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ORIGINAL RESEARCH

# CT-based Assessment of Myocardial Bridging in Patients with Acute Chest Pain and No Atherosclerotic Etiology

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## ABSTRACT

**Introduction:** The term "myocardial bridging" is used to describe an anatomic variant where a band of cardiac muscle overlies a segment of an epicardial coronary artery. It is a highly debated topic, because it can cause conditions such as acute coronary syndrome. Myocardial bridging (MB) can be diagnosed using invasive procedures, but also non-invasive ones, such as Multislice Computed Tomography Angiography (MSCTA). **Objectives:** A comparative analysis was performed on the patients who were admitted to the clinic with typical angina, ischemic ECG changes and muscular bridging shown on MSCTA, and patients with the same symptoms, but without MB. A sub-study was also undertaken in which the MB site and ischemia revealed by thickening of the myocardial muscle, using 3D Polar Mapping, were compared. **Materials and methods:** A retrospective study assessed 59 patients with typical angina pectoris, shortness of breath and clinical appearance of an acute coronary syndrome, and for whom MSCTA was carried out. Patients were divided into two groups: Group 1 — patients with MB, and Group 2 — patients without MB. Thirty patients in Group 1 had 3D polar mapping to evaluate the thickness of the myocardial muscle. **Results:** The mean age of our patients with muscular bridging was 55.51 ± 11.4 years, CI 51.57–59.45 years. Patients without MB had a mean age of 59.17 ± 9.6 years, CI 54.98–63.6 years, p = 0.211. 24.32% of the patients with MB were females and 60.86% from the patients without MB were males, p = 0.040. 40.54% of patients presented with MB in the first segment of the LAD and 15.62% had an MB in the second segment of LAD. In patients with an ischemic site smaller than 2 cm of the MB, the ischemic myocardial area was more pronounced compared to the patients with higher length MB (21.85 ± 6.123% vs. 17.62 ± 5.856%). **Conclusions:** MSCTA is an important procedure that contributes to the clinical investigations of patients with typical angina and suspected acute coronary syndrome. There is a good positive correlation between the location of the MB and the ischemic segments as shown on 3D CT-based polar maps.

**Keywords:** 3D polar mapping, myocardial bridging, angina pectoris

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## INTRODUCTION

Myocardial bridging (MB) is defined as a congenital coronary anomaly,[1] represented by a segment of a major epicardial coronary artery that proceeds intramurally through the myocardium, beneath the muscle bridge. MB can cause variable degrees of systolic compression. It was first described in 1737 by Reyman during an autopsy.[2] Portman and Iwing reported the first case of MB detected by tomography coronary angiography.[3] Because it is a "silent" condition which may be associated with severe ischemia caused by the systolic compression of the coronary artery, MB is a subject frequently debated in the literature. The prevalence of MB is still unknown, although from autopsy studies its reported as being present in 25–85% of the patients.[4] Diagnostic imaging methods such as angiography suggest that the incidence of MB ranges from 0.8% to 4.9%.[5] Non-invasive procedures tend to be more frequently used by clinicians in diagnosing the etiology of coronary artery disease, due to their high specificity. Moreover, many patients accept these procedures as they are not invasive and can be performed ambulatory.[6] Multislice Computed Tomography Angiography (MSCTA) is the primary non-invasive imaging technique used in clinical practice for the diagnosis of MB.

The present study aimed to compare the clinical characteristics of patients presenting with typical angina pectoris and unconfirmed suspicion of an acute coronary syndrome and MSCTA-revealed MB, with patients presenting in the emergency room with unconfirmed ACS and MSCTA-non-revealed MB.[7,8]

Our additional aim was to investigate the functional significance of MB as expressed by the patients' hemodynamics, using MSCTA-based 3D reconstructions of the left ventricular cavities.

## MATERIALS AND METHODS

Fifty-nine patients presenting at the emergency department from January 2015 – September 2015 for typical angina and an ECG diagnosis of myocardial ischemia who were subsequently referred for 64-Slice Computed Tomography Angiography were enrolled in the study. None of the patients underwent percutaneous coronary angioplasty at that visit, nor presented a history of coronary angioplasty. All patients were subjected to blood sampling and MSCTA. According to the radiological protocol for lowering the heart rate, Metoprolol was administered to maintain the heart rate at under sixty beats per minute. An intravenous line was inserted into the right antecubital vein for contrast administration.[9,10] Data from the patients' files were collected, and all the data were entered into an electronic database. Patients were divided into two groups: 36 patients with muscular bridging demonstrated by MSCTA (Group 1) and 23 patients without muscular bridging (Group 2). The following parameters were analyzed: Ca Scoring, serum biomarkers, demographic and clinical characteristics, MSCTA biomarkers.

The study has been carried out in accordance with the code of ethics of the World Medical Association's Declaration of Helsinki. All patients gave written informed consent, and the study protocol was approved by the ethics committee of the Cardio Med Medical Center, the center where the study was conducted.

