Does Myocardial Bridging Affect Coronary Hemodynamics?

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Abstract

Objective: The aim of our study was to evaluate the relationship between a myocardial bridge (MB) and its effects over the coronary artery hemodynamics by using multislice computed tomography (MSCT).

Material and methods: A total of 412 patients examined with coronary computed tomography (CT) angiography were reviewed retrospectively for an MB of the left anterior descending (LAD) coronary artery. We evaluated the correlation between the depth of an MB and the degree of compression to the MB during end-diastolic and end-systolic phases.

Results: 93 (22.6%) MBs were detected in 412 patients, and 81 of the 93 subjects (87.09%) were found in LAD. In 53 (65.43%) of the 81 subjects, the MBs were localized superficially, and 28 (34.57%) of the 81 subjects were deeply in myocardium. A significant difference was found in the luminal narrowing during the end-diastolic phase between the superficial and deep type of MB (p = 0.045), but the narrowing in the end-systolic phase was not correlated with the myocardial thickness over the bridge.

Conclusion: We detected a correlation between the luminal narrowing ratio and the myocardial thickness over the tunneled artery in the end-diastolic phase.

Key words: Myocardial bridge, coronary artery, CT

Introduction

Myocardial bridging (MB) is defined as a segment of a major coronary artery course through the myocardium that normally has an epicardial course. It is an inborn abnormality and is named the tunneled artery. MB most commonly affects the mid-portion of the left anterior descending artery [1]. MB is usually asymptomatic but leads to a variety of clinical manifestations, including sudden death [2]. The coronary artery that is characterized in myocardium is thought to suffer from myocardial contraction during systole and may develop hemodynamic changes in the lumen. The localization of MB and its length and depth in myocardium may be significant for hemodynamics and clinical prognosis. In this study, our aim is to evaluate the relationship between the MB and coronary hemodynamics over a large number of patients in multislice computed tomography (MSCT).
Material and Methods

Study Population

Our institutional review board approved this retrospective study and waived the informed consent requirement. We reviewed 782 patient examinations retrospectively, with coronary computed tomography (CT) angiography being performed in our radiology department between May 2009 and July 2010. All patients in the study had chest pain and were referred from the cardiology department. The patients with coronary artery disease, stent implantation, bypass surgery, left ventricular hypertrophy, and hypertrophic cardiomyopathy were excluded from the study. Furthermore, the MBs that measured suboptimal during the systolic phase because of the reduced image quality were excluded. MBs were detected in 167 (21.35%) of the 782 patients. Only 159/167 (95.2%) patients whose MBs were detected on LAD were included in the study because MB most commonly affected LAD and the diagonal and marginal branches were considered to lead to faults in their measurements. In each patient the location, total length and depth of the MB were measured, and the diameter of each tunneled segment was obtained in both end-diastolic and end-systolic phases. The length and depth of the MB were analyzed and classified as superficial or deep with respect to the depth (≤ 1 or > 1 mm) of the tunneled segment. The images were processed on the workstation, and end-diastolic and end-systolic diameters of MB were automatically performed based on the proximal and distal LAD segments. The faults on the vessel calibration were corrected manually.

MSCT Scanning Protocol

All studies were performed on a 64-slice CT scanner (Phillips Medical Systems Eindhoven, Netherlands). A bolus injection of 80–120ml non-ionic contrast medium (iohexol (Omnipaque 350, GE Healthcare Cork, Ireland) or (iomeprol (Iomeron 400, Bracco, Milano, Italy))) was intravenously injected, followed by a bolus of 40–50 ml of normal saline. The region of interest was manually placed on the ascending aorta. After the injection, an automatic triggering technique was activated with a preset delay (usually 5–8 seconds) by the presence of a 150 Hounsfield Unit (HU) at the aortic root. If the resting heart rate was consistently above 70 bpm, the patient was prepared with beta blocker (5–20 mg, Beloc 5 mg/1 ml, AstraZeneca, Istanbul, Turkey) 2 hours before examination. If there was no contraindication just before scanning, 0.4 mg of nitroglycerin spray was used for coronary vasodilatation.

CT was performed with a multidetector scanner, with the following CT scan parameters (detector collimation, 64 x 0.625 mm, 120–140 kvP, 600–900 mAs; pitch range, 0.2–0.4; gantry rotation time, 0.4 seconds) being applied. The parameters of LightSpeed VCT were as follows: detector collimation, 64 x 0.625 mm, 120 kvP, 300–700 mAs; pitch range, 0.2–0.4; gantry rotation time, 0.35 seconds.

Image reconstruction

A retrospective ECG dating method was used for image reconstruction. Functional MSCT data sets were obtained in 20 cardiac phases (0–95%) in R-R intervals. Narrowest and widest volumes were found in the end-systolic and end-diastolic phases, with measurements being performed according to these phases.

