The Diagnostic Value of Computed Tomographic Coronary Angiography in Patients with Acute Myocardial Infarction versus Stable Angina Pectoris: A Preliminary Report

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Background: Computed tomographic coronary angiography (CTA) is a non-invasive alternative to conventional coronary angiography (CCA) in detecting chronic coronary artery disease (CAD). However, the value of CTA in estimating acute myocardial infarction (AMI) has not been evaluated.

Methods: CTA and CCA were performed on 10 patients with non-ST-elevated AMI and 17 patients with stable angina pectoris. The plaque components and stenosis severity were assessed by both modalities to clarify the diagnostic values of CTA in AMI and stable angina pectoris.

Results: A high total coronary artery calcium (CAC) score was significantly correlated with the presence of CAD and the target lesion CAC score ($p < 0.01$). The AMI group tended to have a lower target CAC score ($p = 0.10$) and target plaque burden ($p = 0.27$), compared to the stable angina pectoris group. To estimate the coronary artery stenotic severity, CTA and CCA had concordant correlations in all segments, except in the proximal left anterior descending (LAD) artery. The calcium score and calcification fraction percentage in the proximal LAD artery were significantly higher than those of other segments ($p < 0.01$). Compared to CCA, CTA overestimated the severity of stenosis in the proximal LAD arterial segment in the stable angina pectoris group ($p = 0.028$), but not in the AMI group.

Conclusions: CTA has diagnostic values similar to those of CCA in detecting coronary lesions in patients with AMI or stable angina pectoris. However, a high level of plaque CAC in the stable angina pectoris group may lead to an overestimation of the severity of coronary stenosis, especially in the proximal LAD arterial segment. Although less remarkable, the impact of CAC on the diagnostic value of CTA was still substantial in patients with AMI.

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Key words: computed tomographic coronary angiography, coronary artery calcium score, coronary artery disease, acute myocardial infarction, angina pectoris

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Acute coronary syndrome and stable angina are two major types of coronary artery disease (CAD) presentation. The development of acute coronary syndromes might not originate from a coronary artery with a severe atherosclerotic burden. Actually, the cellular and biochemical composition of an atheromatous plaque is a major risk factor of developing an unstable ischemic event.[1] Vulnerable or high-risk plaque tends to be small in size but has a high lipid content and macrophage activity that cause an evolution of vascular lesions in the direction of rupture and thrombosis. However, the presence of these unstable coronary atheromas cannot be excluded by normal coronary angiography.

Clinically, multislice computed tomographic coronary angiography (CTA) is applied to non-invasively detect CAD with a high negative predictive value.[2] In contrast to conventional coronary angiography (CCA), CTA is also able to characterize the plaque composition and easily detects plaque that is not visible on CCA on account of positive remodeling.[3] Thus, CTA was thought to provide additional information for stratifying the risk of plaque instability (Fig. 1). Acute myocardial infarction (AMI) is a typical type of acute coronary syndrome. However, the value of CTA still needs to be investigated in patients with AMI. Before an invasive procedure is undertaken, it is valuable to know the underlying etiology of the AMI such as chronic totally occluded or thrombus-rich lesions, the status of reperfusion, the lesion component, and the calcification severity.

Previous studies demonstrated that CTA appears reliable for identifying coronary lesions with soft or mixed plaque, however, with an attenuated value in lesions with significant calcification.[4] The "blooming" effect, a physical phenomenon linked to x-rays, tends to exaggerate the size of very dense structures. The border between the lumen and calcification is difficult to determine on account of the small difference in density, leading to an overestimation of stenosis severity.[5] It is well known that the calcification component is more remarkable in stable angina

