Current perspective
Multidetector computed tomography of the coronary arteries

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Over the past decades, the feasibility of non-invasive coronary imaging has been explored using different modalities, such as magnetic resonance and electron beam computed tomography. Despite encouraging initial results, neither technique is yet considered suitable for routine clinical use. Recent developments in multidetector computed tomography have expanded the potential of contrast-enhanced spiral computed tomography coronary angiography. Promising results have been published with the use of 4-slice spiral computed tomography; however, cardiac motion and calcium deposits in the artery wall rendered a substantial number of scans inadequate for interpretation. Recently, a new generation of scanners, equipped with more and thinner detector rows (8 and 16 detectors) and an increased rotation speed, have been introduced. These technical advances will have a significant impact on cardiac imaging: at an increased gantry rotation rate, up to 32 slices can be acquired in 1 s. The improved spatial and temporal resolutions have led to the opportunity of acquiring high-quality images of the entire heart within a single breath-hold.

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Introduction

In many industrialized countries coronary artery disease is the most common cause of hospitalization and mortality[1,2]. Coronary angiography (CA) is the current gold standard for the assessment of the morphologic status of the coronary arteries and is increasingly being combined with interventional therapeutic procedures such as balloon angioplasty and stent implantation. Although CA has become a relatively safe procedure with a low incidence of complications, the inconvenience for the patient as well as the economic burden have rendered necessary an alternative, non-invasive method for the visualization and assessment of the coronary arteries. Therefore, non-invasive imaging modalities such as electron beam computed tomography (EBCT) and magnetic resonance were developed to quantify calcium deposits and coronary artery morphology and flow[3].

In the last years, multidetector-row computed tomography (MDCT) scanners with simultaneous acquisition of multiple slices (4 to 16) in less than half a second of gantry rotation time have become available[4-7]. Multiple slice acquisition by these scanners has considerably improved cardiac application, such as non-invasive MDCT CA[7]. Initial experiences have shown that coronary stenoses may be detected with a good sensitivity and specificity[6-8].

This article discusses the technical potential and current clinical applications of MDCT in the non-invasive evaluation of the coronary arteries.

Multidetector spiral computed tomography and electron beam computed tomography techniques

In the last decade, computed tomography (CT) investigation of the heart was the exclusive domain of EBCT. This technique was primarily used to assess myocardial perfusion and function and then to visualize the coronary arteries[3]. EBCT acquires 30 to 40 cross-sectional images in the craniocaudal direction to include the full extent of the coronary vasculature. The tomographic slices have a fixed thickness of 3 mm and an acquisition time of 50-100 ms: the entire heart is imaged during a single 20-30 s breath-hold. EBCT has a high temporal resolution, but the main limitations of this system affecting image quality are its low spatial resolution and pronounced noise, especially in obese patients. Another limitation of EBCT is that the ECG-synchronization can only be performed prospectively, limiting image reconstruction on a predefined cardiac phase[3,7].

In the early 1990s, the introduction of helical CT provided a valuable tool for three-dimensional non-invasive large-vessel analysis: helical CT scanning consists of continuous data acquisition during patient feed in the gantry. Helical CT scanners with a single detector row allow the acquisition of one slice for tube rotation, with a spatial and temporal resolution which are insufficient to examine the entire heart during a breath-hold[4-6].

The first multidetector-row spiral CT scanners were introduced into clinical routine in 1998: they allowed for the simultaneous acquisition of 4 slices during a single gantry rotation in the subsecond range (0.5-0.8 s)[6]. The MDCT scanners currently available allow for the simultaneous acquisition of 8-16 slices with a minimum gantry rotation time of 0.375 s. Even faster scanners are expected and will be soon developed. Large body segments may now be examined at very high temporal and spatial resolutions. These main technical innovations may be exploited to evaluate body districts such as the heart and coronary arteries[5-7]. In fact, MDCT has a higher spatial resolution compared with EBCT and provides a better signal-to-noise ratio, which crucially affects image quality, especially when small structures are assessed[3,7]. The temporal resolution of MDCT is slightly lower than that of EBCT (200-250 ms compared with 50-100 ms), although the faster gantry rotation time ($\leq$ 0.4 s) and partial acquisition with retrospective ECG-gating provide a good diagnostic accuracy.

