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Original Article

Diagnostic performance of 320-slice computed tomography coronary angiography for symptomatic patients in clinical practice

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ABSTRACT

Objective: Multi-slice computed tomography (MSCT) coronary angiography has been reported as an effective alternative to invasive conventional coronary angiography (CCA) for the diagnosis of coronary artery disease (CAD). However, in previous reports, the diagnostic accuracy of MSCT has not been significant enough to be of benefit in symptomatic patients. The aim of this study was to identify the usefulness of 320-slice computed tomography coronary angiography (320-CTA) for symptomatic patients in terms of the diagnostic accuracy of 320-CTA and the prevalence of vasospastic angina pectoris (VSAP) within the study cohort.
Methods: We retrospectively analyzed 513 consecutive symptomatic patients with suspected CAD who had undergone 320-CTA and CCA. We determined the diagnostic accuracy of 320-CTA using CCA as the reference standard. Ergonovine provocation tests were performed on patients without significant coronary artery stenosis on CCA.
Results: Of the total cohort of 513 symptomatic patients, 39% had obstructive CAD. The patient based analysis of the accuracy of 320-CTA showed a sensitivity of 91.0%, a specificity of 71.0%, a positive predictive value of 66.5%, and a negative predictive value of 92.5%. Of the 314 symptomatic patients who did not have significant coronary artery stenosis on CCA, 58 (18%) were diagnosed with VSAP using ergonovine provocation tests.
Discussion: The negative and positive predictive values indicate that 320-CTA cannot replace CCA for symptomatic patients. Indeed, a combination of CCA and ergonovine provocation tests should be taken into consideration for symptomatic patients.

1. Introduction

Coronary artery disease (CAD) is the leading cause of death and a major cause of disability worldwide [1]. In patients with suspected CAD, an evaluation demonstrating the presence and severity of CAD is necessary to provide appropriate clinical management. Conventional coronary angiography (CCA) has been the gold standard for the clinical imaging of CAD. CCA can precisely determine the extent, location, and severity of coronary obstructive lesions, and identify patients who require revascularization. Multi-slice computed tomography (MSCT) coronary angiography has been described as an effective alternative to invasive coronary angiography [2,3]. On the other hand, previous reports have found that MSCT coronary angiography has an unacceptable negative predictive value for symptomatic patients, compared with that of CCA [4]. However, these reports were based on the less accurate 64-slice version of MSCT coronary angiography. The 320-slice version of MSCT has a wide area detector which enables a greater coverage per gantry rotation and whole heart coverage in a single heat beat.

Regarding suspected stable angina pectoris, current guidelines recommend the use of MSCT coronary angiography when considering the pretest probability of disease [5,6]. The guidelines do not take into account the diagnostic accuracy of the developed MSCT coronary angiography, because the diagnostic performance of 320-MSCT coronary angiography in routine clinical practice has not been studied enough. Moreover, the guidelines do not consider the prevalence of vasospastic angina pectoris (VSAP) in symptomatic patients. VSAP is a well-known disease that can cause cardiac death if not treated appropriately [7–9]. Therefore, an accurate diagnosis of VSAP through the use of a provocation test is considerable. No previous studies have evaluated the prevalence of VSAP in patients without significant coronary artery stenosis on computed tomography coronary angiography (CTA).

This study aimed to identify the usefulness of 320-slice computed tomography coronary angiography (320-CTA) for symptomatic patients

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in terms of determining the diagnostic accuracy of 320-CTA and to determine the prevalence of vasospastic angina pectoris (VSAP) within the study cohort.

2. Patients and methods

Between October 2010 and March 2014, 4482 consecutive patients who were clinically suspected of having CAD underwent 320-CTA. CCA was performed, if 320-CTA findings suggested significant organic coronary artery stenosis, or if it did not suggest significant organic stenosis in spite of symptoms suggestive of CAD. Patients were excluded from the study if they had undergone coronary interventions or CABG surgery, were undergoing hemodialysis, had congestive heart failure classified as New York Heart Association Class III or IV, had aortic stenosis, or had an allergy to contrast media.

Fig. 1 shows the patient eligibility for study participation. We enrolled 4482 patients who were suspected of having CAD in the study. Of these patients, 1558 underwent CCA within 3 months, and of these patients, 952 were symptomatic. Of the patients who were symptomatic, 236 were excluded because they had a history of percutaneous coronary intervention, 66 were excluded because they had a history of CABG surgery, 11 were excluded because of hemodialysis, and 27 were excluded because of arrhythmia (12 patients had atrial fibrillation and 25 had frequent premature atrial or ventricular contractions). Eighty-nine patients with circumferential deposits of calcium in their coronary vessels were excluded from the study. Therefore, a total of 513 eligible patients with suspected CAD were analyzed.

