstructions used for evaluation of coronary arteries, one can perform 3D MIP(maximum intensity projection) and 3D VRT (volume rendered technique) reconstructions, which allow the study of coronary ostium anatomy, of normal or abnormal coronary emerging arteries, of coronary flow preeminence, as well as the anatomy of ascending aorta and also of the vessels emerging of it.

The comparative studies CTA versus, invasive angiography performed by varied authors (Molet, Ropers, Nikolaou) concerning sensitivity, specificity and NPV (negative predictive value) provided the following data: (Figs. 8,9)
- Sensitivity 96-100%;
- Specificity 91-92%;
- NPV 95-100%.

As the figures presented above suggest, the method presents high values of sensitivity and specificity, and proved efficient in diagnosing the presence or absence
of coronary stenoses in patients with atypical thoracic pain, with minimal or no modifications of ECG during pause and on effort trial, in those with inconclusive effort tests or with borderline enzymatic markers. It also proved highly useful in emergency cases in young patients with angina-type thoracic pains, with no ECG modifications, where, besides ruling out or confirmation of coronary pathology, it also allows ruling out other causes of precordial pains (aortic dissection, pulmonary thromboembolism).

Like any other investigation and diagnosis method, this presents both advantages and disadvantages. The former include: the noninvasive method of coronary stenosis diagnosis, short time of investigation, no need for hospital admission of the patient pre and post-investigation, high sensitivity and specificity values, NPV between 96-100% (if by CT angiocoronarography one cannot detect stenotic lesions, the patient no longer requires further investigations and the therapeutic approach can thus be revised).

The drawbacks are represented by the fact that it is a method that makes use of X-rays and iodine-based contrast agent (the same as that which is used in invasive angiocoronarography), which renders this method as inappropriate and forbidden for both patients allergic to iodine and pregnant women. As for allergy to iodine based contrast agents, intensive care medical staff present at the time of the investigation, along with the possibility of administration of premedication to lessen or reduce sensitivity can prevent or reduce the risk of major allergic reactions. The limits of this method would be the presence of severe calcifications at the level of coronary arteries, which obstruct visualisation of vascular lumen and stenosis quantification. This method cannot be used in patients with rhythm disturbances (atrial fibrillation, frequent ventricular and atrial extra systoles – bigeminism, trigeminism).

To sum up, CT angiocoronarography proves to be a method with high sensitivity and specificity values, useful in the assessment of patients with cardiac pathology and especially in coronary patients, likely to relieve the services of cardiac cathetherism, reducing the expenses related to the investigation of an increasing pathology in Romania as well.

REFERENCES