For cardiac CT applications, the synchronization of data acquisition with the cardiac cycle can be performed in a prospective ECG-triggered or retrospective ECG-gated way. The procedure of prospectively triggering scan acquisition to sequential diastolic phases is routine in cardiac EBCT[3,7]. EBCT only acquires a single phase of the cardiac cycle, representing a compromise for the assessment of all coronary arteries. Instead, ECG-gated MDCT acquires a three-dimensional data set of the entire heart including different phases of the cardiac cycle. Data acquisition by MDCT allows for the retrospective selection of the optimal phase with the least motion for imaging each coronary segment. Adaptation of the reconstruction window to each coronary artery rather than using one fixed time point in the cardiac cycle provides optimal image quality[9,10]. This technique allows one to obtain two or three-dimensional angiographic off-line reconstructions of all coronary segments from a single MDCT data set. Nevertheless, matching of image data with the corresponding cardiac phases by retrospective gating may be difficult or even impossible in patients with pronounced arrhythmia, particularly if higher-frequency premature beats are present or in the presence of an absolute arrhythmia (atrial fibrillation)[10]. Due to the complete acquisition of the data in all cardiac phases, the X-ray radiation of retrospective ECG-gated spiral CT is higher than prospectively ECG-triggered sequential acquisition (a recent clinical trial estimates a radiation exposure dose of 6.7-13.0 mSv for MDCT and of 1.5-2.0 mSv for EBCT)[11]. However, strategies for dose reduction are under investigation[12].

A major advantage of MDCT is the universal applicability of the scanners to all areas of the body and to other diagnostic fields, while EBCT scanners are cardiac-dedicated.

Assessment of coronary arteries by multidetector-row computed tomography

Selective CA has been the gold standard for coronary imaging since its introduction in 1959[13]. CA is an invasive procedure: complications requiring emergency surgical intervention occur in approximately 0.8% of all cases (mortality 0.1%)[14]. For these reasons, CA is not used as a screening method and besides its utilization in the clinical follow-up is very limited.

The concept of non-invasive imaging of the coronary arteries stems from the desire to avoid both the risk associated with CA and the expense of hospital admission. Besides, CA is restricted to the intraluminal assessment of coronary vessels without visualizing wall structures and therefore fails to demonstrate early coronary heart disease, before narrowing of the lumen has occurred[6,7].

The image quality and diagnostic accuracy of MDCT, as demonstrated in the emerging clinical investigations on coronary CT angiography (CCTA)[8,15-17], favorably compare with those of CA and offer theoretical advantages in plaque characterization and visualization of the coronary arteries.

Visualization and assessment of coronary vessels require high contrast resolution, high spatial resolution, motion free images with complete coverage of the heart volume in a single breath-hold. Acquisition must be performed with thin collimation (~1.25 mm or less) due to the small size of these vessels.

Several protocols are now available for MDCT of the coronary arteries, depending on the scanner technical properties, on the slice collimation and on the interval reconstruction that the radiologist would like to use[6,7,9,15-23]. Suggestions about MDCT protocols are reported in tables I and II (the reported figures are the maximal theoretical).

The volume of interest in CCTA is acquired after intravenous contrast medium administration. Contrast agents currently used in CT are non-ionic iodinated compounds with a iodine concentration of 300-400

Table I. Scan parameters for protocols with 4, 8 and 16 detector-row scanners.

Acquisition	Manufacturers	Detector configuration (channels × mm)	Pitch	Table speed (mm/s)	Scan time (s)*
High-resolution	GE	4 × 1.25	1.5	9.375	32
	Philips	4 × 1	1.5	12	25
	Siemens	4 × 1	1.5	12	25
	Toshiba	4 × 1	1.375	11	27
High-resolution	GE	8 × 1.25	1.5	27	11.1
High-resolution	GE	16 × 1.25	1.375	55	5.5
	Philips	16 × 1.5	1.25	60	5
	Siemens	16 × 1.5	1.5	72	4
	Toshiba	16 × 2	0.9375	60	5

* scan time for a hypothetical volume coverage of 30 cm.

