Diagnostic accuracy of 64-slice multidetector computed tomography for selecting coronary artery bypass graft surgery candidates

Hye-Jeong Lee, MD,[a] Jung-Sun Kim, MD, PhD,[b] Young Jin Kim, MD, PhD,[a] Jin Hur, MD,[a] Kyung-Jong Yoo, MD, PhD,[c] Kyu Ok Choe, MD, PhD,[a] and Byoung Wook Choi, MD, PhD[a]

Objective: The objective of our study was to investigate the diagnostic accuracy of computed tomographic coronary angiography for the selection of candidates for coronary artery bypass graft surgery.

Methods: Institutional review board approval was obtained. We included 172 patients (mean age, 63 years; 127 men and 45 women) with a suspicion of coronary artery disease who underwent both computed tomographic coronary angiography and conventional coronary angiography. We established eligible criteria for coronary artery bypass graft surgery based on American College of Cardiology/American Heart Association practice guidelines: 3-vessel disease, left main coronary artery disease, and left main coronary artery equivalent disease. Results of computed tomographic coronary angiography and conventional coronary angiography were reviewed retrospectively by 2 radiologists and 2 cardiologists who were unaware of the other examiners' findings. Diagnostic performances of computed tomographic coronary angiography were calculated, with conventional coronary angiography as the reference standard.

Results: The overall sensitivity, specificity, positive predictive value, and negative predictive value of computed tomographic coronary angiography for the selection of coronary artery bypass graft surgery candidates were 85.9%, 96.0%, 93.8%, and 90.7%, respectively. We also obtained high diagnostic performances for 3-vessel disease (sensitivity, 83.1%; specificity, 96.5%; positive predictive value, 92.5%; negative predictive value, 91.6%), left main coronary artery disease (sensitivity, 94.7%; specificity, 96.7%; positive predictive value, 78.3%; negative predictive value, 99.3%), and left main coronary artery equivalent disease (sensitivity, 100%; specificity, 100%; positive predictive value, 100%; negative predictive value, 100%).

Conclusions: Patients selected as candidates for coronary artery bypass graft surgery with conventional coronary angiography can also be relatively accurately classified by using computed tomographic coronary angiography with 64-slice multidetector computed tomography. (J Thorac Cardiovasc Surg 2011;141:571-7)

Conventional coronary angiography (CCA) is the gold standard to evaluate the extent and severity of all coronary artery luminal stenoses. For patients with angina or myocardial infarction or those who have abnormal noninvasive tests for coronary artery disease (CAD), angiography also helps the physician choose the optimal treatment. These can include medications, percutaneous coronary intervention (PCI; balloon angioplasty or coronary stenting), or coronary artery bypass graft surgery (CABG).[1,2] However, a noninvasive technique for the anatomic assessment of the coronary arteries would be highly desirable because of the associated economic deliberations, the inconvenience to patients, and the small,[3] but not negligible, risk of complications of CCA. Use of contrast-enhanced computed tomographic coronary angiography (CTCA) appears promising enough to warrant pursuit of detection of CAD.[4] Especially since the advent of multidetector computed tomographic (MDCT) scanners, the diagnostic performance for the assessment of significant coronary arterial stenoses has significantly improved, and the proportion of nonassessable segments has decreased.[5]

Currently, CTCA is a useful method for excluding insignificant CAD in patients with vague symptoms and clinical findings who do not need CCA. All patients with at least 1 significant stenosis on CTCA are classified as having significant CAD. Most symptomatic patients with significant CAD on CTCA are referred for CCA. This suggests that CTCA might be a suitable tool for selecting patients who are considered for CCA to plan treatment.[6] However, if a patient with CAD requires CABG as revascularization therapy, CCA acts only as a diagnostic measure and might be an unnecessary procedure for the patient. If we can accurately select CABG candidates using CTCA, CCA would not be necessary to confirm the same diagnosis, and we could skip the CCA for CABG candidates. However, few studies

From the Department of Radiology, Research Institute of Radiological Science,[a] and the Division of Cardiology[b] and the Department of Cardiovascular Surgery,[c] Cardiovascular Center, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea.

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Address for reprints: Byoung Wook Choi, MD, Department of Diagnostic Radiology, Severance Hospital, Yonsei University College of Medicine, Shinchon-dong, Seodaemun-gu, Seoul 120-752 Korea (E-mail: bchoi@yuhs.ac).

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting
CAD = coronary artery disease
CCA = conventional coronary angiography
CT = computed tomography
CTCA = computed tomographic coronary angiography
LAD = left anterior descending coronary artery
LCx = left circumflex coronary artery
LM = left main
MDCT = multidetector computed tomography
NPV = negative predictive value
PCI = percutaneous coronary intervention
PPV = positive predictive value

have evaluated the diagnostic performance of CTCA in this role.[7,8]

Therefore the purpose of our study was to retrospectively investigate the diagnostic accuracy of CTCA by using a 64-slice MDCT for the selection of CABG candidates.

