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Quantification of myocardial perfusion SPECT studies in Chinese population with Western normal databases

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Abstract

Background—The purpose of this study is to assess diagnostic performance of the current quantification packages using Western normal databases in detecting coronary artery disease in Chinese population.

Methods—Seventy-five patients who underwent rest/stress myocardial perfusion SPECT and coronary angiography (CAG) were enrolled. Emory Cardiac Toolbox (ECTb) and Quantitative Perfusion SPECT (QPS) with its standard (QPS-standard) and simplified (QPS-simplified) methods were used to quantify these studies. A preliminary Chinese normal database was created from 80 normal subjects (QPS-simplified-Chinese). Receiver operator characteristic (ROC) was used to assess the accuracy of the four normal databases in detecting $\geq 50\%$ or $\geq 70\%$ stenosis given by CAG.

Results—The enrolled cohorts had lower body mass index (BMI) and smaller heart size than Western population. The areas under ROC curve of ECTb, QPS-standard, and QPS-simplified were significantly lower than QPS-simplified-Chinese in detecting $\geq 50\%$ stenosis, but not in detecting $\geq 70\%$ stenosis. Diagnostic accuracy was much lower in the RCA and LCX territory.

Conclusion—Chinese normal database is needed for accurately applying these quantification methods to Chinese population, especially for detecting moderate defects in regions with relatively greater attenuation impact. An alternative approach could be modification of the existing Western normal databases for low-BMI and/or small-heart subjects.

Keywords

Myocardial perfusion SPECT; quantification; normal database

INTRODUCTION

Single photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI) is a widely accepted test for diagnosis and prognosis of coronary artery disease (CAD).^{1–4} The success of SPECT MPI is, in part, thanks to the quantification techniques as

an aid to visual image interpretation. Quantification of the extent and severity of myocardial defects increases the objectivity and reproducibility of SPECT MPI. Currently, validated computer software packages are available on almost all SPECT system. All of the software packages carry their specific normal databases, which are required for accurate quantification and mainly based on Western population. The accuracy of the Western normal databases has not been determined when applied to Chinese population.

Localized soft tissue attenuation by the breasts, lateral chest wall, abdomen, and left hemidiaphragm may create artifacts that mimic true perfusion abnormalities and decrease test specificity.^{5,6} As the current SPECT MPI quantification approach is based on the comparison of a patient's perfusion distribution against a normal distribution pattern as represented by a normal gender-matched database, it partially compensates for differences in attenuation between average male and average female patients.^{7,8} The Western people with high risks of CAD usually have higher body mass index (BMI), which could result in more attenuation compared to their Chinese counterparts. Therefore, using Western normal databases for quantitative assessment of Chinese patients can result in overestimation of the degree of attenuation artifacts in the images, so that the quantification software may fail to detect small and/or mild-to-moderate defects. In addition, Chinese patients usually have smaller left-ventricular (LV) chamber size than Western patients. It has been shown that the current quantification packages were less accurate for patients with small LV chamber size due to the limited resolution of SPECT MPI.⁹ These concerns lead to a question that whether a Chinese normal database is needed in order to use the current quantification software packages to diagnose Chinese patients as accurate as reported by their validations in Western population.

This study is aimed to compare the accuracy of the two state-of-art quantification software packages, Emory Cardiac Toolbox (ECTb) (Emory University, Atlanta, GA, USA)¹⁰ and Cedars Quantitative Perfusion SPECT (QPS) (Cedars Sinai Medical Center, Los Angeles, CA, USA),¹¹ in a Chinese population to their published accuracy in detecting CAD in Western population, respectively. We also generated a preliminary Chinese normal database using a vendor-provided tool in QPS and evaluated its accuracy in detecting CAD in the Chinese population.

