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Coronary artery visualization using a 64-row multi-slice computed tomography in unselected patients with definite or suspected coronary artery disease: A comparison with invasive coronary angiography

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Abstract

Background: *Multi-slice computed tomography (MSCT) is becoming an increasingly acknowledged means of visualizing coronary arteries. The accuracy of 64-MSCT is still a subject of clinical evaluation. Our study, performed with a 64-slice scanner, was intended to assess the concordance of coronary artery lumen visualization in MSCT and invasive coronary angiography (ICA), both in post-revascularization and previously medically treated patients.*

Methods: *We examined data from 73 patients (31 women, 42 men, mean age 59 years) referred to our hospital in 2006 and 2007 who underwent MSCT and subsequent ICA. Twenty two patients had a history of previous revascularization. Of the remaining 51 patients with intermediate coronary artery disease probability, the indication for 64-MSCT was suspicion of coronary artery disease. MSCT coronary angiography was performed with Aquilion 64 scanner (Toshiba, Japan). We evaluated 15 segments of four native coronary arteries (RCA, LM, LAD and Cx in all patients plus 11 arterial and 22 venous conduits). The cut-off value for significant stenosis was the lumen cross section area reduction exceeding 50%, regardless of segment.*

Results: *Regarding native arteries, MSCT and ICA findings were coherent in 80.8% of all patients, 93.8% of vessels, and 98.4% of segments. MSCT coronary stent patency evaluation was 90.9% correct. The by-pass grafts evaluation was entirely concordant in both methods. The respiratory and heart rate variability artifacts hindered the MSCT analysis in ten patients (13.7%). The artifacts occurrence in misinterpreted studies was nearly two-fold higher than in those that were coherent (21.4%* vs. *11.9%).*

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Conclusions: *We concluded that a reliable evaluation of the coronaries by means of 64--MSCT is feasible both in patients with suspected coronary artery disease and those with definite coronary artery disease who had previous coronary intervention. Patient selection and co-operation is necessary to avoid respiratory and heart rate variability artifacts that may hinder analysis.* (Cardiol J 2009; 16, 5: 413–417)

Key words: multislice computed tomography, coronary angiography

Introduction

Multi-slice computed tomography (MSCT) is becoming an increasingly acknowledged means of visualizing coronary arteries (computed tomography coronary angiography, CTCA) [1–3]. Not only does it offer constantly higher image quality, it also bears no risk of peripheral arteries catheterization. Moreover, the radiation dose delivered by the modality remains within reasonable limits, if performed with modern systems [1, 2]. All the same, invasive coronary angiography (ICA) still remains the 'gold standard' in coronary stenosis detection [4].

Despite several years of MSCT being present in the field of cardiac imaging, the scope of indications for the procedure remains relatively narrow. The ACC/AHA 2006 Appropriateness Criteria for Cardiac Computed Tomography and Cardiac Magnetic Resonance Imaging [2] specify clinical conditions justifying the use of CTCA imaging. With regard to coronary artery disease (CAD) diagnosis, the presence of symptoms remains crucial. The CTCA is considered appropriate in patients with chest pain syndrome and intermediate pre-test probability of CAD, uninterpretable echocardiography (ECG), uninterpretable or equivocal stress test or those unable to exercise [2]. In subjects with acute chest pain, the procedure should be considered if the serial enzymes remain negative and no ECG changes manifest [2, 3]. According to an increasing number of studies, CTCA is a diagnostic modality with high sensitivity and negative predictive value in symptomatic patients at low to intermediate risk [2], with exceptional aptitude to exclude significant CAD presence [3]. In asymptomatic patients, on the other hand, CTCA evaluation is only regarded as uncertainly indicated in high CAD risk patients and as utterly inappropriate for those at low to moderate risk. The possibly least utilized 'appropriate' indication is the etiology assessment in patients with new onset of heart failure, despite the method being both safe and accurate for differentiating between idiopathic and ischemic dilated cardiomyopathy [5].