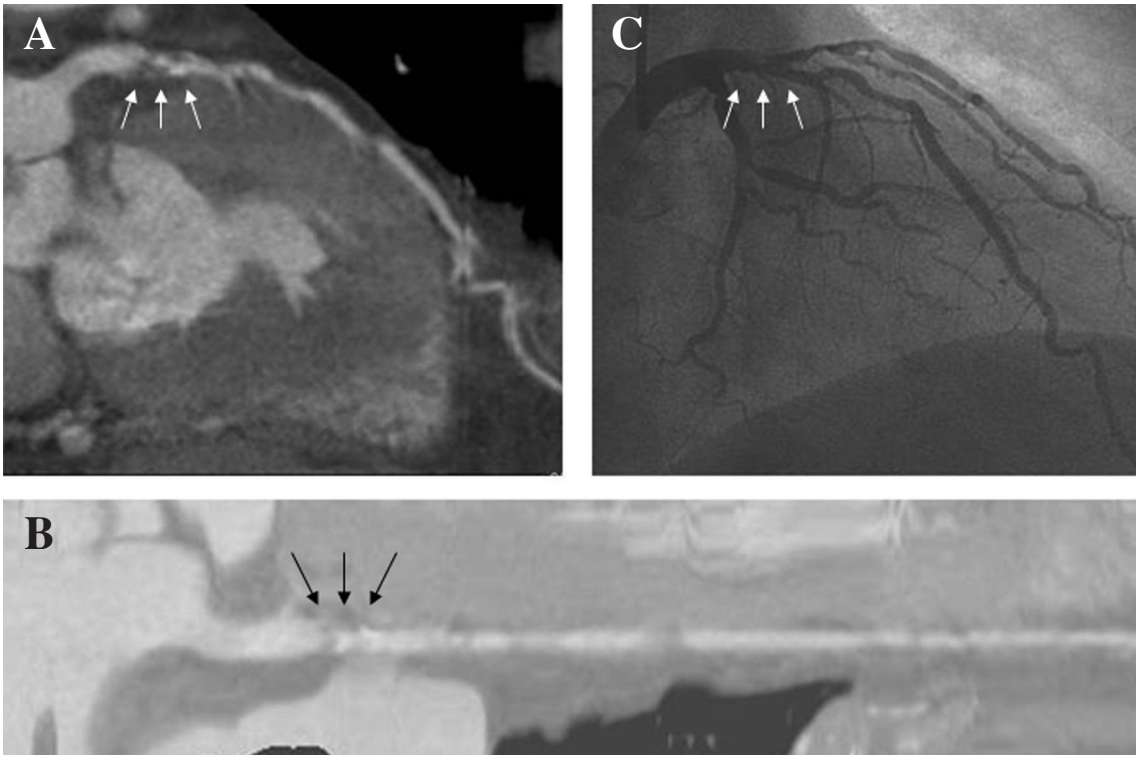

Fig. 1 In a patient with stable angina pectoris, computed tomographic coronary angiograms show significant stenosis at the proximal segment of the left anterior descending coronary artery (A, curved multiplanar reconstruction and B, lumen views). Remarkable calcification can also be noted in this segment. Conventional coronary angiograms demonstrated no significant coronary stenosis in this segment (C), suggesting an overestimation of coronary stenosis.

compared to culprit lesions in unstable angina.[6] Accordingly, CTA may have a better diagnostic value in AMIs. However, such data are still not established in an AMI population.

This study recruited patients with acute non-ST-elevated myocardial infarction and patients suspected of having angina pectoris. The aims were to clarify the values of CTA in AMI and stable angina pectoris.

METHODS

Patients

From November 2007 to June 2008, 27 patients were consecutively enrolled and underwent coronary angiography and CTA, including 10 patients with non-ST-elevated AMI (the AMI group) and 17 patients with ischemic chest pain suspected of having CAD (the stable angina pectoris group). AMI was defined as patients with non-ST-elevated AMI with elevated cardiac troponin I levels and typical chest pain. Subjects were excluded from further analysis if it was not possible to obtain adequate 2-dimensional (2D) datasets, or if they could not undergo complete cardiac catheterization. Additional exclusion criteria were atrial fibrillation, impaired renal function (serum creatinine of > 2.0 mg/dL), pacemaker implantation, or dyspnea that precluded holding the breath for 10 s. Baseline characteristics, including age, gender, biochemistry, hemogram, and risk factors, were recorded. A resting electrocardiogram (ECG), chest x-ray, cardiac isoenzyme data, and drug history were collected as well. This study was approved by the Institutional Review Board of Chang Gung Memorial Hospital, and all patients provided informed written consent before participation.