Table II. Multidetector-row computed tomography (MDCT) coronary angiography protocol.

4-slice MDCT protocol
- Calcium score scan (4 × 2.5 mm; 300 mAs; 140 kV; slice thickness 3 mm)
- Delay time based on test bolus (20 ml contrast media, 30 ml saline flush)
- Angiographic scan (4 × 1 mm; 300 mAs; 140 kV; rotation time 500 ms; slice thickness 1.25 mm)
- Iomeprol 300 or 400 (300 or 400 mg I/ml)
- Flow rate: 3 ml/s
- Volume: 120-140 ml of contrast medium and 50 ml of saline flush

16-slice MDCT protocol
- Calcium score scan (16 × 1.5 mm; 300 mAs; 120 kV; slice thickness 3 mm)
- Delay time based on test bolus (20 ml contrast media, 30 ml saline flush)
- Angiographic scan (400 mAs; 16 × 0.75 mm; 120 kV; rotation time 420 ms)
- Iomeprol 300 or 400 (300 or 400 mg I/ml)
- Flow rate: 3-4 ml/s
- Volume: 100-120 ml of contrast medium and 50 ml of saline flush

mg/ml. A total volume of 100-140 ml is administered with a power injector at a flow rate of 3.5-5 ml/s, flushed if possible with saline solution. The delay time between the start of the injection and scanning may be determined by using either a test-bolus or the bolus-tracking technique[9]. The "test-bolus" is operator-dependent; instead, by using the "bolus-tracking" technique, the delay time is automatically calculated by the scanner.

Contrast agents with a higher iodine concentration (400 mg I/ml) provide a better arterial enhancement, even when the same quantity of iodine is administered. This permits depiction of smaller vessels, facilitates post-processing and reduces the overall volume of contrast medium required by approximately 30%[24].

Once the entire cardiac volume has been acquired with a retrospective ECG gating, all these data can be used to visualize the coronary vessels in different phases of the cardiac cycle. Post-processing of the coronary arteries should be performed on dedicated workstations, which permit the interactive evaluation of the vessels using all possible reconstructions and rendering algorithms, such as multiplanar reformations, maximum intensity projections, volume rendering, endoluminal views and navigation (virtual angioscopy)[6,7,9,10,25] (Fig. 1). Cardiac images may be reformatted in various orientations, such as the short- and long-axis chamber views, for morphologic and functional analysis. It is possible to obtain curved reformatted views showing an entire coronary branch in a single image (multiplanar reformations). Volume rendering reconstructions offer a three-dimensional global view of the heart (Fig. 2), whereas virtual angioscopy generates endoluminal views of the arterial wall and plaques[25] (Fig. 3).

Even with the earlier 4-slice MDCT scanners, noninvasive CCTA has shown a good diagnostic accuracy for the detection and quantification of hemodynamically significant stenoses, especially in patients with a heart rate ≤ 65 b/min[6,9,15,17-23]. However, with 4-row technology, several factors decrease image quality

Figure 1. *Maximum intensity projection of the left anterior descending artery demonstrates a calcified plaque* (arrow) *at the level of the proximal tract.*

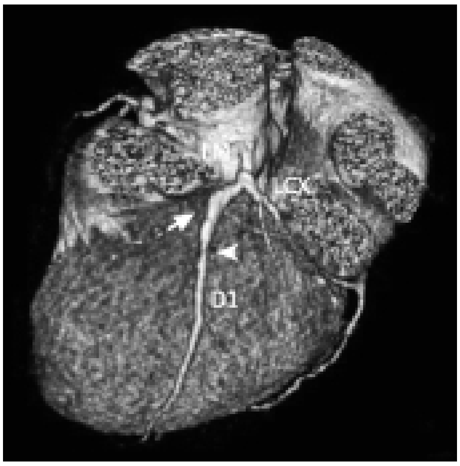

Figure 2. *Anterior view of the heart by volume rendering algorithm, showing the left main coronary artery (LM), the left circumflex artery (LCX) and the first diagonal branch (D1). The left anterior descending artery is occluded in the proximal tract* (arrow) *and therefore is not visualized. The three-dimensional image depicts a high-grade stenosis of the D1* (arrowhead).