The method's applicability in post-revascularization (either percutaneous or surgical) patient evaluation remains undecided [1–3, 6]. Despite an increasing amount of favorable data, the MSCT imaging in symptomatic patients is still classified as merely uncertain. In post-revascularization asymptomatic patients, the 2006 ACC/AHA recommendations represent an even less confirmatory approach, categorizing the modality as inappropriate, regardless of time since coronary intervention [2]. Indeed, a recently published meta-analysis recognizes a number of limitations, mostly of a procedural nature [5]. Nevertheless, constant technological development, leading to the introduction of increasingly more sophisticated systems, including dual--source MSCT, allows enhanced coronary artery visualization, regardless even of heart rate irregularities, which were previously considered a major drawback [1, 2]. Consequently, the latest studies conclusively demonstrate the in-stent restenosis detection feasibility by means of CTCA [6]. Our study, performed with a 64-slice scanner, was intended to assess the concordance of coronary artery lumen visualization in CTCA and ICA, both in post-revascularization and previously medically treated patients.

Methods

We examined data from patients referred to our hospital in 2006 and 2007 who underwent CTCA and subsequent ICA. For this analysis, we selected 73 records in which the time interval between the two procedures did not surpass two weeks. This group comprised 31 women, mean age 59 years, and 42 men, mean age 58 years. Twenty two of the patients had a history of previous revascularization: eight of them had undergone coronary artery bypass grafting, ten percutaneous transluminal coronary angioplasty with stent implantation, and four a hybrid procedure. The main indication for 64-CTCA was a recurrence of symptoms that had not been considered typical. In the remaining 51 patients with intermediate CAD probability, as evaluated by means

of the Diamond-Forrester method [7], the indication for 64-CTCA was suspicion of CAD. All patients gave informed consent.

MSCT coronary angiography (CTCA) was performed with Aquilion 64 scanner (Toshiba, Japan). The detector collimation was 64 × 0.5 mm with the rotation time of 0.4 s. Computed tomography pitch factor was 0.2–1. The tube current was set at 400 mA and tube potential at 120 kV. Depending on the scanning time, a total dose of 100 mL to 120 mL of nonionic contrast (iomeprol, Iomeron 400, Bracco Int.) was injected in the antecubital vein at a flow rate of 5 mL/s. The ECG-gated scanning of the heart, preceded by Sure-Start monitoring at the start scan position, was performed. The cut-off for heart rate was set at 65 beats per minute. If the heart rate was higher, metoprolol succinate (Betaloc, Astra Zeneca, Sweden) at a dose of 5–10 mg was administered intravenously, if not contraindicated. The protocol did not include a use of oral/sublingual short-acting nitrates. The scanning was triggered once the descending aorta opacity reached 180 Hounsfield units. Cardiac images ranging from the aortic root to the apex were acquired during a single breath-hold of approximately 10 seconds.

Parameters of reconstruction were as follows: image width: 0.5 mm, reconstruction interval: 0.3, total number of images per reconstruction: 453. Depending on the scanning span, the dose length product and the effective dose ranged between 1200––1400 mGy × cm^2 and 19–22 mSv, respectively.

Images of the coronary arteries were transferred to a remote workstation (Vitrea2; Vital Images Inc., USA) for post-processing. We evaluated 15 segments of four native coronary arteries: right coronary artery (RCA), left main (LM), left anterior descending (LAD) and circumflex (Cx) in all patients, plus 11 arterial and 22 venous conduits. The cut-off value for significant stenosis was the lumen cross section area reduction exceeding 50%, regardless of segment. A comparison with invasive ICA findings which finally revealed significant coronary stenosis in 39 patients (53.4%) was performed to verify the accuracy of MSCT assessment. Data was considered coherent if both ICA and MSCT findings were either above or below cut-off (> 50%, ≤ 50% lumen narrowing). Fisher exact test (χ^2) was used for comparisons. A two-sided p-value of less than 5% was considered significant.

Results

Regarding native arteries, MSCT and ICA findings were coherent in 80.8% of all patients, 93.8% of vessels, and 98.4% of segments. The consistency of both methods was even higher in patients with no significant stenosis and reached 94.1% per patients, 98.5% per vessels and 99.6% per segments ($p < 0.001$). We managed to obtain excellent quality MSCT images in 86.3% of studies. The respiratory and heart rate variability artifacts hindered the MSCT analysis in ten patients (13.7%), three of whom had an MSCT result inconsistent with ICA (4.1%). The artifacts occurrence in misinterpreted studies was nearly two-fold higher than in those that were coherent (21.4% *vs*. 11.9%, per patient analysis); however the difference was insignificant. Thus, we did not exclude them from statistical analysis, considering artifacts still an incremental part of MSCT study. There was no significant difference in location of discrepantly analyzed segments: five (27.8%) in each of RCA, LAD and Cx, and three (16.7%) in LM. The MSCT over- (n = 7 segments, 38.9%) or underestimation (n = 11 segments, 61.1%) of stenosis remained unaffected by discrepant plaque morphology which was found to be soft in ten segments (four over- and six underestimated), calcified in five segments (two over- and three underestimated) and mixed in two (both underestimated). The by-pass grafts evaluation was entirely concordant (100%) in both methods (Fig. 1). MSCT coronary stent patency evaluation was 90.9% correct (Fig. 2). The modality falsely showed one in-stent restenosis and failed to visualize one.