CTA

All patients enrolled in this study underwent 64-slice CT before the invasive coronary angiography. Patients were in a fasting state, with oxygen therapy to facilitate breath-holding and a venous catheter (18-gauge) in the antecubital fossa of the right arm. Electrodes were positioned on the thorax. To reach the ideal heart rate of 60 beats per minute, appropriate doses of β-blockers were administered to slow the heart rate in the absence of usual contraindications. A nitroglycerine sublingual prescription was routinely used. Holding the breath for approximately 10 s was necessary for the 64 multi-detection CT. Other parameters were the volume to be explored of 12~15 cm, the optimum spatial resolution of submillimetric slices at a density of 120 kV, a current of 440 mA, a temporal resolution of < 250 ms to avoid kinetic artifacts, and a gantry speed of 350 m/s per rotation with ECG gating. A non-enhanced scan to calculate the total calcium score (Agatston score) was performed before the CTA. One hundred milliliters of Iodixanol (Visipaque®) was injected intravenously with an automatic syringe at a rate of 5 mL/s, followed by a 50-mL saline flush. A second acquisition was carried out during the parenchymatous stage with thicker slices (1.25 mm) and a lower voltage (90~100 kV) to improve the resolution in density. This was performed 3~10 min after the start of the injection. The best phase to investigate each coronary artery was in diastole, at 70%~80% of the R-R cycle. 2D sections are essential for the study of stenosis and atheromatous plaque. At different moments of the cardiac cycle, 10 such phases were reconstructed during the ECG-gated acquisition of the R-R cycle for every 10%. The image obtained was the sum of the data acquired during the arterial phase (coronary arteries) and parenchymatous phase (myocardiography).

Coronary arteries were assessed according to the 15-segment model proposed by the American Heart Association (1, proximal, 2, mid, 3, distal, 4a, posterior descending, 4b, posterolateral of the right coronary artery, and 5, left main coronary artery; 6, proximal, 7, mid, 8, distal, 9, first diagonal, and 10, second diagonal of the left anterior descending (LAD) artery; and 11, proximal, 12, first marginal, 13, mid, 14, second marginal, and 15, distal branch of the left circumflex artery).[7] In the 15 segments, only the proximal, middle, and distal parts of coronary segments (segments 1, 2, 3, 5, 6, 7, 8, 11, and 13) were used for comparisons between CTA and CCA.

According to the density, centricity, and surrounding structures, plaques were divided in 2 types: fibrosis and calcified plaque. The coronary plaque burden, plaque volume, fraction of soft plaque (soft plaque volume/total plaque volume), and calcium score (Agatston score) were also calculated. The mean CT density of the plaque was obtained by calculating the mean CT density from 3 sequential cross-sectional images of the lesion. The plaque composition was classified into 1 of 3 categories by the CT density: soft plaque (CT density < 70 Hu),

fibrous plaque (70 Hu < CT density < 128 Hu), and calcified plaque. Intra-plaque enhancement was defined as partial enhancement but not by dense calcification in lower-CT-density plaques. The plaque composition and frequency of intra-plaque enhancement were compared between the different groups. The volume of each plaque component in the target lesion was calculated. The most severe stenosis site in the stable angina pectoris group and the culprit lesion in the AMI group were defined as the target lesions. The vessel area was measured in both the lesion and reference segments.

Two experienced observers manually performed the quantification. After positioning the plane orthogonally to the course of the coronary arteries, cross-sectional images were obtained of the most severe narrowing and of the proximal and distal reference sites. Minimal lumen diameters were measured in these 3 images. The reference diameter was calculated by averaging the proximal and distal minimal lumen diameters. The percent diameter stenosis was calculated by subtracting the reference diameter from the minimal lumen diameter, and dividing this by the reference diameter. Stenosis of 50% of the diameter measured with quantitative CTA was described as significant stenosis.

