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Myocardial bridging as evaluated by 16 row MDCT

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Abstract

Purpose: The purpose of this study is to find out the prevalence, appearance and clinical symptoms of myocardial bridging (MB) by MDCT coronary angiography (CTA).

Materials and methods: A total of 280 (50 females) consecutive patients followed with coronary artery disease or postoperative stent and bypass control, underwent CTA performed by 16-MDCT scanner between January 2006 and April 2006. Short axis multiplanar reformatted images were evaluated. MBs were classified as complete and incomplete bridges with respect to continuity of the myocardium over the tunneled segment of left anterior descending artery (LAD) in interventricular groove and the cut-off value is 1.3 mm. Patients diagnosed with MB on CTA who had prior catheter angiography studies were re-evaluated for the presence of MB.

Results: One hundred and twenty MBs [98 (81.6%) on LAD, 2 (1.6%) on diagonal branch, 11 (9.1%) on obtuse marginal, 4 (3.3%) on right coronary artery, 5 (4.1%) on ramus intermedius artery] were detected in 108 (38.5%) patients. Eighty-five (70.8%) of bridged segments in 79 (28.2%) patients were complete and the rest [35 (29.2%) in 34 (12.1%) patients] were incomplete. In 12 patients two MBs (either on different arteries or on the same artery) were detected. The length of bridged segments in patients with complete and incomplete MBs varied between 4–50.9 mm (mean 18 mm) and 4–37.3 mm (mean 13.6 mm), respectively, and the depth of myocardium over the artery ranged between 1–6.4 mm (mean 2.3 mm) and 1–1.2 mm (mean 1 mm), respectively. Thirty (27.7%) out of 108 patients, in whom MB was detected on CTA, were found to have correlative catheter angiography studies, retrospectively and MB was detected only in 4 (13.3%) out of 30 patients.

Conclusion: MDCT coronary angiography is a non-invasive, efficient method in the diagnosis of MB avoiding the procedural risks that catheter angiography carries. MDCT coronary angiography allows direct visualization of the bridge itself and may thus give the opportunity to differentiate between complete and incomplete myocardial bridges.

Keywords: Myocardial bridging; MDCT; Cardiac imaging; CT angiography; CT imaging; Cardiovascular imaging; Conventional angiography

1. Introduction

Myocardial bridging (MB) is an anatomical abnormality of the coronary arteries characterized by the myocardial encasement of these arteries. The encased artery is called the 'tunneled artery' [1–5].

Despite the fact that it is a congenital anomaly, the patients are usually symptomless until the third decade [3]. Although this phenomenon has generally been considered a benign process, it may also cause myocardial ischemia, myocardial infarction, myocardial stunning, left ventricular dysfunction, ventricular septal rupture, premature death after cardiac transplantation, ventricular tachycardia and sudden cardiac death [6–14].

An autopsy study by Ferreira et al. classified MBs into two categories: *superficial bridges* (75% of cases) which cross the artery perpendicularly or at an acute angle toward the apex, and *deep bridges* in which muscle bundles arise from the right ventricular apical trabeculae (25% of cases) crossing the LAD transversely, obliquely, or helically before terminating in the interventricular septum [15]. Besides that, arterial segments located in a deep interventricular groove may not be totally covered by myocardial fibers, but by a thin layer of connective tissue,

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nerves, and fatty tissue. This kind of bridging, which is classified as "*incomplete*" may also cause compression of these vascular structures during the systole [5].

Myocardial bridging of the coronary arteries is reported to occur in 15–85% of autopsy series and in 0.5–2.5% angiographic examinations [1,3,4,16,17]. However, the prevalence may rise up to 40% with the provocation test done during conventional angiographies [2,5]. This anomaly is more frequently detected in patients with hypertrophic cardiomyopathy with a prevalence upto 30% of coronary angiographies of these subjects [18]. The incidence of this anomaly also seems to be increased in patients with heart transplantation [19].

Conventional invasive diagnosis of MB is done by coronary angiography in which typical "milking effect" and a "step down–step up" phenomenon are observed with induction as systolic compression of the tunneled segment [3–5]. The diagnosis can also be made using other invasive methods, e.g., intravascular ultrasound (IVUS), and intracoronary Doppler (ICD). Morphological and functional features of MB can also be detected and quantified with the help of these methods [17,20]. In this study, we aimed to find out the prevalence, appearance of myocardial bridging (MB) by MDCT coronary angiography (CTA), a new and rapidly developing non-invasive method.