Discussion

In accordance with previous observations, CTCA and invasive coronary artery findings reached exceptionally high coherence in patients with no significant coronary stenoses [8–10]. This observation, together with MSCT non-invasiveness, confirms the method's excellent potential to efficiently 'sieve' patients before eventual referral to ICA [1, 3]. The above should probably also apply to subjects with surgical revascularization history, as demonstrated by our findings [11]. As far as stent patency evaluation and possible in-stent restenosis detection are concerned, the situation remains slightly more ambiguous [6]. Although our results seem promising, data published so far tends to vary, pointing at the assessment reliability being dependent upon not only heart rate irregularity but also stent size and treated segment diameter [12]. Whether or not the newly developed techniques, including dual-source MSCT [13], will overcome these restraints remains to be seen. Another quandary requiring further research is defining the actual correlation

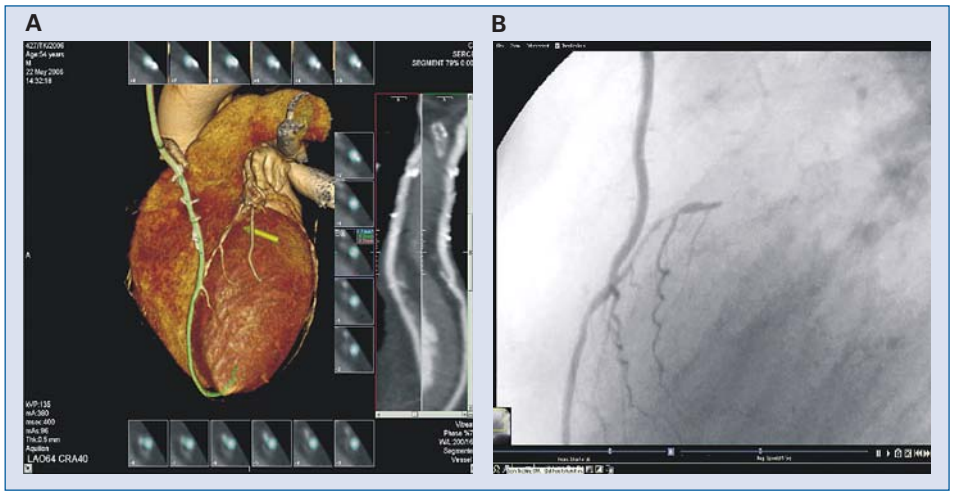

Figure 1. Comparison of the left interior mammary artery with the left anterior descending: evaluation by means of 64-multi-slice computed tomography (**A**) and invasive coronary angiography (**B**).

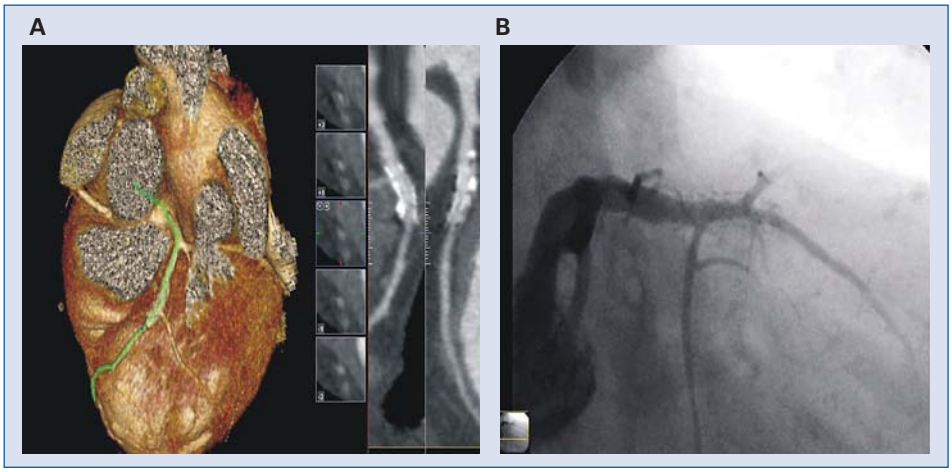

Figure 2. Comparison of the stent evaluation by means of 64-multi-slice computed tomography (**A**) and invasive coronary angiography (**B**).

between artifacts occurrence and misinterpretation risk as well as potential correlation between the plaque morphology and imaging concordance.