CCA

Quantitative coronary angiography was performed on the same or second day after CTA with a Philips digital angiography system (Philips Integris BH 3000, Philips, Bast, The Netherlands). Hemodynamic data were recorded during the procedures. The left ventricular ejection fraction was calculated using the right anterior oblique view of the left ventriculogram. Coronary angiograms were taken in multiple projections, and were independently assessed by 2 experienced cardiologists. Segmental coronary artery stenosis was analyzed using the same 15-segment model employed for the CTA analysis. CAD was diagnosed if there was a lesion with > 50% luminal stenosis in any major coronary artery. The most severely stenotic site in the stable angina pectoris group and the culprit lesion in the AMI group were analyzed as target lesions. A complex lesion was defined as a type B or C lesion according to the American College of Cardiology/American Heart Association (ACC/AHA) classification system.[8]

Statistical analysis

Differences in the baseline characteristics and coronary artery parameters between the 2 groups (AMI group and stable angina pectoris group) were evaluated using Chi-squared and unpaired *t*-tests. Correlations among all of the parameters of coronary artery stenosis estimated by CCA and CTA were assessed by paired *t*-test for all 9 segments examined. For continuous variables, results are presented as the mean ± standard deviation (SD). Categorical variables are presented as the number (%), and comparisons between groups were analyzed by a Chi-squared test with contingency tables. Variables included in the analysis were age, gender, hypertension, diabetes mellitus, having ever smoked, and the body mass index. A two-tailed probability value of < 0.05 was considered to indicate statistical significance. All statistical analyses were performed using SPSS 15.0 for Windows (SPSS, Chicago, IL, U.S.A.).

RESULTS

Patients

In patients with AMI, CTA was performed 16.5 ± 12.1 h after the time point of chest pain. The numbers of diseased vessels were similar between the AMI and stable angina pectoris groups ($p = 0.09$, Table 1). Of the 10 AMI patients, culprit lesions were noted in the LAD artery in 4 (40%), in the left circumflex artery in 3 (30%), and in the right coronary artery in 3 (30%). There were no significant differences in any demographic variable between these 2 groups, although there were trends for the incidences of male gender and current smoking to be slightly higher in patients with AMI (Table 1). Although exhibiting typical symptoms of angina pectoris, coronary angiograms were normal in the 6 stable angina pectoris patients. In these 6 patients, coronary vasospasms were demonstrated in 4 patients by an ergonovine provocation test.

Components of coronary plaque determined by CTA

The calcium score, plaque volume, and fat and calcification fractions were estimated by CTA (Table 2). Further analysis was performed which focused on differences between the groups. There was a 2.4-fold insignificant increase in the target plaque calcium

Table 1. Demographic Characteristics

Characteristic	All N = 27	AMI N = 10	Stable angina pectoris N = 17	*p* value
Age (years)	60.1 ± 12.3	59.7 ± 14.6	60.4 ± 11.2	0.90
Male gender, no. (%)	22 (81.5)	10 (100.0)	12 (70.6)	0.12
Body mass index (kg/m^2)	26.6 ± 4.1	26.4 ± 5.7	26.7 ± 3.1	0.82
No. of diseased coronary arteries (%)				
0	6 (22.2)	0 (0)	6 (35.3)	0.06
1	8 (29.6)	3 (30.0)	5 (29.4)	1.0
2	8 (29.6)	4 (40.0)	4 (23.5)	0.42
3	5 (18.5)	3 (30.0)	2 (11.8)	0.33
Medical history, no. (%)				
Hypertension	16 (59.3)	6 (60.0)	10 (58.8)	1.0
Diabetes mellitus	10 (37.0)	5 (50.0)	5 (29.4)	0.42
Current smoking	15 (55.6)	8 (80.0)	7 (41.2)	0.11
Family history of CAD	7 (25.9)	1 (10.0)	6 (35.3)	0.20
Lipid profile (mg/dL)				
Total cholesterol	196.7 ± 58.7	200.1 ± 67.7	194.7 ± 54.9	0.82
LDL cholesterol	130.6 ± 50.1	133.9 ± 57.4	128.7 ± 47.1	0.80
HDL cholesterol	33.2 ± 10.0	31.4 ± 9.3	34.3 ± 10.4	0.47
Triglycerides	185.3 ± 172.4	230.4 ± 259.0	158.8 ± 92.6	0.31
Current medication, no. (%)				
Aspirin	25 (92.6)	10 (100.0)	18 (88.2)	0.52
β-blockers	12 (44.4)	6 (60.0)	6 (35.3)	0.26
ACE inhibitors/ARB	16 (59.3)	7 (70.0)	9 (52.9)	0.45
Insulin	3 (11.1)	1 (10.0)	2 (11.8)	1.0
Statins	18 (66.7)	6 (60.0)	12 (70.6)	0.68

Continuous data are presented as the mean ± standard deviation.