The images were evaluated at the workstation (EBW; Philips Medical Systems or Card IQ Xpress Pro, GE Healthcare) and were analyzed using thin-slab maximum intensity projection (MIP) reconstruction, curved multiplanar reconstruction and volume rendering in addition to the axial images by two radiologists who were experienced in coronary CT angiography.

Treatment

We also evaluated the patients with a myocardial perfusion scan who have a myocardial bridge and severe coronary artery disease. Medical treatment was done according to the myocardial perfusion reports, and patients were taken to follow-up. The patients that have no response to medical therapy were evaluated with interventional coronary angiography.

Results

Data from a total of 782 patients were reviewed, with atherosclerotic risk factors of all patients being summarized in Table 1. 167 MBs were diagnosed in coronary arteries. The coronary arteries involved are presented in Table 2, with the clinical examples being shown in Figures 1A, B and Figure 2. In 159 MBs that were diagnosed in LAD, 103 of 159 (64.77%) were localized superficially and 56 of 159 (35.23%) were deep in myocardium. The middle segment of LAD...
was involved in 82 of 159 (51.57%) MBs, and the distal segment was involved in 77 of 159 (48.43%) MBs. The mean length of MB was 23.7 mm (range, 1.4–67.3 mm). There was no significant difference in the length between superficial and deep types of the MBs (p = 0.838). The mean thickness of the bridge in the deep type of MB was 3 mm (range, 1–6 mm). The correlations between the length and depth of the MBs were weak (r = 0.154) and in a negative direction statistically (p> 0.05). None of the MBs had a hemodynamically significant segmental narrowing during the systolic and diastolic phases. Although there was no statistically significant difference in the luminal narrowing during the end-systolic phase, there was a statistically significant difference in the luminal narrowing during the end-di-
astolic phase between the superficial and deep types of MBs (p = 0.045). The mean of the narrowest diameter in deep-type tunneled arteries was 1.91 mm in the end-diastolic phase and 1.94 mm in the end-systolic phase.

**Discussion**

The frequency of MB reported in angiographic studies varies from 0.5–16%; however, the frequency reported was 80% in the autopsy series [3]. Cay et al. revealed MB incidence of 1.22% among a Turkish population who underwent coronary angiography [4]. The reason for this low rate was unreported superficial MBs. Kantarcı et al. reported a 3.5% incidence of MB [5]. We found a higher incidence of MB (21.35%) in our study. MB could be shown on conventional angiography, intravascular ultrasonography and coronary CT angiography. The incidence of MB increased because of the widespread use of these techniques.

Although MB was generally considered a benign anomaly, myocardial infarction, ventricular tachycardia, syncope, and atioventricular block might be seen as a complication [6-9]. Ferreira et al. reported that the deep type of MB was associated with the ischemia and the sudden death [10]. Hostiuc et al. reported that the main cause of the sudden death due to the hemodynamically significant MB seemed to be electrical in association with the increased myocardial fibrosis and edema [11]. Achrafi reported that MB was detected with a high prevalence in patients with hypertrophic cardiomyopathy [12]. Ishikawa et al. showed that there was prominent narrowing in the lumen of the arterial segment proximal to the myocardial bridge, but there was no significant difference in the luminal narrowing ratio between the tunneled artery and the segment proximal to the MB [13].

The significant finding that was identified in our study was the luminal narrowing in the end-diastolic phase, where the coronary vascular bed filled up with blood. Ge et al. used intravascular ultrasonography and reported the persistent decrease in the MB diameter of LAD during early diastole, which is similar to and more like (41%) our study [14]. The persistent luminal diameter decrease was considered with the delay in diastolic relaxation. Schwarz et al. showed that the heart rate was increased due to the delay in the diastolic relaxation, and demonstrated luminal narrowing in the tunneled artery by using intravascular ultrasonography [15].

The reduction of the diameter of the lumen may not be correlated to the severity of symptoms. In fact, there is a modification of the flow in the coronary arteries in case of MB that does not depend on the severity of the bridging [16].

In our study the average length of the tunneled artery was measured at 23.7 mm, with this result being similar to the other studies in the literature [10], and we found that there was no relationship between MB depth and length. The correlation between the myocardial thickness overlying the bridge, especially in the deep type, and the length of the MB has not been reported in the literature yet.

Although atherosclerosis was rarely seen in the MB segment, it was commonly seen in the pre-MB segment. The localization of atherosclerotic plaques was not mentioned in our study and it is considered a limitation.

**Conclusion**

Comparison of luminal narrowing between the superficial and deep types of MB in two cardiac phases is important to show the coronary hemodynamics. As a result of our study, we detected a statistically significant difference of the luminal narrowing between the superficial and deep types of MB in the end-diastolic phase; however, there was not a considerable difference in the end-systolic phase (p<0.05).

**Conflict of interest statement**

We do not have any financial support or conflict of interest for this paper.

**References**