Conclusions

A reliable evaluation of the coronaries by means of 64-MSCT is feasible either in patients with suspected CAD or those with a definite CAD who had previous surgical coronary intervention. Coronary stent evaluation still remains to be explored. Patient selection and co-operation is necessary to avoid respiratory and heart rate variability artifacts that may hinder analysis.

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References

1. Bluemke DA, Achenbach S, Budoff M et al. Noninvasive coronary artery imaging. Magnetic resonance angiography and multidetector computed tomography angiography. A scientific statement from the American Heart Association Committee on Cardiovascular Imaging and Intervention of the Council on Cardiovascular Radiology and Intervention, and the Councils on Clinical Cardiology and Cardiovascular Disease in the Young. Circulation, 2008; 118: 586-606.

2. Hendel RC, Patel MR, Kramer CM, et al. CCF/ACR/SCCT/ /SCMR/ASNC/NASCI/SCAI/SIR: 2006 Appropriateness criteria for cardiac computed tomography and cardiac magnetic resonance imaging: a report of the American College of Cardiology Foundation Quality Strategic Directions Committee Appropriateness Criteria Working Group, American College of Radiology, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, American Society of Nuclear Cardiology, North American Society for Cardiac Imaging, Society for Cardiovascular Angiography and Interventions, and Society of Interventional Radiology. J Am Coll Cardiol, 2006; 48: 1475–1497.
3. Poon M, Rubin GD, Achenbach S et al. Consensus update on the appropriate usage of cardiac computed tomographic angiography. J Invasive Cardiol, 2007; 19: 484–490.
4. Scanlon PJ, Faxon DP Audet A-M et al. ACC/AHA guidelines for coronary angiography: Executive summary and recommendations. A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Coronary Angiography). Circulation, 1999; 99: 2345––2357.
5. Andreini D, Pontone G, Pepi M et al. Diagnostic accuracy of multidetector computed tomography coronary angiography in patients with dilated cardiomyopathy. J Am Coll Cardiol, 2007; 49: 2044–2050.
6. Hamon M, Champ-Rigot L, Morello R, Riddel JW, Hamon M. Diagnostic accuracy of in-stent coronary restenosis detection with multislice spiral computed tomography: A meta-analysis. Eur Radiol, 2008; 18: 217–225.
7. Diamond GA, Forrester JS. Analysis of probability as an aid in the clinical diagnosis of coronary-artery disease. N Engl J Med, 1979; 300: 1350–1358.
8. Cademartiri F, Maffei E, Palumbo A et al. Diagnostic accuracy of 64-slice computed tomography coronary angiography in patients with low-to-intermediate risk. Radiol Med (Torino), 2007; 112: 969–981.
9. Meijboom WB, van Mieghem CA, Mollet NR et al. 64-slice computed tomography coronary angiography in patients with high, intermediate, or low pretest probability of significant coronary artery disease. J Am Coll Cardiol, 2007; 50: 1469–1475.
10. Miller JM, Rochitte CE, Dewey M et al. Diagnostic performance of coronary angiography by 64-row CT. N Engl J Med, 2008; 359: 2324–2336.
11. Nieman K, Pattynama PM, Rensing BJ, Van Geuns RJ, De Feyter PJ. Evaluation of patients after coronary artery bypass surgery: CT angiographic assessment of grafts and coronary arteries. Radiology, 2003; 229: 749–756.
12. Cademartiri F, Schuijf JD, Pugliese F et al. Usefulness of 64-slice multislice computed tomography coronary angiography to assess in-stent restenosis. J Am Coll Cardiol, 2007; 49: 2204–2210.
13. Leber AW, Johnson T, Becker A et al. Diagnostic accuracy of dual-source multi-slice CT-coronary angiography in patients with an intermediate pretest likelihood for coronary artery disease. Eur Heart J, 2007; 28: 2354–2360.