Abbreviations: ACE: angiotensin-converting enzyme; ARB: angiotensin II receptor blocker; CAD: coronary artery disease; HDL: high-density lipoprotein; LDL: low-density lipoprotein.

score in the stable angina pectoris group compared to the AMI group ($p = 0.10$). The AMI group also tended to have a lower target plaque burden ($p = 0.27$) compared to the stable angina pectoris group. When the analyses were performed for each segment, the calcium score and calcification fraction percentage were significantly higher in the proximal LAD arterial segment ($p < 0.005$ and 0.01, respectively), compared to the other segments (Table 3).

Diagnostic values

Of the 27 patients enrolled, left main artery stenosis was noted in 1 (3.7%), LAD artery stenosis in 15 (55.6%), left circumflex stenosis in 11 (40.7%), and right coronary artery stenosis in 13 (48.1%). No significant coronary stenosis was noted in 6 (22.2%) patients. Compared to CCA, CTA had a similar ability to enumerate the number of diseased vessels (Table 2). The diagnostic values of determining the presence of CAD are shown in Table 4. However, CTA tended to have a higher specificity in the AMI group compared to the stable angina pectoris group (Table 4).

To estimate the coronary artery stenosis severity

Table 2. Component of Coronary Artery Plaque Estimated by Computed Tomographic Coronary Angiography

Variable	AMI N = 10	Stable angina pectoris N = 17	*p* value
CAD disease number	1.8 ± 1.0	1.7 ± 1.1	0.09
Total calcium score	478.5 ± 775.2	494.6 ± 571.8	0.38
Target plaque calcium score	39.9 ± 71.2	96.6 ± 76.5	0.10
Target fat plaque fraction	9.4 ± 7.9	11.0 ± 7.9	0.31
Target plaque volume (%)	32.4 ± 13.3	38.6 ± 18.6	0.27
Target plaque calcification fraction	1.6 ± 2.5	2.0 ± 5.9	0.61

Values are presented as the mean ± standard deviation.
Abbreviations: AMI: acute myocardial infarction; CAD: coronary artery disease.

Table 3. Global Calcium Score and Calcification Fraction Percentage and Those for Each Segment in All Patients (*N* = 27)
Position

	Calcium score percentage	Calcification fraction
Global	484.5 ± 695.0	2.7 ± 6.8
Left main	48.2 ± 124.0	3.2 ± 8.4
Proximal LAD artery	261.5 ± 290.0*	9.5 ± 11.6†
Middle LAD artery	19.8 ± 68.5	2.5 ± 6.2
Distal LAD artery	0.5 ± 1.7	0.4 ± 1.7
Proximal LCX artery	57.3 ± 93.3	1.0 ± 2.7
Middle LCX artery	19.2 ± 77.0	0.6 ± 1.1
Proximal RCA	85.3 ± 144.1	3.1 ± 6.8
Middle RCA	58.4 ± 137.6	1.2 ± 3.5
Distal RCA	33.6 ± 57.7	1.4 ± 4.9

Abbreviations: LAD: left anterior descending; LCX: left circumflex; RCA: right coronary artery; *: $p < 0.005$; †: $p < 0.01$, compared to non-proximal LAD segments.

using the 15-segment model, CTA and CCA had concordant correlations in all segments, except in the proximal LAD arterial segment (Table 5). Further analysis showed that proximal LAD arterial plaque had a higher calcification fraction (9.5% ± 11.6%) compared to the other segments (1.8% ± 5.3%, p = 0.008).

Of the 10 patients with AMI, total occlusion of the culprit lesion was noted in 3 (30%), significant thrombus content in 1 (10%), chronic totally occluded lesions in 2 (20%), severe calcification in 2 (20%), and complex lesions (type B or C lesions according to the ACC/AHA classification system) in 3 (30%) by CCA. CTA correctly identified these lesions in 3 (100%), 1 (100%), 1 (50%), 2 (100%), and 3 patients (100%), respectively.