MATERIALS AND METHODS

Patients

The test cohort—Seventy-five subjects (59 men and 16 women), who met the enrollment criterion below, were retrospectively selected from 1200 consecutive patients referred for rest/stress gated SPECT MPI to the Department of Nuclear Medicine, the First Affiliated Hospital of Nanjing Medical University, Nanjing, China, from January 1st, 2008, to July 1st, 2009. These patients underwent rest/stress gated SPECT MPI and coronary angiography (CAG) within 3 months. Patients with a history of myocardial infarction and cardiomyopathy were excluded. Patients whose SPECT MPI images had significant extra-cardiac uptake adjacent to the myocardium were also excluded.

Low-likelihood cohorts—A low likelihood of CAD was defined based on age, sex, pretest symptom, and electrocardiogram response to treadmill stress test.¹² 165 low-likelihood subjects were selected from those referred for Tc-99m sestamibi SPECT MPI with adequate level of treadmill stress (reached $\geq 85\%$ heart rate). We excluded those who had a history of CAD or other confounding cardiac conditions, including congestive heart failure, cardiomyopathy, left-bundle branch block, or paced rhythm. In addition, these subjects had SPECT MPI studies of good to excellent quality, normal ventricular volumes, wall motion, and global systolic function, and no evidence of transient ischemic dilatation,

as determined by at least two experienced nuclear cardiologists. From the 165 subjects, 80 subjects were randomly selected for the generation of the Chinese normal database and the other 85 subjects were used to evaluate normalcy rates.

MPI Data Acquisition

A 2-day Tc-99m sestamibi protocol was used. Patient avoided intake of caffeine-containing drinks or food. Patient preparation included abstinence from short-acting nitrates, long-acting nitrates, calcium blocker, and beta-blocker for at least 2, 6, 24, and 48 h, respectively. The Tc-99m sestamibi dose range was 25–30 mCi for both rest and stress studies based on patient's weight or BMI.

Patients underwent a symptom-limited treadmill test using standard Bruce protocol. Tc-99m sestamibi was intravenous injected when a $\geq 85\%$ heart rate is achieved. Exercise was continued at the workload for 1.5 to 2.0 minutes when possible. When exercise testing was contraindicated or unsuitable, an adenosine stress test was performed via infusion at $140 \mu\text{g/kg/minute}$ for 5 minutes and Tc-99m sestamibi was injected at the end of the second minute.

Both rest and stress image acquisitions were started at 60 minutes after the administration of Tc-99m sestamibi. The patients were requested to ingest 200 mL pure milk or moderate fat-enriched food at 20 minutes after radiopharmaceutical injection on the purpose of promoting tracer clearance from gallbladder. Gated SPECT MPI was acquired using the Philips CardioMD dual-head cameras with low-energy high-resolution collimators. Images were acquired over a 180° noncircular orbit from 45° right anterior oblique to 45° left posterior oblique, with 32 seconds per projection, 64×64 matrix and $140 \text{ keV} \pm 20\%$ energy window for emission images. No attenuation correction was performed for these images.

MPI Data Processing

Tomographic reconstruction and oblique reorientation were done using the vendor-provided software, Auto-SPECT-Plus on JetStream (Philips Medical Systems, Milpitas, CA). Data were reconstructed by filter back-projection (FBP) with a Butterworth filter (order = 5 and cutoff frequency = 0.66 Nyquist for both rest and stress data). The reconstructed and reoriented short-axis images were then submitted to QPS and ECTb, respectively.

The same processing steps were applied to the 80 subjects selected for generation of a preliminary Chinese normal database. The short-axis images were submitted to QPS simplified normal database generator to generate the preliminary Chinese normal database. The process of database generation was totally automated, and no other manual intervention was needed.