### SUB-STUDY FOR CT ANALYSIS OF MB

In the CT analysis sub-study 30 patients with muscular bridging on whom MSCTA reconstructions of the ventricular cavities had been carried out, were enrolled. This non-invasive procedure consisted in the measurement of the thickness of the ventricular walls and the detection of thinned areas, which showed ischemia and contractility dysfunction. The left ventricle was divided into seventeen segments for regional analysis of left ventricular function or myocardial perfusion according to AHA (Figure 1).[9] The area with contractility dysfunction is shown

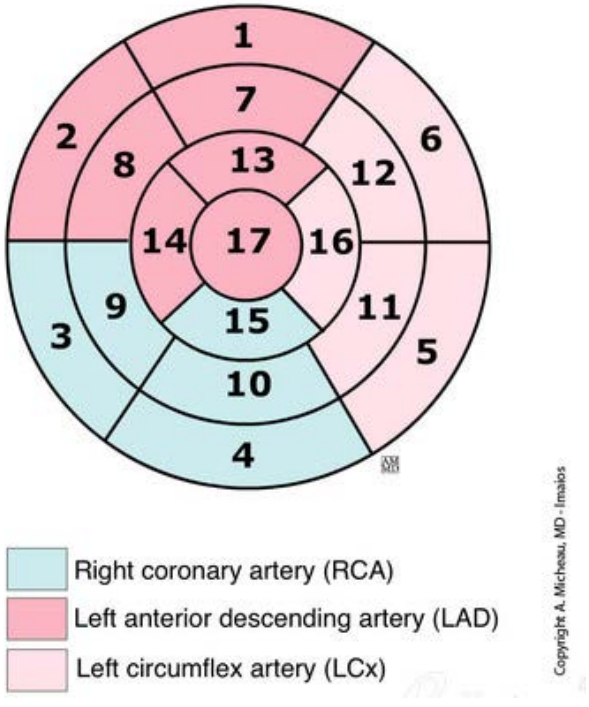


**FIGURE 1.** Left ventricle segmentation

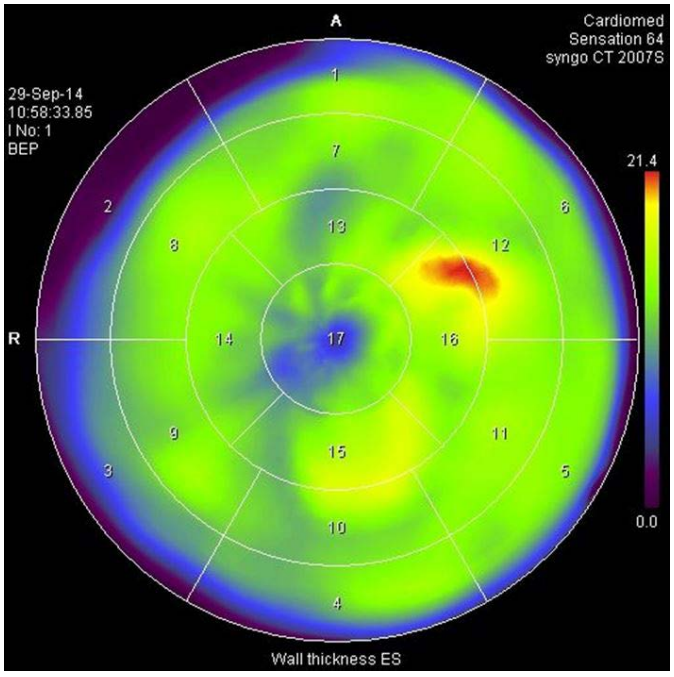


**FIGURE 2.** Polar map showing a thickening of the anterior wall colored in purple-blue

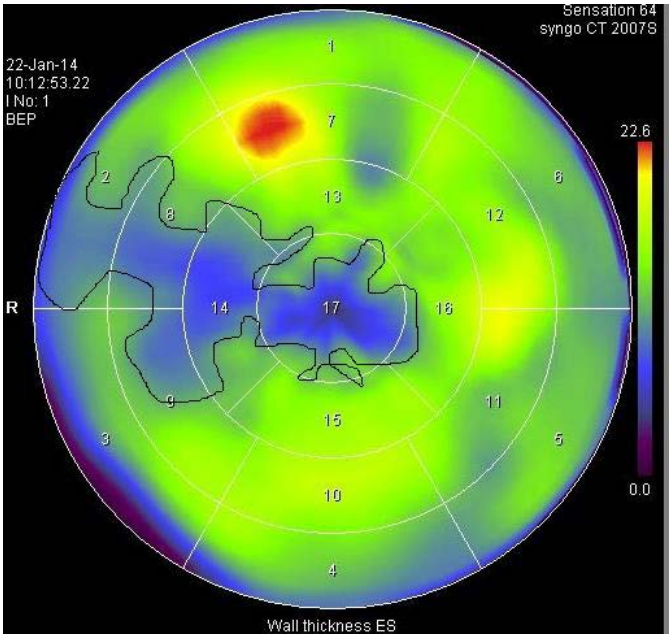


**FIGURE 3.** Polar map showing an ischemic zone marked with blue color

colored in a blue-purple spot on both the polar map and the 3D image of the ventricle (Figure 2). The thickness of the left ventricular wall was measured at end-systolic and end-diastolic phases, resulting in a polar map of the left ventricle showing all the segments colored according to their thickness or systolic thickening (Figures 3 and 4).