Differences between the AMI and stable angina pectoris groups

CTA and CCA showed concordant correlations in estimating segmental coronary artery stenosis, except in the proximal LAD arterial segment. Further analysis was performed to explore which group had a significantly associated diagnostic value in the proximal LAD arterial segment. Table 5 shows that the associated was only significant in the stable angina pectoris group (p = 0.028). Then, values of all 9 segments were averaged to depict the global abilities of CTA and CCA to estimate coronary stenosis. The associated was still present only in the stable angina pectoris group (34.9% ± 113.3% vs. 10.7% ± 25.4%, p = 0.001), and not in the AMI group (37.9% ± 114.4% vs. 19.1% ± 33.5%, p = 0.081).

DISCUSSION

This study demonstrates that CTA is a promising modality with diagnostic values similar to those of standard CCA in both AMI and stable pectoris angina patients. A previous reports showed that CTA has an excellent ability to rule out coronary artery stenosis in low-risk patients.[9] However, in patients with AMI, the diagnostic value of CTA still needed to be elucidated. In the clinical setting of acute chest pain, although CTA is valuable for the "triple rule out", including coronary artery stenosis, pulmonary embolism, and aortic dissection,[10] many difficulties are still encountered such as interference with the CTA interpretation due to dyspnea, an inability to hold the breath, arrhythmias, and a long period of time required for image reconstruction. Moreover, high-risk patients often have severe coronary calcification, multiple stenting, or bypass vessels, all of which significantly influence the quality and accuracy of CTA images. This preliminary study was conducted to explore the different diagnostic values of

Table 4. Diagnostic Values of Computed Tomographic Coronary Angiography (CTA) in Estimating Coronary Artery Stenosis in Patients with Acute Myocardial Infarction (AMI) and Stable Angina Pectoris

	AMI		Stable angina pectoris	
	Sensitivity [95% CI]	Specificity [95% CI]	Sensitivity [95% CI]	Specificity [95% CI]
Global	52.0% (13/25) [0.32-0.72]	84.6% (55/65) [0.73-0.92]	50.0% (10/20) [0.28-0.72]	80.9% (106/131) [0.73-0.87]
Left main	(0/0)	100% (10/10) [0.66-1.00]	0% (0/1) [0.00-0.95]	93.7% (15/16) [0.68-0.99]
Proximal LAD artery	50.0% (1/2) [0.03-0.97]	75.0% (6/8) [0.36-0.96]	50.0% (1/2) [0.03-0.97]	73.3% (11/15) [0.45-0.91]
Middle LAD artery	75.0% (3/4) [0.22-0.99]	100% (6/6) [0.52-1.00]	33.3% (1/3) [0.02-0.87]	71.4% (10/14) [0.42-0.90]
Distal LAD artery	0% (0/3) [0.00-0.69]	71.4% (5/7) [0.30-0.95]	50.0% (1/2) [0.03-0.97]	86.6% (13/15) [0.58-0.98]
Proximal LCX artery	50.0% (1/2) [0.03-0.97]	75.0% (6/8) [0.36-0.96]	0% (0/2) [0.00-0.80]	80.0% (12/15) [0.51-0.95]
Distal LCX artery	50.0% (1/2) [0.03-0.97]	83.3% (5/6) [0.36-0.99]	50.0% (2/4) [0.09-0.91]	84.6% (11/13) [0.54-0.97]
Proximal RCA	50.0% (1/2) [0.03-0.97]	87.5% (7/8) [0.47-0.99]	100% (1/1) [0.05-1.00]	75% (12/16) [0.47-0.92]
Middle RCA	60.0% (3/5) [0.17-0.93]	100% (5/5) [0.46-1.00]	75.0% (3/4) [0.22-0.99]	84.6% (11/13) [0.54-0.97]
Distal RCA	66.7% (2/3) [0.13-0.98]	71.4% (5/7) [0.30-0.95]	66.7% (2/3) [0.13-0.98]	78.5% (11/14) [0.49-0.94]

Abbreviations: LAD: left anterior descending; LCX: left circumflex; RCA: right coronary artery.