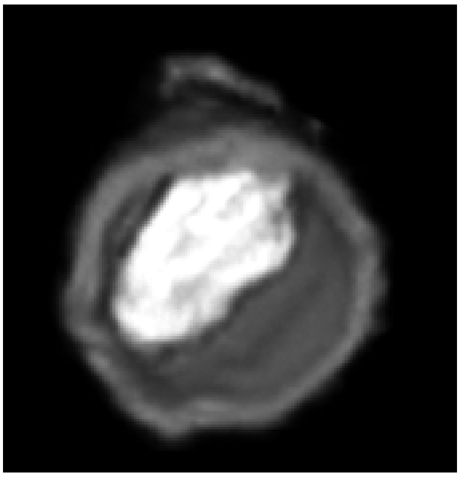

Figure 3. *Virtual coronaroscopy generates endoluminal views of the artery wall and plaques. This image shows a luminal narrowing (70%) of the left anterior descending artery caused by a soft tissue plaque in a 72-year-old symptomatic patient.*

and render the interpretation difficult: the two main impediments are a high heart rate and severe calcifications[6,7,9]. Four-slice MDCT provides a maximum temporal resolution of 250 ms, which is adequate only at low heart rates (≤ 65 b/min) and requires that patients hold their breath for 30-40 s, too long in cases of cardiorespiratory disease. Assessment of the luminal diameter in the presence of severe calcifications yields unsatisfactory results. Published data quantifying the amount of calcifications critical for image interpretations are limited. A recent study suggests a threshold for maximum calcifications to Agatstone Score 300[26].

More recent 16-slice MDCT scanners have a minimum gantry rotation time of 0.375 s and acquire 32 slices in 0.75 s, permitting us to overcome most of these limitations[9]. The higher spatial resolution, through the reduction of partial volume effects, improves the diagnostic accuracy of 16-slice MDCT and allows visualization of small-in-caliber vessels, whereas advantages of shorter scan time are a more comfortable breath-hold (approximately 20 s) and a lower volume of contrast agents[8,9,16]. Dedicated algorithms using only the data from a half gantry rotation per slice, provide a temporal resolution ≤ 210 ms, permitting us to scan patients with a heart rate > 65 b/min[8]. However, to obtain excellent image quality, a lower heart rate is preferable.

A limitation of MDCT is the use of ionizing radiation which is slightly higher as compared to that of single slice spiral CT. All manufacturers provide several means to reduce X-ray exposure, by significantly improving the quality of detectors and by modulating the mAs throughout the acquisition[6,7,9].

Comparison of coronary computed tomography angiography versus coronary angiography

The first experience of coronary artery imaging by means of ECG-gated MDCT was reported by Ohnesorge et al.[27] in 2000. Even with 4-row technology, noninvasive CCTA has shown a good diagnostic accuracy in the detection and quantification of coronary lesions[15,17-23]. The results obtained from different centers are encouraging: CCTA of the coronary arteries is feasible and has a sensitivity of 70-85%, a specificity of 80-95%, a positive predictive value of 0.7-0.9 and a negative predictive value of 0.8-0.9 for the detection of hemodynamically significant stenoses[15,17-23]. The best visualization is achieved in the left main (LM) and in the left anterior descending artery (LAD), while imaging of the circumflex (LCX) and of the right coronary (RCA) arteries is more difficult, especially in their middle-distal tracts. In the analysis of separate segments, as defined by the American Heart Association[28], Nieman et al.[17] found that the LM and the proximal-middle LAD (segments 5-7) were visualized in most cases (90%) and 6/8 stenoses were correctly detected. However, only 51% of the LCX segments were assessable and only 2/4 stenoses were detected. Another study by Nieman et al.[23] confirmed that the sensitivity in detecting stenoses ≥ 50% in the proximal segments (LM 5, LAD 6, RCA 1) is significantly higher than that in distal segments (LAD 8, LCX 13, RCA 3) or side branches. Kopp et al.[19] found, in the assessment of proximal segments, a sensitivity and specificity of 97% for reader 1 and of 99 and 98% respectively for reader 2 (RCA 1-2, LM 5, LAD 6-7, LCX 11); nevertheless, the evaluation of distal tracts provided poor results for both readers (i.e. 1/6 stenosis detected by reader 1 and 3/6 stenoses by reader 2 in the evaluation of segment 12). Hence, 4-slice CT may be considered a valid diagnostic tool in the non-invasive assessment of stenoses of the proximal and middle segments of the coronaries; vessel stenoses cannot be excluded in distal segments with a luminal diameter < 2 mm[6,9].