2.1. Scan protocol and image reconstruction

All CT scans were performed using a 320-detector CT scanner (Aquilion ONE; Toshiba Medical Systems Corporation, Tochigi-ken, Japan) with 320 detector rows, each 0.5 mm wide, and a gantry rotation time of 350 ms. The tube voltage was 120 kV and the current was automatically adapted to the patient's body mass index and thoracic anatomy. We used a prospective electrocardiographic gating method. For prospective scanning, the phase window was set at 5–85% of the R–R interval for patients with a heart rate of <65 beats/min. Beta blockers were administered to patients whose heart rates were ≥65 beats/min. The start delay was defined by bolus tracking in the ascending aorta, and the scan start was automatically initiated after reaching the threshold level of the baseline Hounsfield units plus 100 Hounsfield units. The contrast medium was injected into an antecubital vein over 10 s and the volume of the contrast medium was adapted according to the patient's body weight (22.2 mg/kg). All of the images were acquired during an inspiratory breath hold. An initial dataset was reconstructed at 75% of the R–R interval, with a slice thickness of 0.50 mm and a reconstruction interval of 0.25 mm.

For each patient, the reconstruction of the data with a minimum level of artifacts was undertaken at the CT console by reconstructing the available 5% intervals. The images were then transferred to an image post-processing workstation (Ziostation, Tokyo, Japan). The image sets available on the workstation included axial reconstructed images sent from the CT unit, multi-planar and curved planar reconstructions that had been rotated through 360° along the course of each coronary artery and the major side branches, and thin-slab maximum-intensity projection images that were created at the workstation.

2.2. CT image quality analysis

Two reviewers with >3 years of experience in MSCT coronary angiography reviewed all of the CT images. The first reviewer was not informed of the patient's clinical information, and the images were evaluated independently at different times. The three main coronary arteries and their major side branches down to a minimum diameter of 1.5 mm were identified. The images of the vessels were assessed and categorized into three groups: “excellent”, which included those without any artifacts and calcifications that would interfere with the evaluation of the coronary vessels; “fine”, which included those with minor artifacts and calcifications, but evaluation of the vessel lumen was possible; and “poor”, which included those with motion artifacts or circumflex calcifications that prevented evaluation of the coronary artery lumen. We excluded those images from the analysis that were categorized as “poor”. If there were any discrepancies between the reviewers with regard to the quality of the images of the vessels or the severity

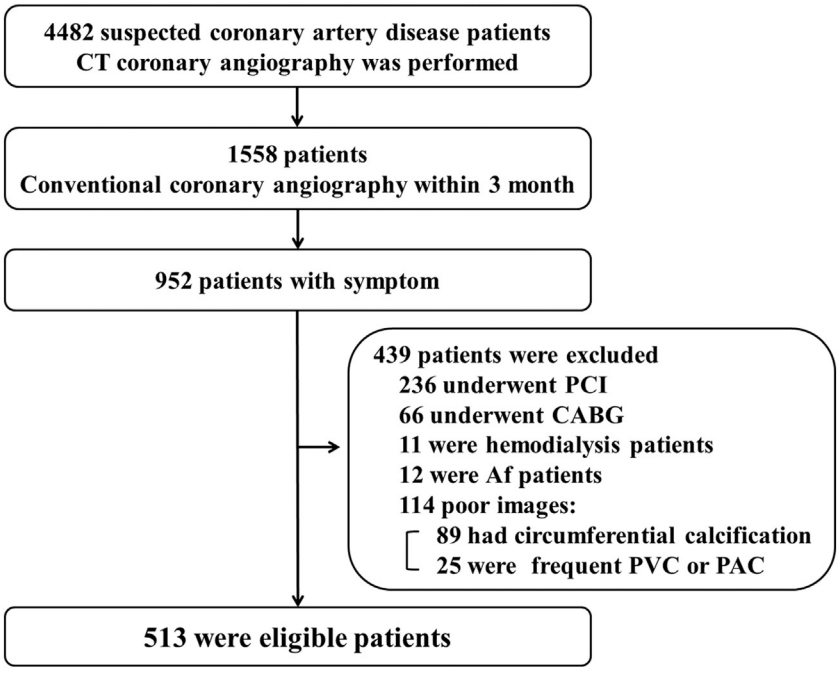

Fig. 1. Patient flow chart. PCI = percutaneous coronary intervention; CABG = coronary artery bypass graft surgery; PVC = premature ventricular contraction; PAC = premature atrial contraction.

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