Table 5. Coronary Artery Stenosis Severity Estimated by Computed Tomographic Coronary Angiography (CTA) and Conventional Coronary Angiography (CCA) in Patients with Acute Myocardial Infarction (N = 10) and Stable Angina Pectoris (N = 17), and in All Patients (N = 27)

	All patients			Acute myocardial infarction			Stable angina pectoris		
	CCA	CTA	*p* value	CCA	CTA	*p* value	CCA	CTA	*p* value
Left main (%)	4.8 ± 15.3	5.4 ± 13.2	0.89	0 ± 0	2.5 ± 5.4	0.17	7.7 ± 18.9	7.1 ± 16.1	0.92
Proximal LAD artery (%)	12.2 ± 29.5	34.4 ± 35.2	0.007	12.5 ± 27.0	29.0 ± 29.6	0.13	12.1 ± 26.6	37.5 ± 38.6	0.028
Middle LAD artery (%)	22.8 ± 36.9	29.4 ± 32.9	0.42	35.5 ± 41.5	25.5 ± 36.7	0.25	15.3 ± 32.8	31.8 ± 31.4	0.17
Distal LAD artery (%)	15.6 ± 28.6	17.9 ± 28.0	0.78	29.4 ± 38.6	21.7 ± 33.2	0.72	8.2 ± 19.1	15.9 ± 25.8	0.28
Proximal LCX artery (%)	14.8 ± 32.7	27.6 ± 36.1	0.19	22.0 ± 41.6	34.5 ± 35.9	0.5	10.6 ± 26.8	23.5 ± 36.6	0.28
Distal LCX artery (%)	7.6 ± 22.0	12.0 ± 31.9	0.47	6.3 ± 17.7	13.1 ± 33.3	0.26	8.2 ± 24.3	11.4 ± 32.2	0.71
Proximal RCA (%)	15.2 ± 23.3	21.9 ± 29.5	0.23	24.0 ± 27.6	22.5 ± 26.0	0.87	10.0 ± 19.4	21.5 ± 32.2	0.08
Middle RCA (%)	30.9 ± 38.0	33.5 ± 41.5	0.76	41.5 ± 41.9	23.5 ± 35.1	0.11	24.7 ± 35.2	39.4 ± 44.8	0.22
Distal RCA (%)	22.0 ± 40.3	28.6 ± 40.6	0.46	32.5 ± 45.6	28.8 ± 41.6	0.81	17.1 ± 38.0	28.5 ± 41.5	0.31

Abbreviations: LAD: left anterior descending; LCX: left circumflex; RCA: right coronary artery.

CTA between AMI and stable angina pectoris patients.

The ability of CTA to detect the number of diseased coronary arteries and estimate the diameter stenotic percentage was highly compatible with the ability of CCA. Interestingly, our data revealed that the diagnostic value of CTA in the proximal LAD artery was limited compared to the other coronary segments. Further analysis showed that CTA overestimated the severity of coronary stenosis in the proximal LAD arterial segment only in the stable angina pectoris group. This limitation was not demonstrated in the AMI group. As suggested by the findings in our study, the discordance may have involved the higher calcification component in the proximal LAD arterial segment in the stable angina pectoris group compared to the AMI group. Different severities of calcification components remarkably influenced the correct interpretation of coronary lesions by CTA.

Coronary calcification represents the severity of atherosclerosis and also has prognostic value. Previous reports showed that a high CAC score potentially predicts the presence of significant CAD.[11] On the other hand, a higher total CAC score also predicts a higher risk of future cardiac events.[12] Our data showed a higher CAC score in patients with CAD compared to those without significant coronary stenosis. In addition, our findings revealed that the total CAC score was closely correlated with the plaque CAC score, suggesting that significant target lesion calcification can simply be predicted by a high total CAC score. From the point of view of interventional cardiologists, the use of a variety of coronary modification devices, such as a rotablator or cutting balloon, depends on whether or not severe superficial calcification exists. By estimating the total and plaque CAC scores, CTA can provide meaningful information before a coronary intervention.

The component of target lesions, especially the amount of calcification, is potentially associated with the value of CTA to correctly estimate a coronary lesion. Previous studies reported that the calcification component is rich in chronic angina pectoris, compared to unstable angina.[6] In line with this notion, the stable angina pectoris group in our study tended to have a higher plaque calcification fraction than did the AMI group, although the statistical power was not optimal due to the small number of study patients. When estimating coronary lesions in a subject with stable or chronic CAD, experienced interpreters should take the CAC score into account to avoid overestimating the stenosis severity, especially in the proximal LAD arterial segment.