The advent of 16-slice scanners is providing dramatic effects on cardiac CT. The increased number of simultaneously acquired slices and the faster gantry rotation time allow accurate visualization of the coronary tree with a submillimeter isotropic reconstruction, including distal and side branches < 1.5-2 mm in diameter, without respiratory and motion artifacts[8], even in subjects with an increased heart rate[16].

Ropers et al.[16] have recently demonstrated that 16-slice MDCT depicts coronary artery stenoses with a high accuracy, and a low rate of non-assessable arteries (sensitivity 92%, specificity 93%, positive and negative predictive values 79 and 97%). Nieman et al. have reported a sensitivity of 95% and a specificity of 86% for the detection of stenoses ≥ 50% in 59 patients (Table III)[8,15-23,28].

Furthermore, MDCT is yielding promising results in the assessment of stent and bypass patency[29-31]. Proximal anastomosis of the bypass may be reliably demonstrated in most cases: contrast medium distribution allows one to determine whether the surgically created collateral passage is patent or occluded. Distal anastomosis continues to be a challenge for imaging because of its small diameter, similar to that of distal segments of the coronaries. Ropers et al.[29] found that bypass patency could be demonstrated with a high sensitivity and specificity (98 and 99% respectively) but only 62% of the patent grafts could be evaluated for the presence of severe stenoses.

Imaging of stented segments is more difficult: stent occlusion is usually depicted, but partial restenoses could not be precisely assessed, due to metallic artifacts[30,31].

In conclusion, it is too early to define the precise clinical indications for CCTA. Currently, catheter CA continues to be the method of choice in patients with angina pectoris or myocardial infarctions, both because of its diagnostic accuracy and the possibility of performing direct interventions (Table IV). Nevertheless, as has happened in all other arterial districts, it can easily be foreseen that CCTA will soon have the potential of replacing invasive diagnostic procedures.

Coronary artery calcium

Coronary calcium scoring can only be performed by means of CT. Prior to the introduction of MDCT, coronary calcium screening was exclusively performed in specific centers equipped with EBCT. With the advent of helical CT, calcium scoring is not limited to specialized centers, but has become widely available in clinical practice[26]. The ever more widespread installation of MDCT scanners for general clinical purposes will make coronary calcium scoring a powerful tool in the investigation of coronary artery disease. It has been demonstrated that MDCT can accurately assess coronary calcium and the scores correlate highly with EBCT.

Coronary calcium scoring provides an estimate of the extent of coronary atherosclerotic disease and a measure of the overall plaque burden. Shaw et al.[32] reported a 5-year mortality among 10 300 subjects who had undergone coronary calcium scoring for risk assessment. Patients with scores > 400 and, in particular, > 1000 had a significantly higher mortality compared with subjects with lower calcium scores. The predictive ability of the calcium score was independent of other cardiovascular risk factors. These data reinforce the concept that increasing amounts of coronary calcium indicate an increased coronary risk and contradict suggestions that extensive calcium signifies plaque stabilization. With this rationale, the degree of coronary artery calcifications could be used for screening in asymptomatic patients and may become part of the traditional Framingham risk stratification. In a patient with an intermediate pre-test risk

Table III. Sensitivity and specificity of 4- and 16-slice multidetector-row computed tomography (MDCT) coronary angiography in the detection of hemodynamically relevant stenoses.