**FIGURE 4.** Myocardial thickening (blue spot on the left image) shown on polar map; 3D reconstruction of the left ventricle during systole (on the right)

## RESULTS

The mean age of patients with MB was 55.51 ± 11.4 years, CI 51.57–59.45 years; patients without MB had a mean age of 59.17 ± 9.6 years, CI 54.98–63.6 years.

24.32% of patients with MB were females, while 60.86% without MB were males (p = 0.04).

The mean diastolic blood pressure was significantly higher in patients with MB (78.72 ± 9.5 mmHg, CI 75.05–81.79) compared to patients without MB (72.08 ± 11.68 mmHg, CI 67.03–77.14), p = 0.029.

Patients with MB presented significantly lower levels of cholesterol and triglycerides as compared to patients with chest pain associated with other etiologies. The mean level of cholesterol was 152.11 ± 29.7 mg/dl (CI 129.28–174.94) in patients from Group 1, and 190.130 ± 33.99 mg/dl (CI 175.43–204.83) in patients from Group2 (p = 0.04). Also, patients in Group 1 presented a significantly higher mean triglycerides level of 94.3 ± 19.83 mg/dl compared to patients in Group 2 (127.34 ± 40.84 mg/dl, CI 109.69–145.01, p = 0.037).

Patients from Group 1 presented anterior ECG ischemic changes in 50% of the cases and 56.52% of the patients from the Group 2 had anterior ECG ischemic changes, OR: 1.3. (p = 0.8).

**TABLE 1.** Quantification of myocardial ischemia caused by MB

| Parameter | ADA n=29 | Non-ADA n=7 | p value |
|---|---|---|---|
| Decreased contraction amplitude (%) | | | 0.01 |
| Mean ± SD | 23.75 ± 11.140 | 11.83 ± 1.169 | |
| 95% confidence interval | 19.04–28.455 | 10.606–13.060 | |
| Length of MB (cm) | | | 0.8 |
| Mean ± SD | 2.447 ± 1.105 | 2.566 ± 0.383 | |
| 95% confidence interval | 1.980–2.914 | 2.165–2.969 | |
| Area of the myocardial ischemia (%) | | | 0.0006 |
| Mean ± SD | 18.625 ± 4.412 | 11.5 ± 1.049 | |
| 95% confidence interval | 16.762–20.488 | 10.399–12.601 | |
| The depth of MB (mm) | 6 | 2 | 0.05 |

### CT SUBSTUDY RESULTS

CT characteristics of the population enrolled in the substudy are presented in Table 1.

The mean length of the muscular bridging was 2.194 ± 0.914 cm.

40.54% of patients presented with MB in the first segment of the LAD and 15.62% had MB at the second segment of LAD. In patients with an MB length smaller than two cm, the ischemic myocardial area was more pronounced compared to the patients with an MB length greater than two cm (21.85 ± 6.123% vs. 17.62 ± 5.856%). In 70.45% of the cases, patients presented a surface MB, compared to 29.55% who had a deep MB.

Ca Scoring mean values were 90.63 ± 203.69 (CI 40.56–180.56), with no significant differences between the groups (Table 2).

## DISCUSSIONS

In this study, the presence of muscular bridging was much higher in male patients. Patients with MB had a lower level of cholesterol and triglycerides, compared with patients with no MB.[11] This is explained by the possible ischemic etiology of the chest pain in Group 2 patients, the association between coronary artery disease and high cholesterol levels being well-known. In both groups, patients had anterior ECG changes, but without any significant difference between the groups. A higher percentage of muscular bridging was found in the second segment of the left anterior descending artery (LAD) compared to other locations. This could be explained by the trajectory of the LAD, which is distributed to the ventricular anterior wall, the part of the heart with the highest content of muscular fibers. The lack of association between Calcium Scoring and MB could be due to the low number of patients enrolled in the study, and this correlation should be further investigated. MSCTA represents an important procedure that contributes to the clinical investigation of patients with typical angina and a suspected acute coronary syndrome.[12,13]

**TABLE 2.** Calcium Scoring values

| | MB group | Non-MB group | p value |
|---|---|---|---|
| Ca Scoring = 0 | 27% | 30% | 0.8 |
| Ca Scoring <100 | 56% | 53% | 0.9 |
| Ca Scoring 100–400 | 10% | 14% | 0.1 |
| Ca scoring >400 | 7% | 3% | 0.08 |

## CONCLUSIONS

There is a good positive correlation between the location of the MB and the ischemic segments showing on polar maps as thinned areas colored in blue, purple spots. Also, the 3D Polar Mapping procedure can be useful for identification of a correlation between the location of ischemic segments and the ECG location of ischemia.

## CONFLICT OF INTEREST

None declared.

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