Quantitative Analysis

For ECTb, we selected the sestamibi gender-specific normal database. For QPS, the standard sestamibi gender-specific database (QPS-standard) and simplified sestamibi gender-specific database (QPS-simplified) were used. In addition to the above vendor-provided databases, we also chose the preliminary Chinese normal database created by the QPS simplified method (QPS-simplified-Chinese) for quantitative analysis. The following quantitative results were obtained: total defect extent and defect extent for each coronary territory (LAD, RCA, and LCX). In addition, total perfusion defect (TPD) was obtained for QPS-simplified and QPS-simplified-Chinese. TPD was defined as the percentage of the left ventricle hypoperfused and described in QPS simplified method that combined perfusion extent and severity.¹³

Coronary Angiography

CAG was performed with the standard Judkins approach. All angiograms were interpreted visually by at least two experienced cardiologists, who were unaware of MPI results. The interval between CAG and MPI was not more than 3 months and patients who had a revascularization as well as symptoms changed in the interval were not enrolled. In this study we used stenosis with 50% or greater narrowing and 70% or greater narrowing of the luminal diameter respectively as the cutoff of significant CAD.

Statistical Analysis

Receiver operator characteristics (ROC) curves were generated to evaluate the accuracy of the four normal databases in detecting $\geq 50\%$ and $\geq 70\%$ stenosis, respectively. The ROC curves were created using all possible integer score values and a step of 0.1% for the defect extent values. The areas under ROC curves (AUC) were calculated and compared using the Analyze-It statistic package (version 2.0). Paired comparison of the ROC curves was done between the Western normal databases and the Chinese normal database using the Hanley and McNeil method.

The sensitivity, specificity, and normalcy rate of the four normal databases in detecting $\geq 50\%$ and $\geq 70\%$ stenosis were computed using the vendor-suggested abnormal criteria. For both ECTb and QPS, we used 3% as the abnormal criteria for total defect extent.^{10,11} We used 6% as the abnormal criteria for TPD in the QPS-simplified and QPS-simplified-Chinese methods.^{11,13}

The sensitivity and specificity of the four normal databases in detecting $\geq 50\%$ and $\geq 70\%$ stenosis in coronary territories (LAD, LCX, and RCA) were also computed using the vendor-suggested abnormal criteria. For ECTb, we used 10%, 10%, and 12% defect extent for LAD, LCX, and RCA, respectively, as the abnormal criteria.¹⁰ For QPS, we used 3%, 4%, and 2% defect extent for LAD, LCX, and RCA, respectively, as the abnormal criteria.¹⁴

RESULTS

The BMI of the test cohort, low-likelihood cohort used to generate the Chinese normal database, and low-likelihood cohort used to evaluate normalcy rates were 25.3 ± 2.8 , 24.1 ± 3.0 , 23.7 ± 2.2 , respectively, which were significantly lower than those in the two published studies of validating the Western normal databases.^{15,16} The respective BMI were 30.2 ± 6.0 , 30.9 ± 6.3 , and 28.3 ± 6.2 in Wolak et al.¹⁵ and 30.3 ± 5.9 , 30.9 ± 6.3 , and 28.0 ± 6.1 in Slomka et al.¹⁶ The LV chamber size, characterized by a LV size index in Hansen et al.,⁹ was small for the test cohort. Table 1 shows the patient characteristics of the test cohort and the two low likelihood cohorts. Table 2 shows the angiographic characteristics of the test cohort.

The two quantitative software packages (ECTb and QPS) with their Western normal databases did not show significant difference in their performance in the test cohort. Tables 3 and 4 show the sensitivity, specificity, and AUC of the quantitative indices of the four normal databases (ECTb, QPS-standard, QPS-simplified, and QPS-simplified-Chinese) in detecting $\geq 50\%$ and $\geq 70\%$ stenosis, respectively, using the vendor-suggested abnormal criteria. Statistical significance was observed in Table 3, when comparing AUC between the Western normal databases and the Chinese normal database in detecting $\geq 50\%$ stenosis. Similar trend was observed in Table 4 for detecting $\geq 70\%$ stenosis; however, no statistical significance was obtained. This finding indicated that QPS-simplified-Chinese yielded superior results in detecting mild-to-moderate defects. Notably, QPS using the Western normal databases in the Chinese population yielded smaller AUC compared to their

published results in Western population.^{13,14} ROC curves of the four normal databases in detecting $\geq 50\%$ and $\geq 70\%$ stenosis are shown in Figures 1 and 2, respectively. Table 5 shows the normalcy rates of the four normal databases.