Author	MDCT	No. patients	Grade of stenosis (%)	Threshold for vessel diameter (mm)	Analyzed segments*	Sensitivity (%)	Specificity (%)
Knez et al.[15]	4-slice	44	≥ 50	≥ 2	1-3;5-8;11;13	78	98
Nieman et al.[17]	4-slice	31	> 50	≥ 1.5	1-3;5-8;11	81	97
Achenbach et al.[18]	4-slice	64	> 70	≥ 2	–	91	84
Kopp et al.[19]	4-slice	102	≥ 50	–	1-4;5-8;11;12	86	96
Becker et al.[20]	4-slice	28	≥ 50	≥ 1.5	1-3;5-7;11	81	90
Sato et al.[21]	4-slice	54	≥ 50	≥ 2	–	93.5	97.2
Morgan-Hughes et al.[22]	4-slice	30	≥ 70	–	1-2;5-7;11;13	72	86
Nieman et al.[23]	4-slice	53	≥ 50	≥ 2	1-16	82	93
Nieman et al.[8]	16-slice	59	≥ 50	≥ 2	–	95	86
Ropers et al.[16]	16-slice	77	≥ 50	≥ 1.5	–	92	93

* American Heart Association coronary segment classification[28].

Table IV. Comparison between coronary imaging techniques.

Cardiovascular magnetic resonance	Multidetector computed tomography	Selective coronary angiography
	Advantages	
Non-invasive technique Non-ionizing radiation exposure Plaque characterization Functional assessment, myocardial perfusion and kinetics No hospitalization/moderate costs	Minimally invasive technique Assessment of coronary calcium Plaque characterization High-image quality Short acquisition time (20-40 s) No hospitalization/moderate costs	Gold standard diagnostic technique Interventional therapeutic procedures (angioplasty and stent implantation)
	Disadvantages	
Not feasible in patients with pacemakers, other metallic implants or claustrophobia Unable to assess coronary calcium and metallic stent Long examination time (20-30 min)	Not feasible in subjects with high heart rate or arrhythmias Use of potentially nephrotoxic iodinated contrast agents Ionizing radiation exposure	Invasive technique with ionizing radiation exposure and use of iodinated contrast agents Unable to assess plaque composition Hospitalization/high costs

estimate, an increased calcium score would yield a higher post-test risk, mandating intensified preventive treatment[33].

The most valuable use of coronary calcium scoring in symptomatic patients, especially those with atypical chest pain, is to exclude coronary artery disease in subjects with very low scores (sensitivity > 95%)[26,33].

Coronary calcium scanning using MDCT is performed in a few seconds, without contrast media administration and is not impaired by heart rate. By using a 4-row scanner with a slice collimation of 2.5 mm and a recon increment of 1 mm, images of the entire heart for the assessment of coronary calcifications may be acquired in ~18 s[6,7,26,33].

Plaque imaging

The characterization of atherosclerotic plaques is one of the major challenges for non-invasive imaging, since it is well established that sudden rupture of soft plaques can lead to acute vessel occlusion with unstable angina or myocardial infarction. Preliminary data indicate that MDCT may depict small non-calcified plaques and characterize their composition.

Pathophysiologic studies of acute vessel occlusion show that the fibrous cap is the critical portion of atherosclerotic plaques. The thickness of this fibrous layer ranges between 20 μm and 1 mm. Such small structures may be reliably detected and quantified only if the spatial resolution of non-invasive imaging modalities is markedly improved[34].

Schroeder et al.[35] investigated the plaque composition by MDCT in comparison with intracoronary ultrasound as gold standard. MDCT and intracoronary ultrasound yielded identical results in regard of plaque composition and of the quantification of lesions. Becker et al.[36] compared MDCT findings with histopathological aspects in human cadaver heart specimens. On the basis of the mean CT attenuation values, MDCT could reliably differentiate lipid-rich plaques from fibrous-rich plaques and calcified plaques. Recently, Achenbach et al.[37] found that the sensitivity of MDCT in the detection of calcified plaques, with intracoronary ultrasound as reference standard, was 94%. Segments containing non-calcified plaque, alone or in combination with calcified lesions, were depicted with a sensitivity of 78%. However, the presence exclusively of non-calcified plaques was detected only with a 53% sensitivity.