MATERIALS AND METHODS

Patient Population

Institutional review board approval was obtained for this retrospective study, and informed consent was waived. We retrospectively searched a database of CTCA examinations performed over a period of 7 months (January 2007 to July 2007). A total of 1849 consecutive patients underwent CTCA during this period for suspected CAD based on their symptoms and clinical findings. Of these patients, we included only those who underwent both CTCA and CCA with an interval of less than 60 days (mean, 20 days) between the 2 procedures. CCA was performed because of documented coronary lesions on the computed tomographic (CT) scan or because of a physician's request in spite of no significant CAD on the CT scan. Patients with previous CABG or PCI were excluded from the study. A total of 172 patients were included. The study population included 127 men and 45 women with an age range of 42 to 84 years (mean, 63 years). Patient characteristics are summarized in Table 1.

MDCT

All CT scans were performed with a 64-slice MDCT (Somatom sensation 64; Siemens Medical Solution, Erlangen, Germany). In the absence of contraindications, patients with a heart rate of greater than 65 beats/min before the examination received a β-blocker (40 mg of propranolol hydrochloride [Pranol]; Dae Woong, Seoul, Korea), and a 0.3-mg sublingual dose of nitroglycerin was administered before initiation of scanning. Contrast-enhanced CT scanning for coronary angiography was performed in our institution as follows. A bolus of 60 to 80 mL of iopamidol (Iopamiro 370; Bracco S.p.A, Milan, Italy) was injected into the antecubital vein at a flow rate of 5 mL/s, followed by a 50-mL saline flush bolus at a flow rate of 5 mL/s. An automated bolus tracking system was used to synchronize the arrival of the contrast material with the initiation of the scan. CT scanning used the following parameters: retrospective electrocardiographically gated acquisitions with electrocardiographic dose modulation, tube voltage of 120 kV, current of 800 mA, slice collimation of 64×0.6 mm, gantry rotation time of 330 ms, and table feed of 18 mm/s. Scan data were acquired from the tracheal bifurcation to the diaphragm. The field of view was adjusted according to the size of the heart. The mean radiation dose for the CTCA was calculated as 8.3 mSv (5.6–13.3 mSv). Axial images were retrospectively reconstructed on a workstation (Wizard, Siemens Medical Solutions) at an optimal reconstruction window by using a slice thickness of 0.75 mm, an increment of 0.5 mm, and a medium-smooth convolution kernel of B25f. The image data sets were analyzed by using multiplanar reformatted images (vertical long-axis and short-axis views), curved multiplanar reformatted images, thin-slab maximum intensity projection images, and volume-rendering images in addition to the axial images.

CCA

Quantitative CCA with standard techniques was always performed after CTCA (within 60 days of the CT scan). It was performed after achievement of local anesthesia by using a biplane digital fluoroscope (Allura Xper FD10/10; Philips Medical System, Best, The Netherlands) through a femoral approach. A Judkins 5F catheter (Cordis Corp, Miami, Fla) and Omnipaque 350 contrast agent (GE Healthcare, Chalfont St Giles, United Kingdom) was used. A minimum of 6 orthogonal views was obtained.

CABG Criteria

We established eligible criteria for CABG based on practice guidelines developed by the American College of Cardiology Foundation and the American Heart Association.[9] The criteria for CABG were as follows: (1) left main (LM) disease, which was defined as a 50% or greater diameter stenosis in the LM coronary artery; (2) 3-vessel coronary disease, which was defined as a 50% or greater diameter stenosis in all 3 main coronary arteries; or (3) LM equivalent disease, which was defined as a 70% or greater diameter stenosis at the proximal left anterior descending coronary artery (LAD) with a 70% or greater diameter stenosis at the proximal left circumflex coronary artery (LCx). We did not consider any clinical subset, such as diabetes mellitus or congestive heart failure, as criteria for a CABG.

Image Analysis

CTCA scans were reviewed on a picture-achieving and communication system (PACS Centricity 2.0, GE Healthcare). An offline workstation (AquarisNet Viewer V1.8.0.3, TeraRecon) was used for quantitative CT angiographic analysis and percentage diameter coronary arterial stenosis. Two experienced radiologists (with 5 and 8 years' experience in cardiac MDCT, respectively) determined whether there was significant stenosis on each segment and assessed whether the findings on the CTCA scan meet the criteria for CABG. The radiologists were blinded to all data from the patients. Differences in the assessments were resolved by means of consensus. The general image quality of the CTCA scan was classified as being excellent (no artifacts and unrestricted evaluation), good (minor artifacts and good diagnostic quality), fair (moderate artifacts and acceptable for routine clinical diagnosis), or poor (severe artifacts impairing accurate evaluation). When the image quality rating was fair or bad, the reasons for impaired visualization were noted.

Two cardiologists (with 4 and 12 years' experience in coronary angiography, respectively) blinded to the results of CTCA performed angiographic analyses. The coronary arteries were evaluated according to a 16-segment coronary artery model modified from the American Heart Association classification.[10] Quantitative coronary angiographic analysis was performed with the computer-assisted automated edge detection method (CASS System II; Pie Medical Imaging, Limburg, The Netherlands). The guiding catheter was used as a reference for calibration. All measurements were taken from the diastolic frames of the most severe stenosis. The percentage of stenosis was calculated as the minimal lumen diameter divided by the mean reference diameter.

On CTCA and CCA, coronary artery stenoses were classified as follows: minimal (<30%), mild (≥30 to <50%), moderate (≥50 to <70%), and severe (≥70%); significant stenosis was defined as a ≥50% diameter reduction. In the case of multiple lesions on a given artery, the artery was