Tables 6 and 7 show the sensitivity, specificity, and AUC of the quantitative indices of the four normal databases in detecting $\geq 50\%$ and $\geq 70\%$ stenosis, respectively, in the coronary territories (LAD, LCX, and RCA). There was no statistical significance in both tables. However, similar trend was observed in both tables, that QPS-simplified-Chinese yielded superior results to those given by other normal databases. Both ECTb and QPS with their Western normal databases had low sensitivity in detecting LCX and RCA stenosis in the Chinese population, where attenuation had higher impact than the LAD region. This finding suggested that LCX and RCA abnormal criteria developed from Western population were not suitable to Chinese population, whose images had less attenuation effect than those of Western population.

Figure 3 shows a patient example. This patient is a 52-year-old man with BMI of 24 kg/m². This example showed that both ECTb and QPS underestimated the perfusion defect in the RCA territory. The underestimation may be due to inappropriate abnormal criteria in both ECTb and QPS Western normal database for Chinese population. The simplified QPS method with the Chinese normal database correctly picked up the perfusion defect in the RCA territory, which was consistent with the CAG result—95% stenosis in RCA.

DISCUSSION

In this study, three quantification methods with their Western normal databases (ECTb, QPS-standard, and QPS-simplified) were evaluated in a Chinese cohort of 75 patients with suspected CAD. ROC analysis showed that there was no significant difference between these quantification methods, but they yielded inferior results to their published results in Western cohorts. In this study, a preliminary Chinese database was created from 80 normal subjects using the normal database generator in QPS. Quantification using the Chinese normal database improved the accuracy in detecting coronary stenosis. Statistically significant difference between the Western databases and Chinese database was observed when using $\geq 50\%$ stenosis in CAG as the gold standard (Table 3). This finding suggested that the existing Western normal databases were not adequate in detecting coronary stenosis in Chinese population, especially in detecting mild-to-moderate stenosis.

Further analysis of the diagnostic accuracy in coronary territories illuminated the source of error when using the Western normal databases in Chinese population. Abnormal criteria in the Western normal databases were inappropriate when applying to Chinese population, especially in the RCA and LCX region. The existing abnormal criteria in the Western normal databases seemed to account for photon attenuation in a greater level than it should for Chinese population, who has lower BMI than Western population in average, and thus resulted in less sensitivity in detecting RCA and LCX stenosis in Chinese population.

The inadequate performance of Western normal databases in the Chinese population in this study was possibly related to the difference in the average BMI between Western and Chinese population. As noted above, the patients in this study had significantly lower BMI than the patients used to validate the Western normal databases.^{15,16} It remains unclear whether different ethnicity or low BMI was the major factor that resulted in inadequate performance of the existing Western normal databases in Chinese population. In addition, Hansen et al found that the diagnostic accuracy of quantification is less accurate in patients with smaller heart chamber size (LV size index <75) than those with bigger size (LV size index >75) due to the limited resolution of SPECT imaging.⁹ LV size index, which

incorporated pixel size, was calculated as the product of the number of LV short-axis slices and the average radius of LV short-axis slices. In this study, the LV size index was 76.1 ± 14.8 for the entire test cohort, 79.4 ± 14.2 for male patients in the test cohort and 63.9 ± 9.4 for female patients in the test cohort (shown in Table 1). Smaller LV chamber size could be another factor that resulted in less accurate performance of the existing quantification packages in Chinese population. Therefore, besides generation of Chinese normal databases, modification of the existing Western normal databases for low BMI and/or small chamber size could be an alternative approach to this clinical problem.