Our study had a few limitations. The sample size was too small to reach definitive conclusions. The number of patients should be increased in future studies. Moreover, we did not use intravascular ultrasound to evaluate the precise severity of CAD, which is a well-accepted technique.[13] This may have led to an underestimation of the severity of calcification by coronary angiography only.

Conclusions

This study shows that CTA has diagnostic value similar to CCA in detecting coronary lesions in patients with AMI or stable angina pectoris. However, the high plaque calcification component in the stable angina pectoris group may have led to an overestimation of the severity of coronary stenosis. Although less remarkable, the impact of CAC on the diagnostic value of CTA was still substantial in patients with AMI.

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電腦斷層冠狀動脈攝影在急性心肌梗塞病患及穩定型冠狀動脈疾病病患的診斷價值：初步報告

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背 景： 對於穩定型冠狀動脈疾病，電腦斷層冠狀動脈血管攝影是一種傳統心導管冠狀動脈攝影的非侵入性檢查替代方案。電腦斷層冠狀動脈血管攝影可以檢查出傳統心導管冠狀動脈攝影所檢查不到的脆弱血管硬化斑塊。但電腦斷層冠狀動脈血管攝影評估急性心肌梗塞時冠狀動脈血管狹窄情形還未曾被評估。

方 法： 10 位非 ST 段上升型心肌梗塞病患及 17 位穩定型冠狀動脈疾病病患接受電腦斷層冠狀動脈血管攝影及傳統心導管冠狀動脈攝影，同時用兩種不同的檢查來評估動脈硬化斑塊的組成及血管狹窄程度以釐清電腦斷層冠狀動脈攝影在急性心肌梗塞及穩定型冠狀動脈疾病的診斷價值。

結 果： 高的總和冠狀動脈鈣化指數 (CAC score) 和冠狀動脈疾病的存在 (冠狀動脈無狹窄病患 66.5 ± 12.5 比上冠狀動脈有狹窄病患 645.5 ± 177.1, $p = 0.004$) 及標的病灶冠狀動脈鈣化指數 ($r = 0.51$, $p = 0.007$) 有顯著相關。心肌梗塞的病患相較於穩定型冠狀動脈疾病的病患有較低的標的病灶冠狀動脈鈣化指數 (39.9 ± 71.2 vs. 96.6 ± 256.5, $p = 0.50$)，標的動脈硬化斑塊負擔 (32.4% ± 13.3% vs. 38.6% ± 18.6%, $p = 0.38$)，及軟斑塊比例 (9.4% ± 7.9% vs. 11.0% ± 7.9%, $p = 0.61$) 的趨勢。用 15 個區段模組評估冠狀動脈血管狹窄嚴重程度，電腦斷層冠狀動脈攝影除了在左前降枝近端外與傳統心導管冠狀動脈攝影有一致的表現。與傳統心導管冠狀動脈攝影比，電腦斷層冠狀動脈攝影在穩定型冠狀動脈疾病病患的左前降枝近端會高估狹窄嚴重程度 ($p = 0.028$)，但在急性心肌梗塞的病人則不會。進一步分析顯示左前降枝近端的斑塊相對其他區段有較高的鈣化組成比例 (9.5% ± 11.6% vs. 1.8% ± 5.3%, $p = 0.008$)。

結 論： 此研究顯示在急性心肌梗塞病患及穩定型冠狀動脈疾病病患，用電腦斷層冠狀動脈攝影來檢測冠狀動脈病灶有相似於傳統心導管冠狀動脈攝影的診斷價值。然而，高斑塊冠狀動脈鈣化指數在穩定型冠狀動脈疾病的病患會高估血管狹窄的嚴重程度。電腦斷層冠狀動脈攝影的冠狀動脈鈣化指數在心肌梗塞病患無顯著診斷價值。
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關鍵詞： 電腦斷層冠狀動脈攝影，冠狀動脈鈣化指數，冠狀動脈疾病，急性心肌梗塞，心絞痛

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