Cardiac function

The visualization of the myocardium and heart cavities at MDCT allows for the calculation of various parameters of cardiac function, such as the end-systolic and end-diastolic volumes and the ejection fraction from the same volume data set acquired for CCTA without additional acquisition or additional radiation exposure[6,38]. With multiplanar reformation, the heart may be displayed in any desired plane, such as the short and long axes. Since cardiac CT data analysis is based on volumetric acquisition, it is not subject to the inaccuracies of two-dimensional procedures; echocardiography and angiographic ventriculography may under- or overestimate stroke volumes[39].

MDCT may be used for the assessment of wall motion: when multiple cardiac phases are extracted, cine display of the beating heart may become available. Mochizuki et al.[39] evaluated the post-processing interactive multiplanar animation of wall motion in 15 patients, and compared it to that of conventional left ventriculography. The left ventricle was divided into 7 segments according to the American Heart Association classification. The wall motion was visually scored into three grades: normal, hypokinesis, and akinesis. The scores of MDCT and biplanar ventriculography agreed in 94% of cases.

MDCT produces high resolution images of the cardiac chambers and mediastinum and therefore allows accurate assessment of cardiac tumors and congenital heart disease[39].

However, the exact role of MDCT compared to echocardiography and magnetic resonance is still to be established.

Myocardial perfusion

An area of acute myocardial infarction is often observed on contrast-enhanced helical CT as a hypodense rim within a thin myocardial wall. The clinical significance of this perfusion defect has not been elucidated. Koyama et al.[40] presented preliminary data on the potential role of CT in 45 patients with acute myocardial infarction, with regard to the clinical outcome after successful reperfusion therapy. When compared with single-photon emission CT data, the zones of low density corresponded to the infarct area. These authors found that in some patients perfusion defects disappeared when the CT scan was repeated several minutes later (late enhancement). They classified patients with acute myocardial infarction into three groups: group 1 showed no perfusion abnormalities, group 2 showed early perfusion defects and late enhancement, and group 3 showed persistent perfusion defects in the early and late phases. They concluded that the myocardial perfusion pattern on contrast-enhanced CT may predict the clinical outcome of acute myocardial infarction after reperfusion therapy.

Another aspect is the analysis of myocardial enhancement patterns with subsequent assessment of perfusion parameters. In regions of impaired blood supply, myocardial enhancement tends to be lower[41]. In conclusion, the assessment of myocardial contrast dynamics is possible using MDCT, but ventricular coverage and injection protocols need to be improved.

Multidetector-row computed tomography as a screening test

Imaging techniques may be used not only for diagnosing and staging already known disease, but also to detect preclinical and clinically silent pathology. Early disease detection in asymptomatic individuals at high risk with a relatively non-invasive, simple, repeatable test is the cornerstone of beneficial and cost-effective screening[42].

The choice of a specific screening strategy should be based on patient preferences, medical contraindications, patient adherence and available resources for testing and follow-up[43]. Besides, the validation of a screening method requires evidence that the test is effective in avoiding more expensive and invasive methods and in reducing morbidity and mortality rates and that the benefits from screening substantially outweigh potential harms.

Since it has been demonstrated that MDCT allows visualization of the coronary arteries, cardiologists have been gaining interest in using this technology for the screening of coronary atherosclerosis[32,44]. The rationale for investigating the presence of preclinical coronary artery disease resides in the fact that more than half of all first coronary events are sudden cardiac death or acute myocardial infarctions in previously asymptomatic individuals[44]. So, the detection of coronary artery stenoses and calcifications by means of MDCT may be included in more sophisticated models for cardiovascular risk assessment[45].

Conclusions

The emergence of MDCT has had a significant impact on cardiac imaging. In the foreseeable future, MDCT may gain an important place in the clinical work-up of coronary artery disease, considering the fact that it reliably allows us to rule out the presence of significant coronary stenoses.

The non-invasive assessment of coronary arteries should therefore be evaluated in the context of trying to avoid "negative" invasive coronary angiograms and to detect preclinical coronary artery disease in asymptomatic patients with important cardiovascular risk factors. This technique would be useful, in the follow-up of patients with stent or bypass, to monitor progression of disease and response to therapy[46].

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