This study has several limitations. First, the enrolled studies had a mix of two types of stress protocol, exercise and adenosine stress, although previous study demonstrated that exercise, pharmacologic, or mixed normal databases could be used and interchanged for either mode of stress.¹³ Second, the Chinese normal database generated in this study was very preliminary. Its abnormal criteria were not optimized using expert reading results. Lastly, we used CAG as the gold standard in this study, which may not exactly correspond to the physiologic significance of myocardial defects. The degree of stenosis was not quantitatively determined, so the subjective approach may introduce errors in this study.

CONCLUSION

The three widely used quantification methods (ECTb, QPS-standard, and QPS-simplified) with their Western normal databases yielded inferior diagnostic accuracy in detecting coronary stenosis in Chinese population to their published accuracy in Western population. Chinese normal database is needed for accurately applying these quantification methods to Chinese population, especially for detecting mild-to-moderate myocardial defects in regions with relatively greater attenuation impact. As Chinese population generally has lower BMI and smaller LV chamber size than Western population, modification of the existing Western normal databases for low-BMI and/or small-LV subjects could be an alternative approach.

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References

1. Hachamovitch R, Berman DS, Kiat H, et al. Exercise myocardial perfusion SPECT in patients without known coronary artery disease. *Circulation* 1996;93:905–914. [PubMed: 8598081]
2. Beller, GA. Clinical nuclear cardiology: Detection of coronary artery disease. Philadelphia: Saunders; 1995.
3. Hachamovitch R, Berman DS, Shaw LJ, et al. Incremental prognostic value of myocardial perfusion single-photon emission computed tomography for the prediction of cardiac death. *Circulation* 1998;97:535–543. [PubMed: 9494023]
4. Iskander S, Iskandrian AE. Risk assessment using single photon emission computed tomography technetium-99m-sestamibi imaging. *J Am Coll Cardiol* 1998;32:57–62. [PubMed: 9669249]
5. DePuey EG, Garcia EV. Optimal specificity of thallium-201 SPECT through recognition of imaging artifacts. *J Nucl Med* 1989;30:441–449. [PubMed: 2661749]
6. Corbett JR, Ficaro EP. Clinical review of attenuation-corrected cardiac SPECT. *J Nucl Cardiol* 1999;6:54–68. [PubMed: 10070841]
7. Van Train KF, Areeda J, Garcia EV, et al. Quantitative same-day rest-stress technetium-99m sestamibi SPECT: Definition and validation of stress normal limits and criteria for abnormality. *J Nucl Med* 1993;34:1494–1502. [PubMed: 8355069]
8. Eisner RL, Tamas MJ, Cloninger K, et al. Normal SPECT thallium-201 bull's-eye display: Gender differences. *J Nucl Med* 1988;29:1901–1909. [PubMed: 3264019]

9. Hansen CL, Crabbe D, Rubin S. Lower diagnostic accuracy of Thallium-201 SPECT myocardial perfusion imaging in women: An effect of smaller chamber size. *J Am Coll Cardiol* 1996;28:1214–1219. [PubMed: 8890818]
10. Garcia EV, Faber TL, Cooke CD, Folks RD, Chen J, Santana CA. The increasing role of quantification in clinical nuclear cardiology. *J Nucl Cardiol* 2007;14:420–432. [PubMed: 17679051]
11. Germano G, Kavanagh PB, Slomka PJ, Van Kriekinge SD, Pollard G, Berman DS. Quantitation in gated perfusion SPECT imaging: The Cedars-Sinai approach. *J Nucl Cardiol* 2007;14:433–454. [PubMed: 17679052]
12. Diamond GA, Forrester JS, Hirsch M, et al. Application of conditional probability analysis to the clinical diagnosis of coronary artery disease. *J Clin Invest* 1980;65:1210–1221. [PubMed: 6767741]
13. Slomka PJ, Nishina H, Berman DS, et al. Automated quantification of myocardial perfusion SPECT using simplified normal limits. *J Nucl Cardiol* 2005;12:66–77. [PubMed: 15682367]
14. Sharir T, Germano G, Waechter PB, et al. A new algorithm for the quantitation of myocardial perfusion SPECT. II: Validation and diagnostic yield. *J Nucl Med* 2000;41:720–727. [PubMed: 10768575]
15. Wolak A, Slomka PJ, Fish MB, et al. Quantitative myocardial-perfusion SPECT: Comparison of three state-of-the-art software packages. *J Nucl Cardiol* 2008;15:476. [PubMed: 18513656]
16. Slomka PJ, Fish MB, Lorenzo S, et al. Simplified normal limits and automated quantitative assessment for attenuation-corrected myocardial perfusion SPECT. *J Nucl Cardiol* 2006;13:642–651. [PubMed: 16945744]