2. Material and methods

Our patient group is consisted of 280 subjects (230 males, 50 females) who underwent CTA between January 2006 and April 2006. The patients were examined with CTA for several reasons like clinical suspicion of coronary artery disease or the control of coronary stents and bypass grafts.

The pre-examination preparations of the patients were also kept standard. The patients with a heart rate below 70 bpm directly underwent study without any premedication, while the enrollees with a heart rate above 70 bpm received 40–80 mg propranolol orally, 1 h before the examination. The medical problems that leads to the exclusion from CTA study were as follows: history of renal insufficiency, bronchial asthma, history of adverse reaction to iodinated contrast agents, pregnancy, atrial fibrillation.

All studies were done with a 16 channel MDCT scanner (Sensation 16, Siemens Inc., Erlangen, Germany). After obtaining an initial anterioposterior scout image (120 kV, 50 mAs) in supine position, scanning range was planned on an individual basis. The scanning area was between the clavicle and the apex of heart for the enrollees with a history of bypass grafting and from carina to the apex of heart for the subjects. The data acquisition was done within a period of single breath-hold. One hundred to 120 ml of iodinated contrast agent (Ultravist 300 mg/ml, Schering AG, Germany) was injected via the antecubital vein with a 20-gauge i.v. catheter. Contrast agent was administered with an automated power injector (Medrad Envision CT, Pittsburg, PA) with a flow rate of 4 ml/s. To achieve the optimal contrast enhancement, a circular region of interest was placed on the ascending aorta. The imaging protocol of the study were also standardized as follows: after the beginning of the contrast injection samples images were obtained from the level of ascending aorta until the densitometric value at the region of interest reached a threshold of 100 HU. When this level is reached the patient was instructed to hold his/her breath and 4 s after this instruction the image acquisition was started. Scanning was performed by electrocardiography (ECG) gating and slice thickness was 1 mm. Contrast-enhanced MDCT data were obtained with 1 mm slice thickness, 420 ms rotation time (detector collimation: 0.75 mm, table feed 3.4 mm/rotation), 0.23 pitch. The tube current was kept constant at 500 mAs and 120 kV.

The overall data was retrospectively reconstructed between 30% and 70% of the R–R interval with a soft tissue algorithm. All images were post-processed on a Leonardo workstation (Siemens Medical Systems). Axial source images, multiplanar reformatted images (MPR) (especially short axis images), maximum intensity projection, and volume rendered reformatted images of the coronary arteries were obtained for the final interpretation. Images were evaluated by two radiologists simultaneously (MC, TH), in cases where the results among two were not consistent (seven patients), the images were consulted to a third radiologist (MK) who is also experienced in non-invasive cardiovascular imaging.

The thickness of the bridging myocardium overlying the left anterior descending artery (LAD) were measured on short axis MPR images (Fig. 1). For the other arteries and their branches, these measurements were obtained on images where the perpendicularity of the examined vessel and the myocardial bridge is most obvious.

Short axis MPR images were evaluated and myocardial bridges were classified into two subgroups as complete and incomplete. The myocardial bridges with a thickness above 1.3 mm, we were able to demonstrate the continuity of myocardium over the tunneled segment of LAD in interventricular groove. While the bridges with a thickness below 1.3 mm were classified as incomplete, since their relation with the myocardium could not be optimally assessed. Since incomplete bridging is only identified for LAD in the medical literatures [5,15,21], all the bridges over the other coronary arteries including ramus intermedius, diagonal artery, obtuse marginal branch of the circumflex artery and right coronary artery (RCA) were assumed as complete.

We evaluated LAD in its proximal, middle and distal parts. Proximal part was between the origin and the ostium of the first diagonal artery, the middle part was between the end of the proximal part and to the point where second diagonal branch arises, and the distal part included the rest of the artery.

All the patients with MB diagnosed on CTA were reviewed retrospectively to see whether they had prior catheter angiography and, if available, all these angiographies were re-evaluated by a cardiologist (KA) for the presence of MB.

3. Results

In 108 patients, 120 MBs were detected on CTA, while the distribution of their locations were as follows: 98 (81.6%) on LAD, 2 (1.6%) on diagonal branch, 11 (9.1%) on obtuse marginal, 4 (3.3%) on RCA, 5 (4.1%) on ramus intermedius artery. The age range of the subjects varied between 10 and