Figure 1.
ROC curves for detecting 50% or greater stenosis by the four normal databases.

Figure 2.
ROC curves for detecting 70% or greater stenosis by the four normal databases.

Figure 3.
A patient example of perfusion quantification using ECTb and QPS with their Western normal databases and simplified QPS with the Chinese normal database.

Table 1

Patient characteristics

Parameter	Normalcy rate cohort (n = 85)	Chinese normal database cohort (n = 80)	Test cohort (n = 75)
Age	48.8 ± 8.4	49.2 ± 10.9	62.4 ± 9.4
Male	47 (55%)	40 (50%)	59 (79%)
BMI	23.7 ± 2.2	24.1 ± 3.0	25.3 ± 2.8
LV size index *			76.1 ± 14.8
Male			79.4 ± 14.2
Female			63.9 ± 9.4
Adenosine stress	0 (0%)	0 (0%)	48 (64%)
Hypertension	39 (46%)	42 (53%)	48 (64%)
Diabetes	9 (11%)	5 (6%)	9 (12%)
Hypercholesterolemia	17 (20%)	9 (11%)	33 (44%)
Smoking	26 (31%)	11 (14%)	47 (63%)
Typical angina	0 (0%)	0 (0%)	22 (29%)
Atypical angina and non-angina chest pain	81 (95%)	74 (93%)	50 (67%)

* LV size index, which incorporated pixel size, was calculated as the product of the number of LV short-axis slices and the average radius of LV short-axis slices.

Table 2

Angiographic characteristics of the test cohort

Parameter	Number of patients	
	≥50% stenosis	≥70% stenosis
Normal	19 (25%)	36 (48%)
Single vessel	25 (35%)	19 (25%)
Double vessel	15 (20%)	20 (27%)
Triple vessel	16 (21%)	0 (0%)
LAD territory	49 (65%)	31 (41%)
LCX territory	25 (33%)	18 (24%)
RCA territory	23 (31%)	10 (13%)

Sensitivity, specificity, and area under ROC curve (AUC) of the four normal databases in detecting 50% or greater stenosis

Table 3

Normal database	Index	Published AUC	Cutoff (%)	Sensitivity	Specificity	AUC
ECTb	Extent	N/A	3	0.702	0.556	0.74 ± 0.06*
QPS-standard	Extent	0.82 ± 0.03	3	0.596	0.722	0.69 ± 0.06*
QPS-simplified	Extent	0.88 ± 0.02	3	0.632	0.778	0.78 ± 0.06*
	TPD	0.88 ± 0.02	6	0.526	0.944	0.77 ± 0.06*
QPS-simplified-Chinese	Extent	N/A	3	0.722	0.722	0.81 ± 0.06
	TPD	N/A	6	0.667	0.833	0.84 ± 0.05

AUC are expressed as means ± standard deviation. The AUC for extent and TPD were compared between the Western normal databases (ECTb, QPS-standard and QPS-simplified) and the Chinese normal database (QPS-simplified-Chinese) using the Hanley and McNeil method.

* A threshold of $P < .05$ was considered significant.

Sensitivity, specificity, and area under ROC curve (AUC) of the four normal databases in detecting 70% or greater stenosis

Table 4

Normal database	Index	Published AUC	Cutoff (%)	Sensitivity	Specificity	AUC
ECTb	Extent	N/A	3	0.795	0.528	0.81 ± 0.05
QPS-standard	Extent	0.85 ± 0.03	3	0.718	0.694	0.81 ± 0.05
QPS-simplified	Extent	0.89 ± 0.02	3	0.846	0.806	0.86 ± 0.05
	TPD	0.89 ± 0.02	6	0.718	0.917	0.85 ± 0.05
QPS-simplified-Chinese	Extent	N/A	3	0.897	0.611	0.87 ± 0.04
	TPD	N/A	6	0.821	0.750	0.87 ± 0.04

AUC are expressed as means ± standard deviation. The AUC for extent and TPD were compared between the Western normal databases (ECTb, QPS-standard and QPS-simplified) and the Chinese normal database (QPS-simplified-Chinese) using the Hanley and McNeil method. No statistical significance was found in those comparisons.

Table 5

The normalcy rates of the four normal databases

Normal database	Index	Cutoff (%)	Normalcy rate (%)
ECTb	Extent	3	90
QPS-standard	Extent	3	80
QPS-simplified	Extent	3	95
	TPD	6	100
QPS-simplified-Chinese	Extent	3	85
	TPD	6	98

Sensitivity, specificity, and area under ROC curve (AUC) of the four normal databases in detecting 50% or greater stenosis in coronary territories

Table 6

	Published AUC	Cutoff (%)	Sensitivity	Specificity	AUC
LAD extent					
ECTb	N/A	10	0.490	0.846	0.69 ± 0.06
QPS-standard	0.74 ± 0.03	3	0.592	0.538	0.64 ± 0.06
QPS-simplified	0.79 ± 0.03	3	0.720	0.560	0.70 ± 0.06
QPS-simplified-Chinese	N/A	3	0.673	0.654	0.74 ± 0.06
LCX extent					
ECTb	N/A	10	0.320	0.720	0.53 ± 0.06
QPS-standard	0.72 ± 0.03	4	0.240	0.880	0.58 ± 0.06
QPS-simplified	0.75 ± 0.03	4	0.400	0.820	0.62 ± 0.07
QPS-simplified-Chinese	N/A	4	0.600	0.560	0.63 ± 0.07
RCA extent					
ECTb	N/A	12	0.391	0.904	0.65 ± 0.07
QPS-standard	0.75 ± 0.03	2	0.435	0.788	0.65 ± 0.07
QPS-simplified	0.80 ± 0.03	2	0.391	0.885	0.67 ± 0.06
QPS-simplified-Chinese	N/A	2	0.288	0.435	0.68 ± 0.07

Sensitivity, specificity, and area under ROC curve (AUC) of the four normal databases in detecting 70% or greater stenosis in coronary territories

Table 7

	Published AUC	Cutoff (%)	Sensitivity	Specificity	AUC
LAD extent					
ECTb	N/A	10	0.750	0.907	0.86 ± 0.06
QPS-standard	0.77 ± 0.04	3	0.750	0.602	0.79 ± 0.06
QPS-simplified	0.83 ± 0.03	3	0.813	0.674	0.84 ± 0.05
QPS-simplified-Chinese	N/A	3	0.844	0.651	0.88 ± 0.04
LCX extent					
ECTb	N/A	10	0.278	0.702	0.51 ± 0.07
QPS-standard	0.79 ± 0.04	4	0.278	0.877	0.53 ± 0.06
QPS-simplified	0.82 ± 0.03	4	0.389	0.789	0.63 ± 0.07
QPS-simplified-Chinese	N/A	4	0.611	0.544	0.64 ± 0.08
RCA extent					
ECTb	N/A	12	0.471	0.897	0.72 ± 0.08
QPS-standard	0.78 ± 0.03	2	0.529	0.795	0.71 ± 0.07
QPS-simplified	0.83 ± 0.03	2	0.471	0.879	0.72 ± 0.07
QPS-simplified-Chinese	N/A	2	0.706	0.724	0.76 ± 0.07